Discussion Paper No. 02-07

Reassessing the Impact of High Performance Workplaces

Elke Wolf and Thomas Zwick

ZEW

Zentrum für Europäische Wirtschaftsforschung GmbH

Centre for European Economic Research

Discussion Paper No. 02-07

Reassessing the Impact of High Performance Workplaces

Elke Wolf and Thomas Zwick

Non-technical summary

Innovative personnel measures that increase involvement, qualification and motivation of (non-managerial) employees (so-called *high performance workplaces* or just HPW) were extolled as an efficient means to increase firm productivity. The theoretical literature further stresses the complementarities between these measures. In practice, it is however noticeable that some measures, such as profit sharing or employee share ownership have been adopted by a small minority of firms. Despite the supposed complementarities, only very few firms use the full set of measures or combinations of some measures. Some authors point to the fact that extensive organizational changes or incentive contracts may not necessarily provide the expected results, but may even impair employee satisfaction and hence firms' performance. Other reasons for the finding that the incidence of high performance workplaces is smaller than the theoretical literature suggests could be the high implementation costs, employee resistance against innovations and last but not least small and uncertain productivity effects.

The empirical evidence on the productivity effects of HPW is not clear either. While a couple of papers find significant and durable positive effects of HPW on productivity, several studies are rather sceptical about the productivity impacts. The differences between the results may be due to measurement problems, limited and deliberately chosen samples of firms, and the fact that most studies analyse different sets of personnel measures. We show that unobserved heterogeneity among firms and endogeneity of the management practices may affect the conclusions substantially. While unobserved heterogeneity is corrected for in several studies, the endogeneity problem is ignored in most analyses. The vast majority of the empirical studies on the productivity effects of HPW refers to Anglo-Saxon countries, whereas the evidence for Germany is very scarce.

The original contribution of our paper is that we simultaneously account for both unobserved heterogeneity and endogeneity using representative and very detailed establishment panel data for Germany from 1996 to 2000. We find that firms often introduce specific related bundles of individual HPW measures. One common set of measures includes the reduction of hierarchies and the introduction of team-work and independent work groups (denoted here as "organizational changes"). The other (somewhat less) popular bundle contains profit sharing, employee share ownership and incentive training as well as training to support the adoption of organizational changes (denoted as "incentives"). Note that these two bundles represent independent HPW measures. In order to assess the productivity impact of organizational changes and incentive systems, taking into account unobserved

heterogeneity and the endogeneity problem, we extend the 2-step panel procedure applied by Black and Lynch (2001) by instrumenting human resource innovations in the second step. We find that organizational measures have a positive significant impact on firm productivity while incentives have no influence. Another interesting result is that not taking unobserved heterogeneity into account leads to an underestimation of the productivity effects of organizational changes because especially firms with structural productivity problems introduce organizational changes. In contrast, not correcting for selectivity induces an overestimation of the productivity effects of incentives, because firms are more likely to offer incentives in times when they are doing well.

Reassessing the Impact of High Performance Workplaces

Elke Wolf and Thomas Zwick

E-mail: wolf@zew.de, zwick@zew.de

Centre for European Economic Research (ZEW)

July 2002

Abstract
High performance workplace practices were extolled as an efficient means to increase firm productivity. The empirical evidence is disputed, however. To assess the productivity effects of a broad variety of measures, we simultaneously account for both unobserved heterogeneity and endogeneity using establishment panel data for Germany. We show that increasing employee participation enhances firm productivity in Germany, whereas incentive systems do not foster productivity. Our results further indicate that firms with structural productivity problems tend to introduce organisational changes that increase employee participation whereas well performing firms are more likely to offer incentives.

JEL Codes: C23, D23, D24, M12

Key Words: high performance workplaces, microeconometric evaluation, firm productivity, panel regression**.**

Acknowledgements
We want to express our gratitude to the Institut für Arbeitsmarkt- und Berufsforschung (IAB), that enabled the access to the IAB establishment panel. We would also like to thank Irene Bertschek, Bernd Fitzenberger, Stephan Ganter, Thomas Hempell, Elisabeth Müller and Andreas Ziegler for useful comments.

1 Introduction

Innovative human resource practices are often praised as suitable and effective means to increase firm's productivity (Godard and Delaney, 2000; Ichniowski et al., 1997). The common denominator of most of the personnel measures currently discussed is the transition from production methods which are characterised by direct control with fixed pay – often denoted as Fordistic work practices – towards more participation, indirect control and more flexible, that is performance related pay. While only few studies analyse the driving forces behind the restructuring process (see e.g. Lindbeck and Snower, 2000), more research is done on the economic consequences of these organizational changes. However, it is still disputed which human resource measures or bundles of methods have indeed a positive effect on labour productivity or value added of the firm. Although many managers point to the productivity potential of innovative personnel management methods, such as employee participation, training as well as profit sharing or employee share ownership, several observers stress the difficulties and costs of implementing these measures and their disappointing productivity effects.

Up to now, empirical studies could not clearly solve the problem whether innovative personnel management methods are successful either. On the one hand, a couple of papers deduct a significant positive impact on productivity (see the surveys in Ichniowski et al., 1997 and Appelbaum et al., 2000). On the other hand, there are several studies that do not find any significant effects on productivity (see for example the survey in Godard and Delaney, 2000, p. 491). One possible reason for these contradicting results could be the broad variety of measures and their multiple combinations taken into account in different studies – the low productivity effects are frequently attributed to the fact that not all complementary measures have been adopted or that basic preconditions have not been fulfilled by the firms. Furthermore, the evaluation of innovative personnel management methods is plagued by measurement and estimation problems that pose high requirements on the data basis. This last point could be one reason why most empirical studies refer to the situation in Great Britain or the United States, while there are very few studies considering the German case.[1]

Apart from the limited empirical evidence for Germany, theoretical arguments support the necessity for studies referring to German firms, because human resource practices may display different effects in Anglo-Saxon countries and Germany. International comparisons frequently reveal that in Germany the relationship between employers and employees is traditionally based on trust. Furthermore, the German economy is characterised by high shares of qualified, flexible and indirectly

[1] The German literature on this topic is surveyed in Section 2

controlled jobs. Roth (1997) states that German employees are in general strongly committed to their employers and that they are motivated by the product of their work. Taking into account the large differences between industrial relations, the education and training system and the wage culture between the Anglo-Saxon economies and Germany, we cannot assume that innovative personnel methods have comparable productivity effects in both regions. A work atmosphere which is based on trust and co-operation could be beneficial to the implementation of a participative labour organisation. On the other hand, we should expect lower productivity effects from the introduction of innovative human resource management methods in German establishments than in traditional Fordistic establishments in the Anglo-Saxon countries, because on average changes in the labour organisation are smaller. For Germany, however, representative and comprehensive evidence on the productivity impact of (bundles of) innovative personnel measures is scarce. Therefore, the aim of this paper is to close this important gap in the literature by evaluating the productivity effects of organizational changes, training measures, and monetary incentives using representative establishment panel data.

It is not easy, though, to detect empirically if these selected personnel measures increase firm productivity, because firms may tend to introduce innovations depending on their economic situation. The OECD points to this problem as follows: "If firms only began to experiment with new forms of working practices when they faced dire trouble, the existence of practices might be associated with poorer performance, at least over the short-term. On the other hand, if flexible practices were introduced mainly into firms with more highly skilled workforces, there is the danger that higher performance may be attributed to the working practices rather than the higher skills" (OECD, 1999, p. 182). In this paper we show that indeed both factors, selectivity caused by temporary shocks (endogeneity) and unobserved structural differences (unobserved heterogeneity) have an impact on the estimated productivity effects. Thus, we conclude that studies which do not take both effects into account may be plagued by biases.

The paper is organized as follows. The next section presents a theoretical foundation of the expected productivity effects of the selected personnel measures. Section 3 summarises previous empirical results on the productivity effects of high performance work practices. Section 4 describes the estimation strategy that takes possible endogeneity biases into account. The fifth and the sixth part present the data basis (the IAB establishment panel) and a descriptive analysis of how many German firms have introduced selected personnel measures. Section 7 is dedicated to the estimation results of the production function and shows how endogeneity and unobserved heterogeneity bias the results. The last section concludes.

2 Theoretical considerations

Even if changes in the work organisation during the last decades are very diverse and difficult to summarise by a few key words, there is a wide agreement that employee involvement, training activities and incentive systems are the predominant changes (Appelbaum et al., 2000). Each of these categories includes a variety of innovative personnel measures. To enhance the participation of employees, for example, the firm may use team-work, reduce the number of hierarchical levels or delegate responsibility to financially autonomous production units. Financial incentives are often implemented in terms of performance-related wages like profit-sharing or employee share ownership. Training, however, is a very traditional measure to raise the skill level of employees and firm productivity. In the wake of reorganisations towards a more participative work design, training becomes especially important because employees have to cope with the new job requirements and skill demands. Furthermore, innovative personnel managers start using training as a part of an incentive plan. The productivity effect of each measure is not clear in advance and may change if measures are introduced separately or as part of a coherent bundle, the so-called *high-performance work organisations* (HPW), because there may exist complementarities between the single measures (see Holmstrom and Milgrom, 1994; MacDuffie, 1995; Ichniowski et al., 1996 or Lawler, Mohrmann and Ledford 1998).[2] In the following, we will therefore discuss the potential consequences of these human resource practices in more detail.

The main principle behind all initiatives to improve worker participation is to get lower level staff more involved in the decision and work process and grant them greater autonomy and control over job tasks and methods of work (Cappelli and Rogovsky, 1994). This increases the necessity of horizontal communication between front-line employees (Ichniowksi, Shaw and Prennushi, 1997). Both, higher communication and autonomy of non-managerial staff is supposed to be improved if the work organisation is characterized by (autonomous) teams and flat hierarchies (Appelbaum et al., 2000). But how may an increased employee involvement raise firm productivity? Firstly, this strategy takes advantage of the specific knowledge non-managerial employees have about their own work processes and combines the skills of a group of workers. Therefore higher participation increases the expertise used. Secondly, individuals are expected to have a higher identification with their enterprise and the decisions taken, feel more committed and do a better job (Ichniowski, Shaw and Prennushi, 1997; Godard and Delaney, 2000). Thirdly, employees participating at decisions can balance production more effectively to eliminate bottle-necks or interruptions of the production process (Appelbaum et al.,

[2] Other authors point to the synergies between re-organisation and the use of new information and communication technologies (Brynjolfsson and Hitt, 2000; Bresnahan et al. 1999; Askenazy, 1999). In this paper we will focus on organsational changes, though.

2000). Fourthly, reducing hierarchies may make some employees of the middle management redundant and a higher cost autonomy of groups may diminish waste, inventories, and inefficiencies (Appelbaum et al., 2000). Other observers argue, however, that organizational changes which are supposed to improve employees´ participation may also decrease participation. A change of tasks, responsibilities and work structures renders skills obsolete, increases work pressure and may deteriorate the position of some employees. In addition, organizational changes always induce adoption costs that have to be incurred before the pay-off can be observed (Milgrom and Roberts, 1995). If, for example, the returns to reorganisations are small or highly uncertain for the employees and in particular if the organizational change endangers their jobs, employees will hamper these changes (Zwick, 2002a).

Owing to these organizational changes, traditional Fordist control measures are put into question or rendered more costly, because individual effort cannot be measured easily any more (Kruse, 1993; Holmstrom and Milgrom, 1994; Milgrom and Roberts, 1995). Therefore, a coherent set of HPW measures should also contain indirect methods of control and financial incentives in order to bring the employees´ motives into line with the objectives of the management. One possibility is to offer employees a share of the rent or the value added in order to stimulate higher effort and participation in strategic decisions. We therefore deduct that the positive productivity effect of a participative work organisation may be enhanced by performance related pay schemes. A crucial proviso is that employees are affected by both measures, which means in particular that financial incentives are also provided for non-managerial employees who participate in decisions.

Whether financial incentives increase productivity irrespective of the degree of employee participation is also not clear, however. There are several theoretical approaches linking shared compensation schemes, such as profit sharing and employee share ownership as well as profit related pay, to firm performance (Conyon and Freeman, 2001). On the one hand, wages that are partly oriented towards the profit of the firm or payments in terms of firm shares give employees a material interest in improving the economic situation of the firm (Kruse, 1993). On the other hand, performance related pay schemes may support free rider behaviour, because each employee hopes that his or her colleagues work harder to increase the outcome and the remuneration of the team than he does himself or she does herself. Especially in larger firms the additional effort is likely to easily outweigh the additional revenues for co-operative employees. Therefore, incentives may only be productivity enhancing if they are supplemented by a corporate culture that emphasises company spirit, promotes group co-operation and encourages social enforcement mechanisms (Weitzman and Kruse, 1990). Also Appelbaum et al. (2000) point to the fact that performance related pay only makes sense if the concerned employees have considerable discretion on their effort and decisions. Furthermore, there is a large literature arguing that material incentives may crowd

out voluntary co-operation and intrinsic motivation and hence cause counterproductive effects (Eisenberger and Cameron, 1996; Deci et al., 1999, Frey and Jegen, 2000 or Fehr and Gächter, 2001).

Finally, training, for example in the basics of business administration, communication or seminars about the economic situation of the firm, increases the competence of the employees and their readiness to engage themselves in the firm (Ichniowski et al., 1996; Godard and Delaney, 2000). Especially in highly participative work organisations, continuous training seems to be a necessary complement to the increased demand for skills of non-managerial staff. We therefore expect that the productivity effect of measures to improve employee participation is higher if it is supported by a specific training program for the empowered employees. On the other hand, training is sometimes used as a sorting device or as a measure to increase motivation or incentives while productivity-based objectives play only a minor role. Therefore, it is important to differentiate between different types of training (Zwick, 2002b)

Considering the extensive and diverse list of potential consequences of high-performance work practices, it is not clear whether stronger employee participation, financial incentives or training have a positive impact on productivity. The theoretical considerations expounded above suggest, however, that there are complementarities between employee involvement, training activities and incentive systems, provided that they are implemented properly. Therefore, we expect that isolated organizational changes have a lower impact on productivity than a complete new orientation of personnel management (Osterman, 1994; Huselid, 1995; Ichniowski et al., 1996; Appelbaum et al., 2000).

3 Empirical Evidence

Apart from numerous case studies whose results are not fully applicable to other firms and sectors, there are – at least for the USA and Great Britain – several microeconometric studies over the productivity effects of HPW on the firm level. "A review of available studies suggests that there is a positive relationship between new work practices and firm level performance" (Arnal et al., 2001). In particular studies for the US find significant positive productivity effects of *high performance workplaces* (Huselid, 1995; Ichniowski et al., 1997; Godard, 1999, Cappelli and Neumark, 2000; Appelbaum et al., 2000; Black and Lynch, 2001). Addison et al. (2000) state that in the UK changes in employee involvement have larger effects among non-union establishments than for unionised firms and Caroli and van Reenen (1999) show that the effect of changes in work organisation is strongest in establishments with a high share of skilled labour. There is also some evidence that the success is not forthcoming immediately, because employers and employees need to learn how the new work practices are used effectively.

While most empirical studies derive positive productivity effects,[3] at least for some of the measures, little evidence supports the hypothesis that there are complementarities between the measures (Kruse, 1993; Huselid, 1995; Delaney and Huselid, 1996). Some studies even find, that the interaction terms of the measures in the production function estimation are negative (McNabb and Whitfield, 1999b) and thereby indicate that the combined effect is detrimental for productivity.

To our best knowledge, there is no comparable study for Germany on the (joint) productivity effects of HPW measures and their complementarities. However, some papers study the productivity effects of single HPW measures. Most of the studies concentrate on the productivity effects of profit sharing and employee share ownership (see for instance Hübler, 1995; Jirjahn, 1998; Heywood, Hübler and Jirjahn, 1998; Fitzroy and Kraft, 1992; Möller, 2000 and Wolf and Zwick, 2002), while Bellmann and Büchel (2001) and Zwick (2002b) estimate the productivity effects of training. The impact of measures enhancing employee involvement and the joint impact of HPW measures in German firms are not evaluated yet.

4 Methodological Remarks on the Empirical Analysis of Productivity Effects of Personnel Measures

Many empirical studies on the effect of personnel measures on firm productivity are of limited scope because a selective choice of firms, small sample sizes and item non-response renders the data non-representative (Godard and Delaney, 2000; Black and Lynch, 2001). The underlying data often contain information on just a few HPW measures. As a result, there are only very few studies on the complementary effects of coherent measures (Cappelli and Neumark, 2000, p. 12). In addition, the list of measures included changes from study to study and therefore the results are not easy to compare (Cappelli and Neumark, 2000; Appelbaum et al., 2000).

But even with representative firm data including detailed information on the implementation of HPW-measures, it is not straightforward to assess their productivity effects, because the estimation strategy seems to be crucial for the partly contradictory results. The empirical literature discusses several methodological problems, which are ignored in many empirical studies, though. This chapter focuses on the three main problems: multicollinearity of the measures, unobserved heterogeneity among firms and endogeneity of the measures (OECD, 1999; Dearden, Read and Van Reenen, 2000).

---

[3] Doucouliagos (1995) demonstrates in a meta-analysis on the relation between employee participation (in his case participation on decisions and profit sharing and employee share ownership) and firm productivity that these personnel measures have a positive impact on productivity.

As several measures are strongly correlated, it is not easy to attribute the productivity impact to single measures. McNabb and Whitfield (1999b) show, for instance, that the productivity effects of human resource practices depend on how many measures they take into account and the method with which measures are aggregated to bundles. (Imperfect) Multicollinearity between explanatory variables leads to large standard errors of the coefficients and consequently the impact of single HPW-measures can be measured only very imprecisely. Some studies therefore reduce the number of HPW-dimensions by factor analysis methods (Huselid, 1995; MacDuffie, 1995; Ichniowski, Shaw and Prennushi, 1997).

A further problem arises because the choice of certain HPW-measures is possibly endogeneous (OECD, 1999, p. 182). It seems plausible that a transitory external shock increases or decreases the productivity of the enterprise and has an impact on the introduction of HPW-measures at the same time. Dearden, Reed and Van Reenen (2000) and Zwick (2002b) show for example that firms introduce additional training measures when they face a temporary negative demand shock. In addition, Nickell, Nicolitsas and Patterson (2001) conclude that firms introduce organizational changes when they are in economic troubles. The introduction of HWP-measures is therefore no exogenous determinant in the production function (Griliches and Mairesse, 1995). Another source of endogeneity are the differences in the costs and benefits of the introduction of HPW-measures. We would expect that only those firms which expect high benefits or small costs will decide to implement these measures (Godard, 1999; Godard and Delaney, 2000). If the (generally unobserved) introduction costs and benefits are correlated with the productivity of the firm, the decision to introduce the measure is again endogeneous and the estimation biased. This argument becomes relevant if firms with a high level of organizational capital benefit more from changes in the work organisation[4], and are more productive than traditional managed firms.

Firms usually do not only differ with respect to the introduction of personnel measures but also with respect to (frequently) unobservable characteristics like management quality, the activity of the personnel department or industrial relations that do not change quickly over time (Huselid, 1995; Wolf and Zwick, 2002). Some authors argue that firms store and accumulate knowledge that affects their technology of production (Marshall, 1930; Atkeson and Kehoe, 2002). This often-called *organisation capital* is a type of unmeasured capital that is distinct from the concept of physical or human capital entering classical production functions (Prescott and Visscher, 1980). If these unobserved characteristics are correlated with the introduction of HPW-measures *and* with the productivity of the firm – which seems to be plausible here – the ordinary least squares method on the basis of cross-

[4] This may be the case because their workers and managers are used to organizational changes and adopt fast to the new requirements.

sectional data leads to inconsistent estimation results. The productivity effects of these relatively stable unobserved characteristics (the so-called *fixed effects*) can be controlled for example in a panel analysis.

While unobserved heterogeneity is controlled for in some panel studies on the productivity effects of HPW-measures (Black and Lynch, 2001), the endogeneity problem is, according to our best knowledge, ignored in most empirical analyses. In this paper, we show that both problems may have a decisive impact on the evaluation of HPW-measures, however.

Our estimation strategy and our data base allow us to solve the three estimation problems mentioned above all at once. In addition, we present for the first time panel estimations assessing the productivity effects of various HPW-measures using representative data on German establishments. Finally, we can illustrate the impact of unobserved heterogeneity and endogeneity on the estimation results.

5 The Data

To illustrate the significance of our contribution, it is important to describe the data of the IAB establishment panel, which we use for the following analysis, in more detail.[5] The establishments participating in this survey are selected from the parent sample of all German establishments employing at least one employee with social security. Thus, self-employed and establishments that employ only people not covered by social security (mineworkers, farmers, artists, journalists, etc.) as well as public employers with solely federal employees do not belong to the original sample. The random draw on this sample covers information for almost 14.000 German establishments in the year 2000, of which 5.500 are located in East Germany.

The establishments covered by the survey are asked about turnover, number of employees, personnel problems, apprenticeship training, investments, innovations and public subsidies since 1993 (in East Germany since 1996). From time to time, additional topics, such as training and personnel measures are added to the questionnaire. In 1998 and 2000, it was specifically asked, whether during the last two years responsibility and decisions were transferred to lower hierarchical levels, and team-work and/or independent work groups were introduced. In 1996, however, it was asked if these organizational changes have been introduced once. By combining these informations, we therefore know, if these measures are existing in the firms or not. Other questions focus on the existence of employee share ownership and profit sharing programs. Questions on the training activities belong to

[5] A precise description of this data set can be found in Bellmann (1997).

the standard set of questions. For the year 2000, additional information about the purpose of existing training programs is available. We selected the relevant training forms from the list: training for incentive reasons and training induced by organizational changes. Based on the answers to these questions, covering the main characteristics of *high performance workplaces* (Osterman, 1994; Ichniowski, Shaw and Prennushi, 1997; Appelbaum et al., 2000), we can draw a very detailed picture on the personnel measures introduced until 1999. As we do not know the date of the implementation of some of the HPW-measures, we base our evaluation on differences in performance between firms with and without these selected human resource practices.

For the purpose of this analysis, we include profit oriented establishments and establishments that have not been bought by other establishments or bought other establishments only.[6] The variables describing the existing HPW-measures refer to the year 1999. Our panel estimation includes the years 1996 – 1999. According to Black and Lynch (2001), a period of 4 years is still short enough to maintain the assumption underlying within-estimators that the unobserved work-place characteristics are more or less constant over this period. In 1999, we have 6397 firms in our gross sample while during the years 1996 – 1999, 15839 enterprises are covered in total.[7]

6 The incidence of HPW measures in Germany

The survey on the theoretical literature (see Section 2) indicates that there are many reasons for the supposition that German firms can yield a higher productivity level if they use innovative organizational measures such as team-work, flat hierarchies, employee share ownership and profit sharing as well as training.

The main diagonal of Table 1 provides an overview of the incidence of selected HPW measures in our representative sample for Germany. The most common measure is with 26% the delegation of responsibility and decisions to lower levels of hierarchy. The other two measures to enhance employee involvement (team-work and work groups with independent budget) have been introduced by more than 10% of the establishments. Training to support organizational change is offered by far less establishments than incentive training. Employee share ownership is offered by

---

[6] We sort the establishments into the following sectors: Agriculture and forestry, mining and basic materials, food, consumer goods, production goods, investment goods, construction, trade, traffic and communication, credit and insurance, hotels and restaurants, education, health and social affairs, electronic data processing and research and development as well as business consulting, other business services, and other personal services.

[7] The number of observations in the net sample is shown in the tables with the estimation results.

1.5% of the firms only, while profit sharing can be found by almost 8% of the German establishments.

Table. 1: Incidence of HPW measures in 1999 (in %)

		1	2	3	4	5	6	7
1	shift responsibility to lower level of hierarchy	26.0 (100)						
2	team-work and self-responsible teams	10.6 (74.3)	14.3 (100)					
3	work groups with independent budget	7.8 (66.7)	5.6 (48.0)	11.6 (100)				
4	employee share ownership	0.6 (42.7)	0.3 (20.1)	0.3 (19.3)	1.5 (100)			
5	profit sharing	3.2 (41.1)	1.6 (20.0)	1.7 (22.1)	0.7 (8.6)	7.8 (100)		
6	training to support organizational change	4.2 (55.3)	2.4 (31.3)	2.0 (26.3)	0.4 (5.2)	1.6 (20.3)	7.7 (100)	
7	training as incentive scheme	7.3 (52.5)	3.6 (25.7)	3.4 (24.4)	0.3 (2.4)	1.7 (12.3)	3.2 (23.0)	13.9 (100)
8	value added	0.27*	0.23*	0.24*	0.09*	0.17*	0.20*	0.19*

Notes: The figures present the percentage of firms applying a certain HWP measure (based on the whole population). The figures in brackets describe the percentage of firms that use a certain combination of HPW measures (based on the number of firms in the corresponding category).

Source: IAB Establishment Panel, Waves 1999 and 2000, own calculations.

The figures in the lower triangle of Table 1 describe the incidence of different combinations of the measures. That is, for example 7.8% of the establishments in our sample aimed at improving the participation of their employees by shifting responsibility to lower levels of hierarchy *and* by implementing work groups with independent budgets. When we only take the group of establishments that introduce work groups with independent budgets (i.e. set it as 100%) then 66.7% of these establishments introduce both measures. Team-work and self-responsible teams have been introduced by 48% of those establishments that have work groups with independent budgets. Among the firms that implemented team-work and self-responsible teams, a shift of responsibility to a lower level of hierarchy is also very widespread. Much smaller is the joint incidence of profit sharing and employee share ownership. Less than 1% of the German establishments share profits as well as give employee share ownership. Also the joint incidence of all combinations between the financial motivation measures and training or organizational changes are rather low. The percentage of firms which offer all selected HPW measures is tiny. These findings indicate that most German establishments select only a small

number of HPW measures. The EPOC study (Employee Direct Participation in Organizational Change), a survey on increasing employee participation by organizational changes in 10 states of the EU in 1996, comes to similar conclusions (OECD, 1999, p. 200).

Also Osterman (1994), Gittleman, Horrigan and Joyce (1998), Godard and Delaney, (2000) and OECD (1999, p. 200) cannot identify a dominant combination of HPW measures. This finding points to the supposition that there must be severe reasons to introduce only selected HPW measures, even if specific combinations and measures are regarded as *best practice*, at least in the theoretical literature (Godard and Delaney, 2000). It may be argued that the use of specific HPW measures differs fundamentally by industry or establishment size. Besides some combinations with team-work, even if we look at the incidence of measures by business sectors or establishment size groups, we cannot find single personnel measures or a bundle of measures which is offered by the majority of establishments.

There are a couple of reasons why enterprises are reluctant to introduce sweeping organizational changes. Godard (1999) argues that first a high level of trust, co-operation and identification of the employees has to be reached before a simultaneous introduction of several HPW measures is possible and successful. Job security and the support by unions and the work committees also play an important role for the successful implementation of organizational changes (Ichniowski, Shaw and Prennushi, 1997; Pil and MacDuffie, 1999; Zwick, 2002a). In contrast to firms in other countries, these preconditions are likely to be fulfilled in a high share of German enterprises (Roth, 1997). Another reason is that managers may be hostile against organizational innovations fostering employee involvement, because they generally loose control and are urged to share their knowledge and power among workers of lower hierarchies (OECD, 1999). In addition, organizational changes are often encountered by employee resistance in Germany (Zwick, 2002a). This especially happens when the mutual trust between employees and managers is low or the management can not convince the employees that those benefit from the changes. Another reason for retarding and jeopardising organizational changes are employment uncertainty and skill obsolescence of skills (Godard and Delaney, 2000; Zwick, 2002a). Many enterprises may be deterred by high implementation or follow-up costs and introduce the cheap measures first. Furthermore, the success of organizational innovations may depend on key players within the enterprise and on the circumstances within the firm (Bailey, 1993). Finally, German firms traditionally use participative work organisations without calling them team-work or flat hierarchies. When these firms would formally introduce for example team-work this would incur substantial costs, the expected productivity effects would be small, however (Roth, 1997; Godard and Delaney, 2000).

In accordance with the theoretical expectations, there is a positive correlation between the value added and the presence of HPW measures (see the last row in Table 1). This correlation may not be interpreted causally, because the enterprises with and without HPW measures clearly differ for example with respect to size, capital intensity and qualification of the employees. If personnel measures still have an impact on value added after controlling for the main input factors and other relevant determinants is investigated in the next section.

7 Empirical Analysis of the Productivity Effects of HPW-Measures

The productivity effects of HPW measures are determined by estimating Cobb-Douglas production functions (see also Black and Lynch, 2001). The dependent variable denotes the economic value added (turn over minus input costs) and the explanatory variables include capital, the number of employees, selected personnel measures and other control variables. In order to take into account the methodological problems described in Section 4 and to demonstrate their impact on the estimation results, we specify six different models.

7.1 Survey on the estimation models

The first model describes a cross-section regression of a simple Cobb-Douglas production function, where capital stock, labour input, variables describing the existing human resource practices of the establishment and selected control variables are regressed on value added. The strong coherence among the dummy-variables indicating the existence of the personnel measures (see Table 1) is accounted for by aggregating the observed HPW-practices to two independent factors. These two factors can be described intuitively by "organizational changes" and "incentives".[8] To illustrate the sensitivity of the estimation results, we define Model 2 as a very parsimonious specification of the model. Apart from the two bundles of personnel measures, we include only capital and labour as well as dummy variables for East Germany and business sectors in the estimation equation. Model 3 contains the same control variables as Model 1 and additionally an interaction term between both bundles of HPW measures. This specification allows us to examine the complementarity of organizational changes and incentive schemes. The purpose of Model 4 is to analyse the complementarities between all observed human resource

[8] We apply a main component factor analysis to reduce the seven HPW measures to two independent factors with eigen values above 1 (see also Osterman, 1994). The resulting factors "organizational changes" and "incentives" explain 43% of the total variance. The factor loadings and the assignment of the HPW-indicators to the independent factors are shown in Table A2 in the Appendix.

practices. Therefore, we include the seven single HPW measures and selected interaction terms in the estimation of the production function. The endogeneity of the HPW measures is tackled by instrumenting the two bundles of personnel measures. Model 1a to 3a are similar to the cross-section estimates in Model 1 to 3, but use exogenous instruments for organizational changes and incentives within the establishment.

In order to avoid biased estimates caused by unobserved fixed effects, Model 5 and 6 make use of the panel structure of the data. The first step of the estimation procedure applied in Model 5 and 5a is a fixed effects panel estimation, which regresses value added on the time-variant input factors capital and labour. In order to increase the efficiency of the within-estimation, we use the difference estimator proposed by Griliches and Hausman (1986) in Models 6 and 6a. In the second estimation step, the establishment specific fixed effects are explained by the bundles of HPW measures and the other (quasi) time invariant control variables. While Model 5 and 6 are based on observed HPW-factors, we instrument these variables in Model 5a and 6a analogously to the cross-section models. The following section presents the estimation results and interpretations of the alternative model specifications.

7.2 Productivity estimations in a cross-section analysis

First, we estimate the productivity effects of the factors "organizational changes" and "incentives" in a Cobb-Douglas production function for 1999:

$$(1) \qquad \ln Y = \alpha \ln K + \beta \ln L + \gamma_1 F_1 + \gamma_2 F_2 + \delta X + \varepsilon,$$

Equation (1) describes the production function where Y is value added, K is capital which is approximated by replacement investments (Möller, 2000; Bellmann and Büchel, 2001), L is the weighted number of employees, F_1 is the factor "organizational changes", F_2 denotes the factor "incentives", and X represents the vector of control variables. The parameters α, β, γ, and δ are the regression coefficients to be estimated and ε is the normally distributed error term with expected value zero and variance σ^2.

In addition to the inputs capital and labour, further firm characteristics are added as explanatory variables, because we expect that a high share of qualified employees, investments in information and communication technology as well as a modern technical equipment increase the productivity of the establishment (see for example Black and Lynch, 2001). In addition, exporters and co-determined firms usually exhibit a significantly higher productivity (Jirjahn, 1998). East German establishments may still have lower productivity and differences between the

business sectors are captured by 16 dummy variables. A definition of the control variables as well as their average values can be found in Table A1 in the Appendix.

The first column of Table A3 shows the regression results of Model 1. The establishments in our sample produce with constant scale elasticities (the sum of labour and capital productivity does not significantly differ from one) and with a capital intensity of around 0.15.[9] The low and insignificant coefficient of the factor organizational changes surprises considering the theoretical considerations in Section 2. Incentives seem to increase the productivity of the establishments, however. This result is in accordance with Hübler (1995) and Möller (2000). Therefore the output of an establishment is the higher the more incentives in terms of training or employee share ownership or profit sharing are offered. The control variables all have the expected positive effects on the productivity of the enterprises. The productivity gap between East and West Germany is still persistent and the productivity differentials between sectors are jointly significant. The results of Model 2 show that the additional control variables in Model 1 increase the explanatory power of the regression, but do not have an impact on the qualitative productivity effects of HPW measures (see Table A3 in the Appendix).

The complementarities between single HPW measures are widely ignored in the empirical literature (Cappelli and Neumark, 2000). Therefore, we focus on this aspect in Model 3 and 4. In addition to the independent bundles of personnel measures, Model 3 contains an interaction term between both bundles. In contrast to our theoretical considerations – though in accordance with comparable estimations (McNabb and Whitfield, 1999b) – the interaction term is significantly negative. This means that establishments that offer incentives to their employees can not further increase productivity by additionally introducing organizational changes. On the contrary, our results suggest that the combination of both bundles of measures even decreases productivity significantly. This sobering result may be a consequence of the fact that in most German enterprises incentive systems cover only managers, while participative organisations affect mainly non-managerial employees. High profit sharing bonuses or generous employee share ownership schemes for the top level employees may even impair the motivation of the empowered lower level staff. This hypothesis can not be studied on the basis of our data, however.

In an alternative estimation, we study the productivity effects of single personnel management measures and their complementarities (Model 4). In accordance with our theoretical hypotheses, most of the single measures have a positive impact on establishment productivity. Team-work has a significantly negative impact,

---

[9] The low capital coefficient may be a consequence of the approximation of capital by replacement investments. In comparable estimations the capital coefficient has a similar size (Möller, 2000).

however, while financially independent subgroups and training as an incentive do not have any significant impact. Contrary to our theoretical intuition, we only find a small number of complementarities between the single measures. Only the interaction between delegation of responsibility and team-work is significantly positive. Other interaction terms like employee share ownership and profit sharing, delegation of responsibility and training induced by organisation measures as well as training induced by organisation measures and training as incentive device are even significantly negative. This may be a consequence of a bad synchronisation or implementation of single measures. For example, if most employees work in teams but the remuneration is oriented at individual effort or profit of the firm, the productivity impact of this organizational change is expected to be rather limited (Becker and Huselid, 1998). Another explanation may be that too many changes are implemented during a relatively short period of time, such that employees reject the adoption of new arrangements because they may incur a high uncertainty for them (Zwick, 2002a).

7.3 Endogeneity of HPW measures

The explorative regressions in the last section can give only first indications on possible productivity effects of HPW measures, because possibly important unobserved establishment characteristics and endogeneity of the personnel measures are not taken into account. In a next step, we show on the basis of instrumental variable regressions that the results presented in the previous estimations are biased because the choice of HPW measures is endogeneous (Models 1a-3a).

Most data sets do not provide suitable additional variables that meet the requirements for qualifying them as identifying variables in an instrument regression. In the case of panel data, lagged values or differences of the explaining variable in question are often used as instruments.[10] The IAB establishment panel contains further indications on the style of the personnel policy and on expected personnel problems which may serve as identifying regressors. Finally, we identify five suitable exclusion restrictions: expected difficulties to find adequate skilled employees on the labour market[11] and four different strategies of the personnel department to avoid skill gaps.[12] Each of these variables is correlated with the

10 This strategy is however problematic when the instruments are only weakly correlated with the endogeneous variables (Dearden, Reed and Van Reenen, 2000).

11 The dummy variable has value one when the establishment expects problems to find suitable skilled employees on the labour market. It is based on the question "Which personnel problems do you expect in the following two years?".

12 The possible strategies of the personnel department to avoid skill gaps are based on the question "And how did your establishment react on vacancies for skilled jobs?". Possible answers are (1)

introduction of HPW measures because they depict the activity and the expected problems of the personnel department. On the other hand, the identifying variables turn out to be uncorrelated with establishment productivity.

The instrument equations for both HPW factors F_1 and F_2 can be described as follows:[13]

$$(2) \qquad F_i = \alpha_{1i} I_1 + ... + \alpha_{5i} I_5 + \delta_i X + \varepsilon_i \quad \text{with} \quad i = 1, 2,$$

where $I_1 - I_5$ are the identifying variables and X is the vector of control variables from equation (1). Equation (2) is now estimated simultaneously with the production function (1) using the maximum likelihood procedure. This implies that the endogenous factors, i.e. the factors F_1 and F_2 that are correlated with the error term in equation (1) are replaced by the instrumented factors estimated in equation (2), $\hat{F}_1$ and $\hat{F}_2$. These factors are correlated with the original factors but independent from ε in equation (1) and therefore exogenous.

The results of the instrumental equation can be found in Table A5. If an establishment reacts on vacancies for skilled employees by internal job rotation, a shift of orders to other parts of the establishment or co-operations with other establishments, it indicates that the personnel department reacts in a rather flexible way on personnel problems. Establishments that just increase the amount of overtime work when they face a skill gap are less prone to introduce organizational changes. The positive correlation between the introduction of the HPW measures and active strategies of the enterprise to encounter skilled vacancies is therefore not surprising. We also find that establishments tend to re-organize when they expect problems with skilled vacancies. Analogous to other studies larger establishments are more likely to use HPW measures (OECD, 1999). In addition, firms with investments in information and communication technology and modern technical equipment also tend to introduce HPW measures more often (compare also Osterman, 1994). East German enterprises apply significantly less HPW measures, however. In contrast to Osterman (1999) and OECD (1999), our results point to the fact that enterprises that face international competition do not differ significantly from those that only serve local markets. The results for organizational changes and incentives differ only slightly.

---

internal job change, (2) request overtime work, (3) shift jobs to other divisions of the establishment, (4) implement co-operations between establishments.

13 See also the determinants for the introduction of HPW measures in Osterman (1994), McNabb and Whitfield (1999a) and OECD (1999, p. 190).

Table A4 shows the estimation results of the production function of Model 1a to 3a with the instrumented HPW measures. The coefficients of the input factors capital and labour and the additional control variables are almost unchanged in comparison to the estimation results of Model 1 to 3. The estimated impacts of the HPW measures change, however. The incentive schemes lose their significantly positive impact on firm productivity while the coefficients of organizational changes are still not significantly different from zero. Also the interaction term between organizational changes and incentives does not significantly differ from zero now (see Model 3a).

This result implies that the positive productivity effects of incentive systems found in the simple OLS model are a consequence of the fact that firms introduce these measures particularly when they are successful and enjoy a high productivity level (see also Jirjahn, 1998 and Wolf and Zwick, 2002). This conclusion seems plausible when we take into account that employee share ownership and profit sharing can only motivate employees if there is something to distribute, i.e. if the firm has a good profit situation. We can deduce that the choice of the personnel measures is selective. In this case here, mainly competitive establishments offer employee share ownership and profit sharing or specific training measures.

The exact opposite can be stated for the combination of both bundles of HPW measures. The interaction term which was negative without controlling for selectivity now turns insignificantly different from zero. Also Kruse (1993), who controls for selectivity effects of profit sharing, does not find complementarities between profit sharing and other personnel measures, such as autonomous work-teams, employee involvement or job enrichment. In contrast, we can conclude that firms offering incentive systems in addition to organizational changes seem to face clear productivity gaps. This finding is in accordance with the results in Nickell, Nicolitsas and Patterson (2001) who show that establishments change their organizational structure thoroughly when they are in economic troubles.

Following Heckman (1997) or Imbens and Angrist (1994), it may be argued that the estimated effects of the instrumented HPW measures should be interpreted as local-average-treatment-effect, that is, the IV-estimator identifies the average effect induced by variation of the instrument. Hence, the estimated parameters depend on the instruments. Whether the effect of organizational changes or incentive systems yield heterogeneous returns can be tested using the control function approach. The estimation results indicate, however, that the corresponding parameters are not endogenous random coefficients. Thus, the IV-estimator is appropriate and can be interpreted as an average treatment effect.[14]

---

[14] Estimation results are available upon request.

7.4 Unobserved Heterogeneity

Finally, we study the impact of time invariant unobserved heterogeneity on our estimation results (Models 5 and 6). If unobserved characteristics of the establishment, such as management quality or industrial relations, are correlated with both the incidence of HPW measures and productivity, cross-section estimates will be inconsistent. On the basis of panel data, the coefficients of the production function and the impact of unobserved characteristics can be estimated consistently with a fixed effects estimation. A disadvantage of this approach is that the impact of observed (almost) time invariant factors, such as the industry sector, the existence of employee co-determination as well as other variables in the production function, can not be identified, because measurement errors may explain a large part of their variance (Ichniowski, Shaw and Prennushi, 1997; Dearden, Reed and Van Reenen, 2000). This feature proves to be a crucial hindrance in our case, because we only know if an establishment has ever introduced the measures we want to analyse until 1999. Therefore we do not know the exact implementation date and we do not know, if the measure probably has been abandoned again in the meanwhile and our variables of interest do not change over time.

We therefore use the two step estimation procedure suggested by Black and Lynch (2001). In this model, the parameters of the time-variant input factors are determined by a simple Cobb-Douglas production function on the basis of panel data from 1996 to 1999, while the effects of the (almost) time invariant determinants are regressed on the fixed effects from the panel analysis in the second step. Therefore the fixed effects estimation in the first step can be written as:

$$(3) \qquad \ln Y_t = \alpha \ln K_t + \beta \ln L_t + \upsilon + \varepsilon_t \quad \text{mit} \quad t = 1996 - 1999,$$

where υ is the unobserved time invariant establishment specific fixed effect and ε_t the idiosyncratic component of the error term. The estimation results of the first estimation step can be found in table A6 (Model 5). Striking is the low coefficient of the input capital that has a similar size to that in the comparable estimation in Black and Lynch (2001), however. If input and output are chosen simultaneously or if there are measurement errors for the input factors (especially for capital), the within estimator will be inconsistent and we may observe too low capital intensities in the production function (Griliches and Hausman, 1986; Griliches and Mairesse, 1995).[15] Another reason for the strikingly low capital coefficient may be that firm's choices on whether to liquidate or to continue their business generate a selection problem

[15] A remedy for these estimation problems seems possible by using a GMM system estimator (Dearden, Reed and Van Reenen, 2000; Black and Lynch, 2001). The impact of HPW measures on productivity does not change, however, when this estimator is used instead of the fixed effects estimation (Black and Lynch, 2001).

when estimating production functions. Olley and Pakes (1996) illustrate that estimation algorithms that do not accommodate this choice generate a negative bias in the capital coefficient.

In order to increase the efficiency of the panel estimation, our sixth model applies the difference estimator proposed by Griliches and Hausman (1986). This approach does not only use the simple differences between two subsequent years, but also two– and three–years–differences are included in the panel OLS regression of value added (Model 6). The estimation results of the Cobb-Douglas production function are almost identical to those of the fixed effect panel estimator (see Table A6).

On the basis of these first step regression results, we calculate the fixed effect υ for every establishment. The fixed effect can be interpreted as the average establishment specific difference from productivity predicted on the basis of the inputs. This time invariant variable therefore indicates whether establishment productivity was below or above the average of the other firms during the observation period. It serves as dependent variable for the second estimation step. The vector of explanatory variables in the second step contains all (almost) time invariant establishment characteristics from Model 1, that is both bundles of HPW measures and all variables in *X:*

$$(4) \qquad \upsilon = \gamma_1 F_1 + \gamma_2 F_2 + \delta X + \varepsilon.$$

The estimation results are shown in Table A7. Organizational changes as well as incentives have a significant positive impact on the establishment specific fixed effects (Model 5). In comparison to the results of the first model, taking into account unobserved heterogeneity increases the positive impact of organizational changes on firm productivity. This suggests that enterprises which induce organizational changes have unobserved time invariant characteristics that decrease their productivity. Firms with structural productivity problems therefore try to improve their situation by changing their organizational structure. If one ignores the impact of these unobserved fixed effects the measured productivity effect of organizational changes is too low. Also the significance of the impact of incentives increases. The significance and relative impact of the other variables on productivity are roughly the same in Model 1 and 5.[16]

Final statements on the effects of high performance workplace organisations can only be made, however, if we control for both unobserved fixed effects and endogeneity. Therefore, in a next step the HPW measures F_1 and F_2 in estimation (4) are instrumented using equation (2), see Model 5a and 6a in Table A7. Analogous to

[16] An exception is the dummy variable for firms with co-determination that now takes very high values.

Model 1a, controlling for endogeneity reduces the measured productivity increase of incentives and their significance. The coefficient of this HPW factor does not significantly differ from zero in Models 5a and 6a. In contrast to the results in Model 1a the coefficient of organizational changes is now significantly positive (in Model 5a only on a significance level of 8 %). The coefficients of the other explaining variables are more or less the same. This result proves again that taking account of selection effects can be decisive for the evaluation of the productivity effects of personnel measures. When we control for the fact that many firms that restructure their internal organisation are in a precarious productivity position, the assessment of these organizational measures is clearly more positive. We also find that the interaction effect between incentives and organizational changes stays insignificant when we control for both, endogeneity of HPW measures and unobserved heterogeneity.[17]

7.5 Summary of the Estimation Results

In this section, we summarise the estimated productivity effects of HPW-bundles in the models presented in this paper (see Table 2).

Table. 2: Summary of estimation results

Models	1	2	3	1a	2a	3a	5	5a	6	6a
Organizational changes	0	0	0	0	0	0	+	(+)	+	+
Incentives	+	+	+	0	0	0	+	0	+	0
Interaction term: Org. changes*incentives			–			0				

Notes: "0" corresponds to coefficients that do not differ from zero at a significance level of 5%; "+" denotes significant positive coefficient and "–" indicates a significant negative impact. Signs in brackets are only significant at the 10% level.

Simple cross-section analyses suggest that organizational changes exhibit no productivity effects, while incentives seem to have a positive impact on establishment productivity (Models 1 and 2). The combination of both bundles reduces the estimated productivity gains obtained by the use of shared compensation schemes and incentives by training (Model 3). Once we take into account that firms are more likely to introduce these incentive schemes when they are doing better compared to their competitors, no significantly positive productivity effects can be measured any more, however (Models 1a and 2a). Also the seemingly negative interaction effects between the two bundles of HPW measures vanish if we apply an instrumental-variable estimation (Model 3a). Finally, controlling for unobserved heterogeneity in a panel estimation points to the fact that mainly establishments with

[17] Estimation results are available upon request.

a structural productivity problem make use of organizational changes fostering employee involvement. Therefore, we demonstrate that the evaluation of HPW measures leads to exactly the opposite conclusions after controlling for both, endogeneity and unobserved heterogeneity: While incentive systems are productivity neutral, organizational changes fostering employee involvement effectively increase the productivity of the establishment (Model 5a and 6a).

8 Conclusions

Despite the ongoing development of new management strategies and the increasing importance of comprehensive human resource management practices in times when labour is praised as the most important input factor, the empirical evidence on the productivity effects of so-called high performance measures is poor, especially in Germany. The management literature promises highly productive, motivated, and committed employees, provided they receive incentive compensation, are well trained and involved in the decision process and the work organisation. The slogans change so quickly, however, that one cannot help thinking that all these innovations are not much good and quickly lose their fascination.

The OECD (1999) points to the fact that it is not straightforward to decide whether innovative work practices tend to produce higher firm performance or not. For the one thing, firm data with extensive information about the workplace organisation and its innovation – in ideal circumstances matched employer-employee data – are required. For another thing, methodological difficulties, caused by the endogeneity of the decision to introduce organizational changes and unobserved firm characteristics have to be tackled. In this paper, we therefore assess the productivity effects of selected personnel measures, based on a representative establishment panel of German firms.

We show that HPW measures have a positive impact on establishment productivity in Germany. Especially organizational changes fostering employee involvement – often denoted as "participatory" work practices – have a significantly positive impact on productivity. Therefore, the costs and efforts to overcome internal resistance against team-work, introduction of independent work groups or the reduction of hierarchies seem to have a positive return. Also noticeable is the result that especially firms exhibiting a structural productivity gap use these measures to make their production process more efficient.

Shared compensation schemes in terms of profit sharing or employee share ownership as well as training opportunities as incentive schemes do not increase productivity, if we take into account that mainly firms which are doing well offer these measures. In addition, firms offering both – more participation and incentive schemes – can not realise an additional productivity push. Considering these

sobering results, it does not come as a surprise that financial incentives and training in order to motivate the employees are offered by a small share of German establishments only. But also the other high performance work practices investigated here and combinations of them are not established as “best practice” yet. Summing up, we conclude that innovative human resource practices which enhance the participation of employees may increase firm performance, but they are far from being praised as a panacea.

9 Appendix

Table A1: Descriptive statistics of variables

Variables	Average	Notes
Value added (lnY)	14.62	Turnover minus inputs, in DM, logs
Capital (ln K)	11.59	Proxy: Investments - expansion investments, in DM, logs
Labour (ln L)	3.44	Nominal labour volume: weekly labour hours * weighted number of employees (part time employees are multiplied by 0.5), logs
Shift responsibilities	0.33	Responsibilities and decisions have been shifted to lower employee levels, yes = 1/no=0
Team-work	0.22	Team-work and/or responsible work groups have been introduced, yes=1/no=0
Independent work groups	0.20	Work groups with own cost or result accounting have been introduced, yes=1/no=0
Employee share ownership	0.04	Employee share ownership is offered, yes=1/no=0
Profit sharing	0.13	Profit sharing is offered, yes=1/no=0
Training to support organizational changes	0.19	Training is offered because new organizational structures require this, yes=1/no=0
Incentive Training	0.19	Training is offered in order to motivate employees, yes=1/no=0
Share of qualified employees	0.66	Share of employees with a professional degree on all employees
Investment in IT	0.79	Investment in information and communication technology, yes = 1/no = 0
State of technical equipment	2.06	Technical state of equipment, 1 = completely obsolete, 5 = state of the art
Apprenticeship training	0.46	Establishment offers apprenticeship training, yes = 1/no = 0
Collective wage agreement	0.79	Establishment is bound or orients itself on sector or establishment specific collective wages, yes = 1/no = 0
Exporter	0.25	Establishment exports, yes = 1/no = 0
East Germany	0.60	Head quarter of the establishment is in East Germany, yes = 1/no = 0
Co-determination	0.32	The establishment is co-determinated, yes=1/no=0
Individual firm	0.26	The establishment is an individual firm, yes=1/no=0
Partnership	0.11	The establishment is a partnership, yes=1/no=0
Publicly listed firm	0.04	The establishment is publicly listed, yes=1/no=0

Note: The averages are derived from the cross section sample 1999.
Source: IAB establishment panel 1999 and 2000.

Table A2: Rotated[a] component matrix of factor analysis: Personnel measures

Factor	Factor value	Variables	Factor loadings[b]	
Organizational changes	2.15	Shift responsibilities	0.77	(0.04)
		Team-work	0.77	(-0.04)
		Independent work groups	0.71	(-0.02)
Incentives	1.21	Employee share ownership	0.63	(-0.13)
		Profit sharing	0.70	(-0.06)
		Training to support organizational changes	0.55	(0.21)
		Incentive training	0.63	(0.07)

Notes: [a] The factors have been rotated by promax.

[b] In brackets you find the factor loading of the factor not chosen.

Source: IAB establishment panel, wave 1999, own calculations.

Table. A3: Production function without selection correction (cross section)

	Model 1		Model 2		Model 3		Model 4	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Constant	10.212	68.24	9.919	82.01	10.227	69.95	10.151	69.39
Capital	.147	11.73	.160	12.66	.147	11.76	.149	11.93
Labour	.814	39.93	.901	50.51	.817	40.49	.821	40.63
Qualified empl. (%)	.356	5.03			.354	5.01	.348	4.94
Exporter.	.179	3.71			.176	3.65	.169	3.51
Investment IT	.108	2.47			.104	2.39	.098	2.25
Co-determination	.165	3.36			.165	3.36	.148	3.02
State of technical equipment.	-.074	-3.39			-.074	-3.36	-.075	-3.45
East Germany	-.357	-9.57	-.307	-8.52	-.361	-9.74	-.365	-9.78
Individual firm	-.296	-6.29			-.287	-6.07	-.278	-5.92
Partnership	-.076	-1.38			-.073	-1.33	-.072	-1.32
Publicly listed firm	-.099	-1.07			-.081	-.86	-.076	-.80
Org. changes	.012	.74	.017	1.05	.022	1.27		
Incentives	.065	4.25	.079	5.02	.076	4.46		
O. changes.* Incent.					-.015	-1.44		
single HPW measures								
Shift Responsibilities							.102	2.10
Team-work							-.169	-2.55
Indep. work groups							.008	.17
Employee share ownership							.320	2.68
Profit sharing							.181	3.37
Training to support org. changes							.247	3.72
Incentive Training							.037	.71
IA1							.193	2.21
IA2							-.290	-1.61
IA3							-.213	-2.40
IA4							-.184	-1.93
16 sector dummies	Yes		Yes		Yes		Yes	
# Obs.	2033		2037		2033		2033	
corr. R^2	.87		.86		.87		.87	

Notes: The interaction terms IA1 to IA4 are defined as follows. IA1 = Delegation of responsibility to lower hierarchical levels * Team-work; IA2 = employee share ownership * profit sharing; IA3 = Delegation of responsibility * Training induced by organizational changes; IA4 = Training induced by organizational changes * Training as incentive.

Tab. A4: Production function with selection correction (cross section)

	Model 1a		Model 2a		Model 3a	
	Coef.	z	Coef.	z	Coef.	z
Constant	10.231	64.74	9.939	72.41	10.112	49.30
Capital	.147	11.58	.159	12.01	.158	9.15
Labour	.815	21.72	.891	23. 21	.844	17.25
Qualified employees (%)	.365	4.87			.307	3.14
Exporter	.181	3.63			.159	2.65
Investment IT	.113	2.07			.064	.86
Co-determination	.173	3.32			.112	1.45
State of technical equipment.	-.077	-3.15			-.062	-2.03
East Germany	-.359	-7.52	-.300	-6.48	-.405	-6.13
Individual firm	-.300	-5.82			-.149	-1.11
Partnership	-.070	-1.17			-.022	-.28
Publicly listed firm	-.075	-.55			.340	.93
Organisational changes	.058	.26	.031	.15	.203	.73
Incentives	.003	.01	.102	.48	.191	.65
Org. changes*Incentives					-.291	-1.26
16 Sector dummies	Yes		Yes		Yes	
# Obs.	2033		2037		2033	
corr. R^2	.87		.86		.82	
F-test	(27, 2005) 490.87		(19, 2017) 660.50		(28, 2004) 357.15	

Notes: Both HPW bundles "Organizational changes" and „Incentives" are instrumented. Estimation results of the instrumental equations for model 1a can be found in Table A5. The analogous results for models 2a and 3a are almost identical and available from the authors by request.

Table A5: Instrumental equations

	Model 1a				Model 5a			
	Org. changes		Incentives		Org. changes		Incentives	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Constant	-.939	-5.86	-.745	-4.41	-.098	-1.05	-.277	-3.07
Capital	.027	1.86	.034	2.21				
Labour	.220	9.72	.152	6.36				
Qualified Employees (%)	.032	0.39	.174	1.99	.191	2.62	.095	1.35
Exporter	.076	1.33	.082	1.36	.134	2.39	.225	4.14
IT Investments	.283	5.40	.286	5.18	.257	6.43	.426	11.03
Co-determination	-.007	-0.13	.096	1.55	.086	1.61	.153	2.95
State of techn. equipment					-.059	-2.49	-.076	-3.34
East Germany	-.150	-3.41	-.189	-4.07	-.191	-4.86	-.116	-3.05
Individual firm	.008	0.14	-.026	-0.44	-.075	-1.48	-.106	-2.17
Partnership	-.074	-1.13	-.012	-0.18	-.071	-1.18	-.042	-0.72
Publicly listed firm	.372	3.84	.925	9.07	.326	3.14	.703	7.01
Firm size 20-199					.309	6.30	.099	2.10
Firm size 200-499					.706	8.25	.276	3.35
Firm size 500-999					1.015	8.15	.218	1.81
Firm size 1000+					1.383	11.10	.915	7.60
Collective wage agreement	.101	1.95	.047	0.85	.119	2.61	.088	1.99
Internal job changes	.340	3.54	.248	2.45	.384	4.10	.347	3.84
Overtime work	-.221	-2.89	.075	.93	-.179	-2.32	.084	1.13
Shift jobs	.596	3.21	.432	2.21	.502	2.81	.488	2.83
Co-operations between establishments	.487	2.69	.431	2.26	.434	2.43	.615	3.57
Expected skill gaps	.132	2.97	0.125	2.66	.149	3.69	.130	3.34
16 Sectors	Yes		Yes		Yes		Yes	
# Obs.	2808		2808		3326		3326	
corr. R^2	0.24		0.23		0.23		0.23	
F-test	(30, 2777) 30.58		(30, 2777) 28.33		(33, 3292) 31.73		(33, 3292) 31.07	

Table A6: Fixed effects production function

	Model 5		Model 6	
	Coef.	z	Coef.	z
Capital	.026	3.13	.024	3.59
Labour	.473	9.70	.471	11.81
Year dummy 1997	-.016	-0.86		
Year dummy 1998	-.023	-1.19		
Year dummy 1999	.010	0.48		
Difference 1996/1997			-.025	-1.23
Difference 1997/1998			-.020	-0.99
Difference 1998/1999			.038	2.02
Difference 1996/1998			-0.002	-0.08
Difference 1997/1999			0.040	1.72
Difference 1996/1999			.016	0.65
# Obs.	6927		4575	
Corr. R^2	.86		.03	

Table A7: Fixed effects estimation, second step

	Model 5		Model 5a		Model 6		Model 6a	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Constant	-.636	-9.37	-.680	-7.72	13.916	147.45	13.844	100.92
Qualified employees (%)	.632	11.23	.575	8.07	.928	11.87	.790	7.13
Exporter	.246	5.65	.245	4.32	.341	5.62	.307	3.48
Investment IT	.091	2.89	.089	1.43	.157	3.57	.096	0.99
Co-determination	.441	10.66	.439	8.81	.894	15.56	.871	11.24
State of techn. equipment	-.116	-6.38	-.111	-5.00	-.149	-5.89	-.128	-3.70
East Germany	-.410	-13.65	-.360	-8.09	-.437	-10.45	-.309	-4.47
Individual firm	-.474	-12.11	-.470	-10.25	-.841	-15.46	-.818	-11.48
Partnership	-.084	-1.81	-.067	-1.25	-.131	-2.02	-.090	-1.09
Publicly listed firm	.178	2.21	.217	1.69	.279	2.49	.280	1.40
Firm size 20-199	.727	19.16	.624	8.47	2.277	43.17	2.041	17.80
Firm size 200-499	1.386	20.87	1.172	8.11	4.223	45.74	3.725	16.57
Firm size 500-999	1.606	16.53	1.255	5.25	5.078	37.58	4.295	11.54
Firm size 1000+	2.176	22.11	1.839	8.38	6.575	48.05	5.728	16.78
Org. Changes	.034	2.49	.414	1.69	.101	5.40	.912	2.39
Incentives	.073	5.21	-.152	-0.68	.101	5.19	-.255	-0.73
16 Sector dummies	Yes		Yes		Yes		Yes	
# Obs.	3326		3326		3326		3326	
corr. R^2	.66		.57		.85		.76	
F-test	(29, 3296) 224.94		(29, 3296) 174.50		(29, 3296) 645.44		(29, 3296) 400.85	

Notes: In Model 5 and 6 both HPW measures are taken directly, in Model 5a and 6a, they are instrumented. The estimation results of instrumental equation for model 5a can be found in Table A4. The analogous results for Model 6a are almost identical and available from the authors by request.

10 Literature

Appelbaum, E., T. Bailey, P. Berg and A. Kalleberg. (2000): *Manufacturing Advantage – Why High-Performance Work Systems Pay off*, ILR Press, Ithaca.

Addison, J., W. Siebert, J. Wagner and X. Wie (2000): Worker Participation and Firm Performance: Evidence From Germany and Britain, *British Journal of Industrial Relations* Vol. 83(1), 7 – 48.

Arnal, E., W. Ok, and R. Torres (2001): *Knowledge, Work Organisation and Economic Growth, Labour Market and Social Policy*, Occasional Papers No. 50, Organisation for Economic Co-operation and Developement, Paris.

Askenazy, P. (1999): *Technological and Organzational Innovations, Internationalization and Inequalities*, PhD dissertation, Paris.

Atkeson, A. and P. J. Kehoe (2002): *Measuring Organisation Capital*, NBER working paper No. 8722.

Bailey, T. (1993): *Discretionary Effort and the Organisation of Work: Employee Participation and Work Reform Since Hawthrone*, Teachers College, Columbia University, mimeo.

Becker, B. E. and M. Huselid (1998): High Performance Work Systems and Firm Performance: A Synthesis of Research and Managerial Implications, *Research in Personnel and Human Resource Management* Vol. 16, 53-101 JAI Press, CT.

Bellmann, L. (1997): Das Betriebspanel des IAB. Sonderheft das Allgemeinen Statistischen Archivs, Heft 30, in: Hujer,R., U. Rendtel and G. Wagner (eds.), *Wirtschafts- und Sozialwissenschaftliche Panel-Studien*, Göttingen, 169-182.

Bellmann, L. and F. Büchel (2001): Betrieblich finanzierte Weiterbildung und Unternehmenserfolg, in: Backes-Gellner, U. and P. Moog (eds.), *Bildungssystem und betriebliche Beschäftigungsstrategien*, Duncker-Humblot, Berlin.

Boning, B., C. Ichniowski and K. Shaw (2001): *Opportunity Counts: Teams and the Effectiveness of Productivity Incentives*, NBER working paper No. 8306.

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

Bresnahan, T. F., E. Brynjolfsson and L. M. Hitt (1999): *Information Technology, Workplace Organization, and the Demand of Skilled Labor: Firm-Level Evidence*, NBER working paper No. 7136.

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

Cappelli, P. and N. Rogovsky (1994): New Work Systems and Skill Requirements, *International Labour Review* No.2, 205-220.

Cappelli, P. and D. Neumark (2000): *Do „High Performance" Work Practices Improve Establishment-Level Outcomes?* mimeo.

Caroli, E. and J. Van Reenen (1999): Skill Biased Organizational Change?: Evidence From a Panel of British and French Establishments, *The Quarterly Journal of Economics* Vol. 116 (4), 1449-1492.

Conyon, M. J. and R.B. Freeman (2001): *Shared Modes of Compansation and Firm Performance: UK Evidence*, NBER working paper No. 8448.

Dearden, L., H. Reed and J. Van Reenen (2000): *Who Gains When Workers Train? Training and Corporate Prodcutivity in a Panel of British Industries*, IFS Working Paper 00/01, London.

Deci, E., R. Koestner and R. Ryan (1999): A Meta-Analystic Review of Experiments Examining the Effects of Extrinsic Rewards on Intrinsic Motivation, *Psychological Bulletin* 125(6), 627 – 668.

Delaney, J. and M. Huselid. (1996): The Impact of Human Resource Management Practices on Perceptions of Performance in For-Profit and Nonprofit Organizations, *Academy of Management Journal* Vol. 39, 949 – 969.

Doucouliagos, C. (1995): Worker Participation and Productivity in Labor-Managed and Participatory Capitalist Firms: A Meta-Analysis, *Industrial and Labor Relations Review* Vol. 49 (1), 58 – 77.

Eisenberger R. and J. Cameron (1996): Detrimental Effects of Reward. Reality or Myth, *American Psychologist* Vol. 51, 1153 – 1166.

Fehr, E. and Gächter (2001): *Do Incentive Contracts Crowd out Voluntary Cooperation?*, Discussion paper series 3017, Centre for Economic Policy Research, London.

Frey, B. S. and R. Jegen (2000*): Motivation Crowding-Out: A Survey of Empirical Evidence*, Working Paper No. 49, Institute of Empirical Research in Economics, University of Zürich.

Fitzroy, F. and K. Kraft (1992): Forms of Profit Sharing and Firm Performance. Theoretical Foundations and Empirical Problems, *Kyklos* Vol. 45, 209 - 225.

Gittleman, M., M. W. Horrigan and M. Joyce (1998): Flexible Workplace Practices: Evidence From a Nationally Representative Survey, *Industrial and Labor Relations Review* Vol. 52 (1), 99 - 115.

Griliches, Z. and J. Hausman (1986): Errors in Variables in Panel Data, *Journal of Econometrics* Vol. 31, 93 - 118.

Griliches, Z. and J. Mairesse (1995): *Production Functions: The Search for Identification*, NBER working paper No. 5067.

Godard, J. (1999): *When do Workplace Reforms Really Work? An Exploration of Why Reform Program Effectiveness Varies*, mimeo, University of Manitoba.

Godard, J. and J. Delaney (2000): Reflections on the „High Performance" Paradigm's Implications for Industrial Relations as a Field, *Industrial and Labor Relations Review* Vol. 53, 482 - 502.

Heywood, J., O. Hübler and U. Jirjahn (1998): Variable Payment Schemes and Industrial Relations: Evidence from Germany, *Kyklos* Vol. 51, 237 - 257.

Holmstrom, B. and P. Milgrom (1994): The Firm as an Incentive System, *American Economic Review* Vol. 84 (4), 972 - 991.

Hübler, O. (1995): Produktivitätssteigerung durch Mitarbeiterbeteiligung in Partnerschaftsunternehmen? *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung* Vol. 28, 214 - 223.

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

Ichniowski, C., T. Kochan, D. Levine, C. Olson and G. Strauss (1996): What Works at Work: Overview and Assessment, *Industrial Relations* Vol. 35, 356 - 374.

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

Imbens, G. W., J. Angrist (1994): Identification and estimation of Local Average Treatment Effects, *Econometrica* Vol. 62, 467 – 476.

Jirjahn, U. (1998): *Effizienzwirkungen von Erfolgsbeteiligung und Partizipation – eine mikroökonomische Analyse*, Campus: Frankfurt.

Kruse, D. (1993): *Profit Sharing: Does it Make a Difference?*, Upjohn Institute: Kalamazoo.

Levine, D. J. (1995): *Reinventing the Workplace: How Business and Employees Can Both Win*, Brookings Institutions, Washington, D.C.

Lawler, E., S. Mohrmann and Ledford, G. (1998): *Strategies for High Performance Organizations*, Jossey-Bass, San Francisco.

Lloyd, C. (2000): *High Involvement Work Systems: The Only Options for UK High Skill Sectors?*, SKOPE Research Paper 11, University of Warwick.

Macduffie, J. (1995): Human Resource Bundles and Manufacturing Performance: Organizational Logic and Flexible Production Systems in the World Auto Industry, *Industrial and Labor Relations Review* Vol. 48, 197 – 221.

Marshall, A. (1930): *Principles of Economics; An Introductory Volume*, Macmillan.

McNabb, R. and K. Whitfield (1999a): The Distribution of Employee Participation Schemes at the Workplace, *International Journal of Human Resource Management* Vol. 10, 122 - 136.

McNabb, R. and K. Whitfield (1999b): *High Performance Work Systems: Disentangling the Bundles*, mimeo, Cardiff Business School, Cardiff.

Milgrom, P. and J. Roberts (1995): Complementarities and fit: Strategy, Structur and Organizational Change in Manufacturing, *Journal of Accounting and Economics* Vol. 19, 179 - 208.

Möller, I. (2000): Produktivitätswirkung von Mitarbeiterbeteiligung, *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung* Vol. 32, 565 - 582.

Nickell, S., D. Nicolitsas and M. Patterson (2001): Does Doing Badly Encourage Management Innovation?, *Oxford Bulletin of Economics and Statistics* Vol. 63, 5-28.

OECD (1999): New Enterprise Work Practices and Their Labour Market Implications, in: *Employment Outlook*, 177 - 221.

Olley, G.S. and A. Pakes (1996): The Dynamics of Productivity in the Telecommunications Equiupment Industry, *Econometrica* Vol. 64, 1263 - 1297.

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

Pil, F. and J. MacDuffie (1999): Organizational and Environmental Factors Influencing the Use and Diffusion of High-Involvment Work Practices, in: Cappelli, P. (edt.): *Employment Practices: Understanding Differences in Employment Practices*, Oxford University Press, Oxford.

Prescott, E. C. and M. Visscher (1980): Organisation Capital, *Journal of Political Economy* Vol. 88, 446-61.

Roth, S. (1997): Germany: Labor's Perspective on Lean Production, in: Kochan, T. and , R. Lansbury and J. MacDuffie (edts.), *After Lean Production*, ILR Press, Ithaca, 117 - 136.

Weitzman, M. and D. Kruse (1990): Profit Sharing and Productivity, in: Blinder, A. (ed.), *Paying for Productivity: A Look at the Evidence*, Brookings Institution, Washington D.C.

Wolf, E. and T. Zwick (2002): Produktivitätswirkung von Mitarbeiterbeteiligung: Der Einfluß von unbeobachteter Heterogenität, *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung*, Vol. 35, pp. 123-132.

Zwick, T. (2002a): Empirische Determinanten des Widerstandes von Mitarbeitern gegen Innovationen, *Zeitschrift für betriebswirtschaftliche Forschung*, forthcoming.

Zwick, T. (2002b): *Training and Firm Productivity – Panel Evidence for Germany*, SKOPE Discussion Paper No. 23 , Oxford.