The *From–Tayloristic–to–Holistic–Organization* *Model* From an Empirical Perspective

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Abstract

The objective of the paper is to confront the conclusions in the seminal papers of Lindbeck & Snower (2001, 2000, 1996) and Snower (1998) with the empirical evidence in the manufacturing sector, thus testing the *from–Tayloristic–to–holistic-organization* model. Starting from stylized facts as growing incidence of so called high performance/high involvement work systems, the major theoretical findings on determinants and effects of complementary systems of work organization are recapitulated.

The derived hypotheses to be tested are: The coexistence of two distinct types of work organization can be shown. According to their characteristics, these types describe a rank order with respect to the existence of sophisticated instruments of human resource management policy. Due to the complementarity property, we observe increasing productivity effects of team production, thus being larger in holistic firms.

Empirical evidence reveals that still 43% of firms have a Tayloristic work organization. Holistic firms are more productive. Marginal returns from reorganization towards multiple tasks (team work) prove to be negative in Tayloristic firms and to be positive in holistic firms. Although only borderline significant, these results can be interpreted as an indication for the complementarity hypotheses stipulated by Lindbeck & Snower.

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1 Introduction and Summary

The paper contributes to the research of work organization and increasing effects of reorganization. Thus, complementarities between incentive instruments or elements of human resource management strategies are analyzed. The objective of the paper is to confront the seminal theoretical contribution of Lindbeck & Snower (2001, 2000, 1996) with empirical evidence, thus testing the theoretically appealing model, which we denote as the *from–Tayloristic–to–holistic-organization* model.

The reorganization topic is of great interest, both in labor economics (industrial relations, micro founded discussion) and in personnel economics (human resource management, new institutional economics). Starting from stylized facts in the manufacturing sector, the determinants and effects of complementary systems of work organization are discussed. The stylized facts under consideration are, growing incidence of so called high involvement/high performance work systems in the manufacturing sector accompanied by increased use of flexible production technologies, which emphasize versatility of physical capital and of human capital. To sum up, new types of firms emerge or evolve.

Large part of the related literature is empirically oriented and derives plausibility hypotheses, which are then investigated on a descriptive or econometric basis (for an overview: Capelli (1997), Ichniowski, Kochan, Levine, Olson & Strauss (1996), for specific issues: Bertschek & Kaiser (2001), Carstensen (2001b), Freeman, Kleiner & Ostroff (2000), Carstensen & Brand (1999), Ichniowski, Shaw & Prennushi (1997), Pil

& MacDuffie (1996)). Such hypotheses state (i) which firms introduce which work systems or human resource management (hrm) systems, respectively, and (ii) which effects on productivity etc. are expected owing to the introduction of modern forms of work organization. Modern work organizations try — among other things — to dilute the traditional conflict of interest between employers (or management) and employees (or front–line workers) and to avoid use of threatening incentives or close supervision.[1] They also rely on ongoing further training and adaptability.

By a work organization we mean a well–defined catalogue of personnel instruments as for, example, number of tasks and time variability of task assignment, employee involvement in decision–making, information channels and information access for shop floor employees, group or individual based bonus systems and fringe benefits, feedback systems with purchasers and customers (innovation and grievance management), and patterns of geographical mobility of labor input. Correspondingly, we use the terms work organization and hrm system interchangeably.

Respective theoretical contributions are, for example, Lindbeck & Snower (2001, 2000, 1996), Carstensen (2001a), Holmstrøm (1999), Baker, Gibbons & Murphy (1994), Holmstrøm & Milgrom (1994). To conclude, the role of mutually reinforcing instruments is emphasized and diverging equilibria of work organizations are analyzed from a comparative static perspective. As in Lindbeck & Snower (2000) at least two (polar)

1 For an associated integrated theoretical and empirical approach see Bewley (1999). For a discussion on the difficulty to write appropriate explicit contracts, even with low degrees of environmental complexity see MacLeod & Parent (1999).

forms of work organization can be derived. Each firm can be regarded as an organizational equilibrium. Which equilibrium is realized, depends on the current environment, i. e. on the valid constraint set.

The latter will be our starting point: The following paper confronts the conclusions in Lindbeck & Snower, especially Lindbeck & Snower (2000) (hereafter LS00), with the empirical evidence. Their major hypotheses, which have been drawn in a marginal analytic framework, will be investigated econometrically. In detail, we prove the complementarity argument, thereby controlling for self selection of firms in a treatment effects approach.

2 The Idea: Complementary Systems of Work Organization

The research is based on the idea that the existence of complementarities between variables (for example personnel policy instruments or tasks) supports the enactment of well–defined systems (for example hr systems or work organizations). Technically spoken, in analyzing diverging equilibria of work organization we are devoted to analyze idiosyncratic, i. e. firm specific, equilibria. But due to complementarities only a few distinctive equilibrium forms of work organizations exist.

The chain of arguments is as follows: Each firm is characterized by its realized work organization. Accordingly, the work organization (hrm system) is linked to the firm specific equilibrium. Thus, a view onto the aggregate of companies should reveal several characteristic work organizations and, correspondingly, multiple equilibria. The number

of different equilibria, however, should be rather small, since complementarities are effective and personnel related instruments mutually reinforce. Lindbeck & Snower (2000) and Snower (1998), for example, concentrate on the polar case *Tayloristic organization* versus *holistic organization*. Other authors discuss high involvement and high performance work practises in comparison to traditional work practices (cf. Baily (2001), Pil & MacDuffie (1996), Doeringer, Evans-Klock & Terkla (1998)).

Coexistence of several equilibria is the first point in the discussion of characteristic work organizations. Reorganization towards higher ranked equilibria is another: Whenever complementarities do exist, it has to be expected that reorganization will be implemented as a discrete system change from one well–defined system to another, also well–defined, system. The change is driven by simultaneous augmentation of complementary instruments, i. e. is equivalent to a system upgrade. The upgrade hypothesis is based on the complementarity hypothesis. Complementarities can take several forms like (i) flexible manufacturing systems and technological task complementarities, and/or (ii) learning spillovers and informal task complementarities, and/or (iii) intelligent data bases and communication technology based complementarities, respectively.

Reorganization in the sense of equilibrium upgrading is typically initiated by changes in the firms environment or, technically spoken, in characteristic changes in the constraint set. Due to the fact that a simultaneous variation of the respective variables is optimal, given the existence of mutually reinforcing effects and changes in the constraint set, system upgrading takes place if two additional requisites are met: First, simultane-

ous variation must be feasible, such that augmentation of any instrument A must not prevent augmentation of any other instrument B (for example legally forced). This issue is of topological interest (cf. Topkis (1998)).

Second, simultaneous variation is required to be optimal, i. e. it should be the solution to the firms decision problem. Correspondingly, the optimization problem at hand shows monotone comparative statics. Given the objective function is twice continuously differentiable (C^2 property), complementarities and monotone comparative statics are proven using the matrix of cross–partials, where it does not matter, whether the variables of interest are decision variables or parameter values (Sydsæter, Stroem & Berg (2000)). $\binom{k}{2}$ positive cross–partials are identical to a system of k complementary (hr) instruments. In practice, a system upgrade occurs, if the companies environment (formalized by the parameter constraints) trespasses certain thresholds. Under such circumstances, it is optimal to adjust the current decision variables in the same direction, for example, to introduce profit sharing and employee involvement in daily decision making simultaneously.[2]

In the context of hr systems or well–defined work organizations, the system argument emerges in various forms: On the one hand, complementary instruments reinforce each other, which means that the marginal effect of a specific instrument is larger at a higher level of the alternative instruments. In other words, productivity enhancing effects of, for example, team production rise with the level of other complementary instruments and,

2 A prominent example of a function with monotone comparative statics is the well–known Cobb–Douglas production function with complementary inputs capital and labor.

further, with the actual position of the firm in an so called *overall system ranking*. A conceivable perception is that a specific mixture of instruments (hr bundle) with fixed input ratios is optimal due to competing tasks within the workers hours budget. Depending on prevailing parameter values of the general framework, including imperfect observability of worker effort, fluctuations in product demand, economies of scope etc. the following constellation is expected: One equilibrium will be characterized by a) narrow task definitions, b) low intensity of group based pecuniary and non–pecuniary incentives, c) minor worker participation in decision–making, d) low investment in further training programs and negligible incentives for helping colleagues. In contrast, the other, higher ranked, equilibrium is expected to be characterized by a hr system, which shows high intensity of the mentioned instruments (cf. Holmstrøm & Milgrom (1994)).

On the other hand, the complementary system argument is related to complementarities between different tasks in the array of work systems. Technological complementarities as well as informal complementarities are possible explanations. If technological complementarities are prevalent or learning spillovers exist between tasks, then it is optimal to let respective workers not concentrate on just one task, but to rely on multi tasking, where the (monthly) working time devoted to all tasks is limited by the number of contracted standard hours.

This latter perspective is taken by Lindbeck & Snower (2000) in a two task world with two types of workers, which can be distinguished by their (oppositely distributed) comparative advantage in performing tasks. As the objective of this contribution is to

investigate the theoretical results of LS00 empirically, the next section presents the upshot of their Ricardo–type model (cf. Gandolfo (1994)). The corresponding hypotheses are derived in section 4. Section 5 gives a brief description of the data, which are used in the empirical part of the paper. Accordingly, subsection 6.1 identifies the postulated types or work organization and in subsection 6.2 the quantitative empirical analysis of increasing productivity effects follows. Section 7 concludes with suggestions for further further research.

3 The Lindbeck–Snower–Model reconsidered

At the beginning of this section we will restate the four basic conditions of the *from–Tayloristic–to–holistic-organization* model and summarize in brief the model assumptions. Subsequently, the solution of the optimization problem is reconsidered, important characteristics of the second order conditions are elucidated, and corresponding comparative static results are discussed.

LS00 base their argumentation on the following four common factors, which act as background factors that affect major parts of the manufacturing sector:

- Availability of flexible production systems, i. e. versatility of physical capital.
- Availability and cost characteristics of electronic information and communication technologies/systems.
- Disposability of multiskilled employees, global rise of skill standards, i. e. level and versatility of human capital.

- Altered worker attitude towards versatile work and task variety, i. e. preferences for multi tasking.

In short, as complementarity analysis is analysis of second order conditions and these four factors are crucial for the (process of) reorganization as their change initiates the switch–over from Tayloristic organization to holistic organization, given profit maximization. The profit maximizing work organization switches from Tayloristic to holistic,[3] if the corresponding elements in the matrix of cross–partials fall below zero, given an interior solution of the Ricardo-type model exists. Negative cross–partials are ceteris paribus more likely the higher the versatility of physical and human capital, the lower the costs of communication, and the stronger worker preferences for versatile work are. An interior solution exists iff the first order condition implies incomplete specialization of workers.

Generally spoken, the objective of the firm is to determine the profit maximizing degree of worker specialization τ, thus choosing either single tasking (complete specialization: $\tau = 1$) or multi tasking (incomplete specialization: $\tau \neq 1$). The latter corresponds with a pattern of work organization, which is denoted by LS00 as the holistic organization. Here, τ measures the portion of working time that is spent for the task of comparative advantage.

Further model assumptions are as follows: Given physical capital is fixed in the short run, the product Q is manufactured by performing two tasks $L^{\mathbf{1}}, L^{\mathbf{2}}$. Each task is

3 New firms are set up using a holistic work organization.

composed of returns to specialization (for $L^{\mathbf{1}}$ denoted by $s^{\mathbf{1}}$, which is $\partial L^{\mathbf{1}}/\partial\tau_1$ for a type 1 worker) and of returns to informal task complementarities (for $L^{\mathbf{1}}$ measured by $c^{\mathbf{1}}$, given by $\partial L^{\mathbf{1}}/\partial(1-\tau_1)$ for a type 1 worker). The value of $s^{\mathbf{1}}$ rises c. p. with τ_1 and $[1-\tau_2]$.[4] The complementarity effects $c^{\mathbf{1}}$ and $c^{\mathbf{2}}$ result from inter task learning or knowledge spillovers, where $c^{\mathbf{1}}$ rises with τ_2 and with $[1-\tau_1]$. Correspondingly, $c^{\mathbf{2}}$ rises with τ_1 and with $[1-\tau_2]$.

The workers' participation constraint is measured by the reservation wage function $w_p[\tau]$, thus being influenced by the degree of specialization. If workers have preferences for a narrowly defined task assignment and single tasking, the function w_p reaches its maximum at $\tau = 0.5$, i. e. in a multi tasking oriented organization. If, on the other hand, workers prefer versatile work and a flexible task assignment like team production, then the reservation wage w_p reaches its minimum at $\tau = 0.5$ (see also the fourth common factor). With N_1 type 1 workers, N_2 type 2 workers and homogeneous preferences, the wage costs are $w_p \cdot (N_1 + N_2)$.

The solution of the profit maximization problem advises complete specialization (corner solution at $\tau_i = 1, i = 1,2$), if the first order condition $\frac{\partial \mathsf{profit}}{\partial \tau} \stackrel{!}{=} 0$ has no interior solution for τ^* or the second order condition is violated. To summarize, the holistic organization of work according to LS00 is optimal iff $0 < \tau^* < 1$ *and* $\frac{\partial^2 \mathsf{profit}}{\partial \tau \partial \tau} < 0$.

Under the additional assumption of homogeneous price setting behavior of firms, the

4 As noted, τ_i measures the fraction of working time of worker type i, which is devoted to the task that the considered type can perform relatively better. According to the assumed distribution of comparative advantages, τ_1 (τ_2) measures the degree of specialization for type 1 (2) workers.

second order condition for type 1 workers is:[5]

$$\frac{\partial^2 \text{profit}}{\partial \tau_1^2} = (Q_{\mathrm{L^1}} + Q_{\mathrm{L^2}}) \cdot \frac{\partial^2 \mathrm{L^1}}{\partial \tau_1^2} + 2\,\mathrm{L^1}_{\tau_1}\,\mathrm{L^2}_{\tau_1} \cdot Q_{\mathrm{L^1 L^2}} + \sum_{i=1}^{2} Q_{\mathrm{L^i L^i}} \cdot \left(\mathrm{L^i}_{\tau_1}\right)^2 - \frac{\partial^2 w_p}{\partial \tau_1^2} \cdot N_1 \overset{!}{<} 0 \quad , \tag{1}$$

where $Q_{\mathrm{L^i}} = \partial Q / \partial \mathrm{L^i} > 0$ denotes the marginal product of task $\mathrm{L^i}$, with $i = 1,2$. Technological complementarities between the two tasks are captured by the term $Q_{\mathrm{L^i L^j}} = \partial^2 Q / (\partial \mathrm{L^i} \partial \mathrm{L^j}) > 0$ for $j \neq i$, whereas $Q_{\mathrm{L^i L^j}} \leq 0$ for j=i measures the non–increasing marginal product of "task endowment" as an input factor. The second order derivative $\partial^2 \mathrm{L^1} / (\partial \tau_1 \partial \tau_1) = \partial^2 \mathrm{L^2} / (\partial \tau_1 \partial \tau_1) < 0$ is an expression for the change in the degree of efficiency of ongoing specialization. Last not least $-\frac{\partial^2 w_p}{\partial \tau_1^2}$ is negative, if the reservation wage function is U–shaped (i. e. if workers prefer task variety) and positive if workers prefer specialization.

Since $\mathrm{L^1}_{\tau_1} \cdot \mathrm{L^2}_{\tau_1}$ is negative and the respective quadratic terms are positive, the second order condition for holistic (re)organization is more likely to be fulfilled ceteris paribus, the sharper the fall in marginal returns from ongoing specialization, the stronger the technological task complementarities, the greater the preferences for task variety are.

These more technical expressions form the basis for well justified hypotheses about the characteristics of firms and workers within the polar equilibria as well as about incidence and development of holistic work organizations in comparison to Tayloristic organizations. Based on the complementary system argument embodied in the second

5 The expression for τ_2 is obtained by substituting the digits 1 and 2.

order condition, productivity effects of incomplete worker specialization and holistic reorganization can also be predicted.

The next section presents the hypotheses to be tested empirically.

4 Hypotheses

This section prepares for the empirical analysis. As we aim for an empirical test of the Lindbeck & Snower (2000) model, we regard team work as a suitable proxy for incomplete worker specialization discussed in the preceding section. Moreover, we define holistic multi tasking as the combination (formally: *and*–inclusion) of the hr instruments (a) team work and (b) participation of frontline workers in decision–making at the production level (contemporaneous quality adjustments, innovation, engagement in customer relations/feedback).

In general, the theoretical discussion has pointed out that superordinate factors like the cost structure of IT systems, the existence of learning spillovers and synergy effects in training, flexibility of machinery and factory equipment as well as demand fluctuations exert influence on the value function of the maximization problem. From a theoretical perspective, only a few distinct equilibria are conformable with profit maximization, where attainable profit maximum depends on whether certain thresholds are trespassed. The discussion so far has focussed on the dichotomy case of Tayloristic equilibrium versus holistic equilibrium. Consequently, in practice there should exist different types of firms that distinguish by their work organization and which further can be assigned to

one of the above equilibria. Each firm type is characterized by a coherent catalogue of incentive instruments, human resource (hr) management instruments, respectively. The composition of elements is coherent, given the general frame, i. e. the current constraint set (see the four common factor in the preceding section).

Thus, **H1** on the existence of complementary systems is as follows:

H1: A bird's eye view on the aggregate of firms reveals the coexistence of two distinct types of work organization: (i) Tayloristic organization, (ii) holistic organization.

The Tayloristic system of single tasking hardly ever uses inner firm flexibility strategies like job rotation, flexible bundles of tasks or intertemporal hours transfers. It also lacks elaborated schedules and strategies of upskilling or further training as well as the integration of machinery and labor. Third, Tayloristic organizations are characterized by mass production, by high division of labor, by narrowly specified workers performing single tasks and by time invariant worker–task assignments. Fourth, the inherited demarcation and the traditional conflict of interests between labor and management and the preclusion of employee involvement in decision–making are typical for the Tayloristic organization. Lastly, appropriate monetary incentives are based on objective performance measures, which are predominantly linked to the individual worker.

On the other hand, the holistic system of incomplete specialization of labor and multi tasking is characterized by team work and team based participation (Lindbeck & Snower (2000, 355). This includes, for example, job enrichment, job enlargement, over time variability in task assignments, training of co–workers, worker initiated inter-

ventions at the process control level and discretionary control for adjustments in product quality/quantity as well as maintenance of productive equipment. In a nutshell, teams optimize over a vector of product (and task) characteristics. Holistic organizations are expected to make substantial use of modern communication technologies as well as of interrelated learning methods, supporting both, inter and intra task learning. Last not least, more pleasant working conditions, group based monetary incentive systems — incorporating subjective performance measures —, well directed utilization and cultivation of inner firm communication channels are associated with holistic work organizations.

Thus, **H2** postulates a clear–cut ranking of work organizations:

H2: The two types of work organization describe a rank order with respect to the utilization of sophisticated instruments of hr management policies: Lower ranked Tayloristic organization, and higher ranked holistic organization.

The holistic organization itself is characterized by additional elements of personnel policy, including (i) well designed programs of further training and systematic upskilling schemes, (ii) implicit insurance models of working time schedules and annualized hours schemes, (iii) quality management oriented product market strategies, and (iv) appropriate time management strategies. Hence, a reorganization from a Tayloristic to a holistic type is to be interpreted as a system upgrade, thereby exploiting increasing marginal effects from complementarities between the different instruments (Milgrom & Roberts (1994), Milgrom & Shannon (1994), Milgrom & Roberts (1995)).

Technically spoken, complementarity is preserved under the maximization operation

(Topkis (1998), Carstensen (2002)). Thus, the value function has increasing differences, i. e. potential productivity effects of coherent subsystems are lower in the Tayloristic organization. This is the content of hypothesis **H3**:

H3: The productivity enhancing effect of team work is higher in the holistic organization than in the Tayloristic organization.

In general, we analyze whether incomplete worker specialization is linked to a system effect of the work organization, thus making teamwork more reasonable, when incorporated in broader changes in the entire bundle of hr instruments. The three hypotheses are investigated empirically. Following a short description of the data base, the results are presented in section 6. The paper conludes in section 7.

5 The Data

The empirical analysis uses the Hannover Panel, a representative cross–section time–series data set for the manufacturing sector (Lower Saxony, Germany). The sample consists of 1025 privately–owned enterprises and encompasses annual information over the period from 1993 to 1997, for a total of 2686 observations.[6] Participation of firms has been voluntarily. The economic content of the yearly questionnaires is similar to British and Australian WIRS (workplace and industrial relations survey, Millward (1993)).

Part of the information used in the empirical analysis has been conducted for several periods (for example: value added, number of employees, capacity utilization). Other

6 The number of cases drops and varies between the different empirical specifications due to item non–response.

variables such as worker controlled quality assurance or the characteristics of inner firm communication channels and institutionalized information systems are available once. Thus, the complete set of variables necessary to derive the superordinate system of work organization is only available once per firm.

In order to attain sufficient response rates, the questionnaire lacks physical capital and investment in productive capital. Therefore, capital had to be imputed from the records of the German central bank according to sales–classes/ ISIC Rev. 3–classification cells (Bundesbank (1999)). This external data source measures capital shares. To construct physical capital for each sample unit, the capital share within the corresponding industry–sales–class cell is multiplied by industry price deflated sales at the firm level.

Since we use deflated value added as a measure for firm level output per capita and cannot assume homogeneous price setting behavior at the industry level, we use industry production figures and firm market shares as additional variables. The integration of these variables removes the resulting omitted variable bias (Carstensen (2001b), for alternative approaches assuming heterogeneous price setting between industries and homogeneous price setting within industries see Crepon, Desplatz & Mairesse (1999), Klette & Griliches (1996)).

6 Empirical Analysis and Results

This section is structured as follows: We begin with the presentation of the incidence of different firm types (section 6.1). The aim is to empirically identify the two organi-

zational equilibria discussed in **H1**. In particular, the results of a cluster analysis (cf. Jobson (1992)) are discussed. The corresponding characteristics of the two equilibrium types of work organization are documented in tables 1 and 2. Accordingly, the rank order argument (hypothesis **H2**) is analyzed. Systematic differences in the composition of a holistic work organization and a Tayloristic work organization can, indeed, be shown. Interesting results are revealed with respect to remuneration packages and regarding hr instruments like teamwork or employee involvement in decision making.

Subsequently, the coherent system hypothesis is investigated (subsection 6.2). Here, the increasing productivity effect of teamwork, thus incomplete worker specialization, is checked. This examines **H3** (tables 3 to 5).

6.1 Types of Firms

This subsection presents the results of a k-means cluster analysis, where the number of clusters is known to be two with respect to the theoretical findings. The question at hand is, whether the generated clusters differ systematically and can be interpreted consistently. Cluster calculation proceeds as follows: The members of the two groups are conducted by minimizing the squared Euclidean distance between the particular firm and the cluster means until cluster means are stable. On the other hand, the distance between cluster means is maximized.

The generated clusters appear in table 1 and table 2. The considered hr instruments (elements of the firm's constraint set, respectively) are reported in the first column. The group specific values of the regarded variable, e. g. the incidence of *profit sharing*, are

displayed in the second and third column. Tayloristic firms are represented by the group in column 2, holistic firms are represented by the group in column 3. The last column informs about the level of significance at which the difference between the holistic and Tayloristic organization of work is statistically proven for the specific instrument.

Table 1 encompasses two blocks of variables: Product market related variables and elements of the remuneration package. Table 2 gives inside in four subsystems within the hr management policy and division of work attitudes of the firm: a) the information and communication subsystem, b) the task assignment and employee involvement in decision making subsystem, c) the training and human capital accumulation subsystem as well as d) the subsystem of internal quality control and involvement of front–line workers in quality assurance procedures.

We proceed with the description of table 1. The output market related factors in fact seem to constitute two regimes, each belonging to one of the two groups in a well defined manner. Similar results are revealed by the remuneration package: Except the incidence of short–time work and the relative efficiency wage premium for white collar workers, all differences between the group means are significant at the 1%–level.

In sum, this result is interpreted as a first indication for the existence of two distinct types of work organization (**H1**). On the one hand, holistic firms aim at success with a strategy combination of (i) high product quality and (ii) appropriate time management: Almost every firm assigned to the holistic group maintains high quality standards and more than two firms out of three regard time as a crucial input factor, which has

to be considered in the production function. This is realized, for example, by just in time production, completion confirmation procedures, or annualized hours schemes for working time flexibility. Although holistic firms only moderately deploy environmentally friendly production as a means to attract consumers, the incidence is twice as high as in their Tayloristic counterparts.

On the other hand, Tayloristic firms rely upon low price strategies and more tightened customer relations rather than on time management. The predominance within the strategy bundle, although at a lower level, is still on product quality (83.7% in Tayloristic firms compared to 95.7% in holistic firms). On average, Tayloristic firms are smaller than holistic firms and their capacity utilization is slightly lower (91 vs. 345 employees, 87.4% vs. 88.5%). Moreover, overtime and short–time work as well as their simultaneous occurrence is less often observed. The latter results could be considered as evidence for the presumption that demand fluctuations are higher in the holistic segment and that sensible adaption strategies have become a key success factor reinforcing the need for a holistic work organization.

This finding coincides with the Lindbeck & Snower (2000) argumentation on flexible production, where we extend the discussion. In particular, the functional flexibility of human capital (i. e. multi tasking and job rotation) is supplemented by time flexibility of human capital (e. g. stipulated in working time accounts like annualized hours contracts). With such time flexibility arrangements, employers have the option to transfer working hours contingents between periods to counter–balance demand fluctuations.

The agreed on ratio of working time, which can be transferred without being eligible to, e. g., overtime premiums, is definitely higher in the holistic group. Here, about 15% of standard working time is intertemporally transferable without penalization compared to less than 6% in the group of Tayloristic firms.

Table 1: Work organization as a well defined catalogue of hr instruments

General frame/ set of human resource instruments	firm types		type difference
	Holistic	Tayloristic	level of significance *
Product market strategies			
– high product quality [a]	95.7	83.7	**
– proper time management [a]	67.3	37.6	**
– close customer relations [a]	22.7	32.7	**
– low price policy [a]	33.2	38.2	**
– environmental protection [a]	25.3	12.9	**
Firm size and order situation			
– number of employees	345	91	**
– capacity utilization [b]	88.5	87.4	**
– overtime work (Ov) [a]	77.8	63.6	**
– short–time work (Sh) [a]	15.5	13.4	(0.11)
– both (Ov & Sh) [a]	9.6	5.6	**
– working hours transfer buffer [c]	15.1	5.8	**
Remuneration packages			
– efficiency wage premium (blue collor workers) [d]	7.6	6.8	*
– efficiency wage premium (white collor workers) [d]	7.1	6.8	(0.45)
– piece rates (individually based) [a]	26.1	15.6	**
– bonus payments (individually based) [a]	31.1	7.9	**
– piece rates (group based) [a]	9.3	2.9	**
– bonus payments (group based) [a]	9.5	1.7	**
– profit sharing scheme (workers)	29.4	8.5	**
– profit sharing scheme (management)	66.0	32.6	**
Fraction of firm type [in %]	56.6	43.4	

* Significance: ** (1%–level), * (5%–level), † (10%–level).

[a] Percentage of firms utilizing the specific instrument.

[b] Percentage utilization of machinery equipment.

[c] Calculated time buffer in percent (relative to standard workingg hours) allowed by working time accounts or annualized hours schemes, respectively.

[d] Percentage difference between firm specific remuneration level and collective agreement counterpart.

Data: The Hannover Panel, period covered: 1993–1997. K–means cluster analysis has been performed by SPSS 10.0.

The lower part of table 1 reports the type specific usage of typical monetary incentive instruments. The composition of the considered instruments differs by firm type. Monetary incentives seem to play a major rule in holistic firms. If we regard the remuneration package as a bundle of pecuniary instruments, two things have to be mentioned: *First*, the intensity of the instruments bundle is fairly high in holistic firms compared to Tayloristic firms. In detail, the efficiency wage premiums for blue collar workers in holistic firms exceed the reference value in Tayloristic firms (7.6% vs. 6.8%). Also, group and individual piece rates are payed more often. Moreover, productivity related components, in fact both group oriented and individually based, are more frequent part of holistic compensation packages (group bonus: 9.5% compared to 1.7% of firms, individual bonus: 31.1% compared to 7.9% of firms). Analogically, the incidence of profit/gain sharing schemes (ps) for workers and of profit related pay (prp) for management is higher in holistic firms (ps: 29.4% vs. 8.4%, prp: 66% vs. 32.6%).

Second, the weighting of individually based incentives and of group based incentives within the compensation bundle differs by group. Whereas Tayloristic firms emphasize individual piece rates and prp at the management level, holistic firms attach importance to individual bonus payments, to ps schemes for employees and to profit related pay for executives. This gives a good impression of the differences in the pecuniary incentive system between holistic and Tayloristic firms. It seems that holistic firms rely relatively more on team based and profit related elements, thus encouraging mutual pressure among workers and establishing reciprocity (see also the discussion of guilt in Kandel

& Lazear (1992)). In contrast, Tayloristic firms weight objective performance measures higher within the incentive structure, thus inherently facing the danger of evoking dysfunctional incentives, if sufficient product quality is essential (Baker et al. (1994)).

Table 2 focusses on further characteristic subsystems of the overall complementary system of work organization. The *information and communication subsystem* (IaC) can be interpreted as a means of preparing, supporting, evaluating and maintaining other hr instruments/subsystems. For example, IaC systems accompany profit sharing systems and progressive forms of task assignment and serve as a medium in a broader process of interest alignment, i. e. in overcoming the traditional conflict of interests, between entrepreneur and employees. In holistic firms the ratio of firms that regularly use (i) institutionalized information channels, (ii) project and theme related communication channels and/or (iii) the works council is (i) 81%, (ii) 77%, and (iii) 64%, respectively. The reference values for Tayloristic firms are (i) 53%, (ii) 44%, and (iii) 38%, respectively. To sum up, holistic firms are more engaged in elaborated IaC subsystems, where we interpret (iii) as part of this subsystem due to the voice option of works councils (cf. Freeman & Medoff (1984162–190)).

The conclusions, which can be drawn from the *task assignment and participation in decision making subsystem* are similar: Almost three of four holistic firms manufacture in teamwork and/or consign their employees to make production related decisions. The respective simultaneous incidence averages 55%. Within the empirical part of the paper the latter is denoted as holistic multi tasking and teamwork is taken as the empirical

Table 2: Work organization as a well defined catalogue of hr instruments

Communication systems/ set of human resource instruments	firm types		type difference
	Holistic	Tayloristic	level of significance *
Information and communication (IaC) subsystem			
– works council [a]	81.1	52.9	**
– institutionalized regular IaC system/channels [a]	77.1	43.8	**
– regular IaC linked to specific topics/projects [a]	63.6	38.4	**
– degree of unionization [b]	43.6	31.9	**
Task variety/worker responsability subsystem			
– worker partizipation in decision making (P) [a]	71.8	20.9	**
– team work (incomplete specialization, T) [a]	71.7	52.9	**
– team coverage [c]	26.8	13.9	**
– holistic multi tasking (P& T) [a]	54.9	10.5	**
Training subsystem			
– financial support of further training by firms [a]	82.3	47.7	**
– annual per capita expenditures (further training) [d]	283.5	103.7	**
– strategy: continuous learning [a]	25.8	11.7	**
– strategy intensity: ongoing specialization [e]	3.5	2.1	**
– strategy intensity: diminution of comparative disadvantages /utilization of learning spillovers [e]	9.3	2.9	**
– strategie intensity: investment in multiskilling [e]	2.5	1.2	**
Quality assurance subsystem			
– at descretion of individual workers during the production process [a]	57.9	58.2	(0.85)
– at descretion of teams [a]	41.4	18.4	**
– own department for quality control [a]	72.9	43.4	**
Fraction of firm type [in %]	56.6	43.4	

* Significance: ** (1%–level), * (5%–level), † (10%–level).

[a] Percentage of firms utilizing the specific instrument.

[b] Percentage of workforce organized in a union.

[c] Percentage of blue collar workers working in teams.

[d] Industry level deflated values (in DM).

[e] Measure for the intensity by which the training strategy is followed: 0=not an issue, ..., 4=intensive use.

Data: The Hannover Panel, period covered: 1993–1997. K–means cluster analysis has been performed by SPSS 10.0.

pendant of incomplete worker specialization. The difference between holistic and Tayloristic organization of work within this subsection is obvious, since only 21% of the Tayloristic firms engage in worker participation in decision making and 53% practice

team production. The incidence of holistic multi tasking in such firms is even lower, it amounts to 10%.

In addition, human capital accumulation strategies are reported. The corresponding *training subsystem* can be interpreted in conjunction with multiskilling and upskilling, which are regarded as necessary conditions for multi tasking and over time variability of task assignment. The familiar pattern appears: Holistic firms do more often report financial support of further training (82% vs. 48%) and the amount spent per capita is almost triply as high. The portion of firms relying on a continuous learning and upskilling policy is more than twice as high (26% vs. 12%). The training strategy à la LS00 to improve skills within the scope of comparative disadvantage, thereby taking advantage of knowledge spillovers is not widely used. Anyway, the relative frequency is higher within the holistic group (9% vs. 3%).

The last subsystem within the superordinate bundle of hr instruments and elements of work organization includes the quality assurance subsystem. First, we see that both groups do not differ within the usage of worker initiated quality control and respective interventions during the production process. Rather 60% of the firms use this hr instrument to maintain high quality standards. This observation coincides with the previously illustrated facts on product market strategies. As expected, the sphere of team competence is weaker in Tayloristic firms and the existence of an own specialized department that performs (independent and evaluating) quality controls in combination with reasonable feedback systems is more often met in holistic firms.

The overall impression from tables 1 and 2 is as follows: We find supporting evidence for hypothesis **H1**: The sample of firms splits into two distinct groups, which can be separated by their work organization. The corresponding types of firms differ systematically. The first group is denoted as holistic firms, the second group is denoted as Tayloristic firms. Compared to their Tayloristic counterparts holistic firms more often use strategies for flexible production, group related pay and sharing systems, elaborated information and communication systems, team work and worker participation, sophisticated training strategies and multidimensional quality assurance approaches. In general, the composition of the type corresponding hr catalogue fits the description that follows **H1**. Moreover, on a descriptive basis, hypothesis **H2** is supported as well.

The next subsection explores the rank order between the types in more detail. In particular, hypothesis **H3** of increasing effects of reorganization, i. e. of the complementarity presumption of hr instruments, is investigated.

6.2 Complementary System Ordering

According to hypothesis **H3**, the productivity enhancing effect of a ”member” instrument of the complementary work organization (hr system, respectively) should increase with the position of the current work organization in the rank ordering of organizational types (optimal behavior of firms assumed). In the discussed polar case, the rank ordering is as follows: the Tayloristic organization of work takes the lowest position, whereas the holistic organization of work is ranked highest.

Due to Lindbeck & Snower (2000, 1996) we examine the complementarity hypoth-

esis **H3** on the basis of the characteristic ”member” instrument *team work*. Thus, the increasing productivity effect of incomplete worker specialization in comparison to complete specialization or strict single tasking — measured by the value of the dummy variable team work — is investigated. The effect is interpreted as a reorganization effect, whose magnitude depends on the current position of the firm in the organizational hierarchy, i. e. on the realization of the firm type. We take an augmented form of the well established Cobb Douglas production framework. The respective productivity effect is incorporated in the overall efficiency parameter. Thus, given the validity of **H3**, the estimated elasticity of the dummy variable *team work production* should be greater in the holistic sub–sample compared to the Tayloristic sub–sample. The sub–samples coincide with the clusters, which are discussed in the previous subsection.

Methodologically, we follow a treatment effects approach (Maddala (1983, 117–122, 257–267)) to control for selectivity effects. Such effects occurs, since the adoption of team work is the outcome of an optimization decision under given constraints. In other words, firms are not assigned randomly to either alternative (a) team work, or (b) no team work. If this decision is neglected, the estimated team effect is a composed effect, which in addition to the variable of interest (the productivity effect) encompasses a selection effect. This selection effect we like to separate out.

Thus, we adopt the two step procedure discussed in Maddala (1983). Next, the underlying econometric model is briefly summarized. The main concern is with the productivity equation:

$$y_i = \mathbf{X}_i\boldsymbol{\beta} \; + \; \delta team_i \; + \; u_i \quad , \tag{2}$$

where *team* denotes the dummy variable for team production (the empirical pendant for incomplete specialization of workers). The row vector $\mathbf{X}_i$ measures other variables, which influence productivity. The vector of coefficients $\boldsymbol{\beta}$ and the effect from reorganization δ have to be estimated. The distribution of the error term u_i is discussed below.

The latent, but unobserved, decision model for team production is:

$$team_i^* = \mathbf{W}_i\boldsymbol{\gamma} \; + \; \varepsilon_i \quad , \tag{3}$$

with row vector $\mathbf{W}_i$ of determinants, with the corresponding vector of coefficients $\boldsymbol{\gamma}$ and the error term ε_i. The observed value of $team_i^*$ follows the decision rule

$$team_i = \begin{cases} 1, & \text{if } team_i^* > 0; \\ 0, & \text{otherwise} \end{cases} \quad . \tag{4}$$

The error terms are assumed to be bivariate normal:

$$\begin{bmatrix} u_i \\ \varepsilon_i \end{bmatrix} \; \sim \; N\left(\mathbf{0}\,, \begin{bmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{bmatrix}\right) \quad , \tag{5}$$

with ρ as the correlation of u_i and ε_i. The standard deviation of u_i is measured by σ. Because merely the sign of $team_i^*$ is observed, we impose the additional variance restriction $Var(\varepsilon_i) = 1$.

The value of δ is estimated in a two step procedure (Maddala (1983, 122)). The first step estimates the probability to opt for team work:

$$\text{Prob}(team_i = 1 \mid \mathbf{W}_i) = \Phi(\mathbf{W}_i \boldsymbol{\gamma}) \quad . \tag{6}$$

Φ measures the cdf of the standard normal. The row vector $\mathbf{W}_i$ encompasses the accordant determinants within the preceding decision on team production.[7]

On the basis of these results, i. e. using $\widehat{\boldsymbol{\gamma}}$, the selection term λ_i is estimated:

$$\lambda_i = \begin{cases} \frac{\phi(\mathbf{W}_i \widehat{\boldsymbol{\gamma}})}{\Phi(\mathbf{W}_i \widehat{\boldsymbol{\gamma}})}, & team_i = 1 \\ -\frac{\phi(\mathbf{W}_i \widehat{\boldsymbol{\gamma}})}{1-\Phi(\mathbf{W}_i \widehat{\boldsymbol{\gamma}})}, & team_i = 0 \end{cases} \tag{7}$$

The second step is to include the selection term as an additional regressor (see equation (2)) in the productivity equation, so that:

$$\text{E}(y_i \mid team_i) = \mathbf{X}_i \boldsymbol{\beta} + \delta team_i + \underbrace{\rho\sigma}_{\equiv \widehat{\beta}_{\widehat{\lambda}}} \cdot \lambda_i \quad , \tag{8}$$

$$\text{Var}(y_i \mid team_i) = \sigma^2(1-\rho^2 d_i) \quad , \tag{9}$$

with d_i defined as $d_i = \lambda_i(\lambda_i + \widehat{\boldsymbol{\gamma}} \mathbf{W}_i)$.[8]

Before we proceed with an interpretation of the results, some remarks have to be made: The set of regressors in the selection equation includes the outcome of a factor analysis. The corresponding factor model has been estimated by principle components method.[9] Loosely speaking, the matrix of raw data encompasses information on job and

7 In tables 3 to 5 $\mathbf{W}_i$ corresponds to the right hand side variables in the Selection equation (team work).

8 Because the normal assumption is crucial for the consistence of the two step estimator (Davidson & MacKinnon (1993)), kernel estimates of the residuals have been plotted against the normal distribution. The optical impression of these plots is satisfying (see tables 4 and 5 for estimation results).

9 Technically spoken, the aim of factor analysis is to save as much of the information generated by a set of correlated variables by preferably few artificial variables, called factors (see Jolliffe (1986)). The detailed results of the factor model are not presented here, but are available from the author on request.

task characteristics, on their dynamic dimension, on implicit contracts elements in the employment relation, on industrial relations aspects and inner firm parallels, on communication procedures and on flexibility aspects of production. The result is that two factors are retained: (i) task assignment, (ii) two sided insurance. Their estimated factors scores (FScore) are integrated as explanatory variables in the first stage of the treatment model.

The interpretation of these variables is as follows: The task assignment factor captures the phenomenon of time variability in both, task assignment and skill requirements (e. g. dynamic multi tasking). It is dominated by six raw variables: (ia) a proxy (dummy) variable for worker preferences for versatile work, (ib) a proxy for continuous and multi–task learning as part of the inner firm training policy, (ic) a dummy variable for shift work, which is taken as one evidence for flexible production, (id) a dummy variable for the IaC subsystem element, which concentrates on project affiliated communication and theme related information interchange, (ie) a dummy variable for the objective of the firm to provide more favorable working condition and more attractive job slots in the course of process innovations, (if) a dummy variable for the existence of an own specialized department, which undertakes quality control. The latter could be interpreted as an internal control entity, which independently evaluates the quality standard of production.

The second factor catches the occurrence of the firm specific institution of a double sided insurance solution between workers and employers. The underlying insurance model predicts such occurrences, if product demand is exposed to fluctuations and inventories are costly (cf. Carstensen (2000)). To resume the theory, employers are covered

from corresponding profit reducing effects of demand shifts on the one hand. On the other hand, employees are exempted from the associated risk of dismissal. The ordinary institutional setting for such arrangements is a working time account, where both, employer and employee, declare a specific amount of standard working time as being transferable between periods without incurring further costs. From a theoretical perspective, strict requirements with respect to renegotiation–proofness have to be fulfilled, which are linked to information and communication.

This two sided insurance factor is dominated by the following variables: (iia) a dummy for the existence of a working time account scheme, (iib) a dummy variable for the simultaneous occurrence of accompanying IaC systems, which inform workers on the prevailing situation at the output market and on short–term perspectives of product demand, (iic) a dummy variable for the existence of broad spectrum information and communication routines that are mutually maintained by the workers' representation (e. g. works council) and the management level. The high loading on the institutionalized information variable and, especially, on the variable that indicates the concomitance of working hours accounts and product market related information channels/procedures is in line with the theoretical arguments on reciprocal credibility and renegotiation–proofness of the two sided insurance solution. The described factor scores are modelled as determinants in the empirical specification of the decision for team work. Here, it is expected that higher values for task assignment increase the probability of team production. In contrast, the sign of two sided insurance is not clear without ambiguity: If

functional flexibility and time flexibility are substitutes in the firms adaption policy, the estimated coefficient should be negative. If, contrary, both flexibility instruments are part of a superordinate flexibility regime, they mutually reinforce and the expected sign is positive.

As mentioned before, the level of industry production and the firm's market share have to be included in the productivity equation to control for heterogeneous price setting. Taken together, three variants of the same specification are estimated and presented in tables 3, 4 and 5. The variants differ by the sample composition under consideration, but rely on identical parametric specifications. The bottom part of each table shows the results of Wald tests of the joint significance of well defined variable combinations in the selection equation. Documented is the respective level of significance, at which no null hypothesis of lacking influence is rejected. The summary statistics appear in table 6.

In table 3 the whole sample is analyzed, thereby neglecting the complementary system effect. Thus, it is presumed that the team effect does not vary between the different layers within the work organization ranking. Correspondingly, the team effect is expected to be identical for the two firm types, which have been identified in table 1 and table 2. Neither do the driving factors in the selection equation differ per assumption.

Table 4 and table 5 relax these equality assumptions. There, the two clusters are used to generate the Tayloristic sub–sample (represented in table 4) and the holistic sub–sample (represented in table 5). The underlying idea of studying the sub–samples separately is linked to the complementarity hypothesis **H3**: We expect the separately

estimated team effects to differ between the groups. Moreover, the effect documented in table 5 should exceed the comparative value in table 4.[10]

Table 3: Increasing effects of team work: Basic equation with no distinction between organizational types

Variable	Coefficient	(Std. Err.)
Equation 1 : ln(labor productivity)		
capacity utilization	0.243†	(0.143)
ln(capital)	0.670**	(0.020)
ln(labor)	0.043**	(0.011)
ln(industry output)	0.149*	(0.072)
ln(market share)	0.006	(0.009)
team work	0.034	(0.063)
selection term	-0.056	(0.040)
Intercept	4.246**	(0.286)
Selection equation 2 : team work		
ln(labor)	-0.067	(0.066)
Lag(1) ln(knowledge capital)	0.004	(0.022)
FScore task assignment	0.443**	(0.062)
FScore two sided insurance	-0.101†	(0.058)
latest technology	-0.020	(0.127)
well approved technology	0.085	(0.129)
ln(firm age)	0.025	(0.097)
innovation intensity	0.113**	(0.039)
low price policy	0.102	(0.109)
proper time management	0.038	(0.103)
high product quality	0.277	(0.185)
environmental protection	0.010	(0.129)
overtime work	0.231*	(0.116)
Intercept	-0.114	(0.472)
joint significance of variables for ... (levels in parentheses):		
– heterogeneous price setting		(0.09)
– output market strategies		(0.54)
– multiskilling/task–time flexibility		(0.00)
– characteristics of physical capital		(0.05)
N	729	
$\chi^2_{(33)}$	1699.506	

Significativity level : $\dagger$: 10% $*$: 5% $**$: 1% ; sector and year control included.
Estimation results calculated with Stata 7 (StataCorp (2001)).

10 It is further expected that selection matters, i. e. that the coefficient $\widehat{\beta}_{\widehat{\lambda}}$ is significant (see equation (8)).

The results of table 3 are easily summarized: A significant influence on the selection decision can only be shown for four variables. As expected, the factor, which is linked to the need of continuous upskilling and to time varying task vectors increases the probability of team production (significant at the 1%–level). The more product and process innovations the firm launches over a four year period, the more likely team production is adopted (1%–level). The same is valid for overtime work (5%–level). Although only borderline significant (10%–level), the negative sign of the factor that reflects the two sided insurance model (FScore two sided insurance) speaks in favor of the substitutive instruments of adoption argument.

Altogether, according to table 3 the hypothesis of random assignment to the sub–samples (a) team work, (b) no team work cannot be rejected (insignificant selection term in the productivity equation). In contrast, the hypothesis of homogeneous price setting is rejected at the 10%–level if the whole sample is considered (joint significance of industry output and market share). Further, one could draw the conclusion of increasing returns to scale. Finally, the estimated team effect is neither significantly positive nor negative.

We like to know, whether these findings change, when we split the sample as mentioned into the two sub–samples reflecting the diverging types of work organization. The Tayloristic firms are regarded first (table 4): The signs on the included factors stay stable, whereupon the substitutional relationship between time and functional flexibility is now statistically proven at the 5%–level.

The intensity of the previous year value of knowledge capital increases the proba-

Table 4: Increasing effects of teamwork: Regression for Tayloristic organizations only

Variable	Coefficient	(Std. Err.)
Equation 1 : ln(labor productivity)		
capacity utilization	0.315†	(0.200)
ln(capital)	0.657**	(0.025)
ln(labor)	0.021	(0.015)
ln(industry output)	0.065	(0.100)
ln(market share)	0.001	(0.011)
team work	-0.153†	(0.082)
selection term	0.052	(0.054)
Intercept	3.931**	(0.398)
Selection equation 2 : team work		
ln(labor)	-0.109	(0.091)
Lag(1) ln(knowledge capital)	0.046†	(0.026)
FScore task assignment	0.373**	(0.092)
FScore two sided insurance	-0.306**	(0.101)
latest technology	-0.140	(0.182)
well approved technology	-0.098	(0.168)
ln(firm age)	-0.038	(0.125)
innovation intensity	0.038	(0.050)
low price policy	0.175	(0.141)
proper time management	-0.118	(0.141)
high product quality	0.596**	(0.229)
environmental protection	-0.261	(0.197)
overtime work	0.175	(0.150)
Intercept	0.417	(0.588)
*j*oint significance of variables for ... (levels in parentheses):		
– heterogeneous price setting		(0.81)
– output market strategies		(0.07)
– multiskilling/task–time flexibility		(0.00)
– characteristics of physical capital		(0.87)
N	376	
$\chi^2_{(33)}$	1238.135	

Significativity level : $\dagger$: 10% $*$: 5% $**$: 1% ; sector and year control included.

Estimation results calculated with Stata 7 (StataCorp (2001)).

bility of team work (10%–level). A result, which could be interpreted in line with the discussion of knowledge capital and multiskilling as a necessary precondition for incomplete worker specialization. Moreover, a high quality strategy on the product market enlarges the probability for incomplete worker specialization.

The coefficient of the selection term remains insignificant. But in contrast to the above findings, the productivity effect of team production in Tayloristic firm is negative with borderline significance (10%–level). The hypothesis of homogeneous price setting cannot be rejected any longer, although the isolated coefficient on industry output is significant at the 5%–level. The latter can be valued as an indication for Crepon et al. (1999), who do not incorporate the firm's market share, thus assuming homogenous price setting within industries and heterogeneous markups between industries.

If we pass over to the separate treatment model for holistic firms, we notice the (borderline) significant positive coefficient of team production, which is interpreted as a tentative indication for the existence of increasing returns from reorganization towards incomplete worker specialization. In addition, the selection term is significant (5%–level). The latter can be interpreted in a way that the adoption decision is undertaken in hope for productivity gains. Thus, if we had not controlled for selectivity, the productivity effect would have been underestimated. The hypotheses of homogeneous price setting is rejected at the 5%–level, thus the inclusion of the variable combination industriy output/market seems to be sensible.

To resume the alternative estimations, we find evidence for the hypotheses that, first,

Table 5: Increasing effects of teamwork: Regression for holistic organizations only

Variable	Coefficient	(Std. Err.)
Equation 1 : ln(labor productivity)		
capacity utilization	0.080	(0.198)
ln(capital)	0.705**	(0.030)
ln(labor)	0.048**	(0.016)
ln(industry output)	0.199*	(0.097)
ln(market share)	0.018	(0.013)
team work	0.209†	(0.110)
selection term	-0.130*	(0.065)
Intercept	3.804**	(0.455)
Selection equation 2 : team work		
ln(labor)	-0.159†	(0.091)
Lag(1) ln(knowledge capital)	0.042	(0.035)
FScore task assignment	0.435**	(0.095)
FScore two sided insurance	-0.192*	(0.065)
latest technology	0.136	(0.183)
well approved technology	0.277	(0.211)
ln(firm age)	0.067	(0.152)
innovation intensity	0.149*	(0.065)
low price policy	-0.134	(0.171)
proper time management	0.002	(0.162)
high product quality	-0.319	(0.352)
environmental protection	0.047	(0.187)
overtime work	0.209	(0.200)
Intercept	0.653	(0.756)
joint significance of variables for ... (levels in parentheses):		
– heterogeneous price setting		(0.05)
– output market strategies		(0.86)
– multiskilling/task–time flexibility		(0.00)
– characteristics of physical capital		(0.09)
N	396	
$\chi^2_{(33)}$	874.544	
Significativity level : †: 10% *: 5% **: 1% ; sector and year control included.		
Estimation results calculated with Stata 7 (StataCorp (2001)).		

the decision to adopt characteristic subsystems within the overall work organization, studied on the basis of the example of the decision for team production, corresponds to the solution of the firm's maximization problem. If certain threshold of alternative (hr)

instruments or constraints are trespassed, the introduction of the considered subsystem pays off. As can be seen in table 2 the usage of team production is significantly higher in holistically organized firms. Second, we find weak support for the complementarity hypothesis **H3**, measured by increasing productivity effects of team work. On average, deflated labor productivity amounts to EUR 71,324 for holistic firms and to EUR 58,372 for Tayloristic firms. The difference is significant at the 1%–level.

In addition, in table 6 the variables used in the productivity equations are described and their summary statistics are documented.

Table 6: Summary statistics for treatment approach variables

Variable	Mean	Std. Dev.	N	Description [a]
approved technology	0.354	0.478	2022	dummy variable =1, if well approved equipment is used in the production process,
capacity utilization	0.878	0.072	1850	utilization of machinery equipment,
environmental protection	0.179	0.384	2076	dummy variable=1, if output market strategy relies on a(n image) policy of environmentally friendly production,
high product quality	0.887	0.316	2076	dummy variable =1, if output market strategy relies on quality competition,
innovation intensity	2.047	1.452	1815	number of years with innovations over the observation period,
latest technology	0.366	0.482	2022	dummy variable =1, if the production is performed with ultra–modern equipment,
ln(firm age)	3.398	0.52	2521	log of number of years, since the firm exists,
ln(capital)	10.493	0.683	1639	log of fixed assets per capita,
ln(knowledge capital)	8.733	2.87	1306	log of per capita assets in knowledge, calculated via the perpetual inventory method, annual accumulation: sum of R&D expenditures and investment in human capital. Assumptions: pre observation growth rate = 0.05, human capital depreciation rate= 0.15;
ln(labor)	4.396	1.05	1776	log of number of employees (average within year of observation),
ln(labor productivity)	11.600	0.493	1408	log of value added per capita,
ln(market share)	2.209	1.173	1334	log of market share (major product),
low price policy	0.366	0.482	2076	dummy variable =1, if output market strategy relies on price competition,

[a] monetary figures: industry price deflated values (basis: DM)

to be continued...

... table 6 continued

Variable	Mean	Std. Dev.	N	Description [a]
overtime work	0.718	0.45	2122	dummy variable =1, if employees currently work overtime,
sector control			2686	29 dummy variables for sector affiliation,
team work	0.633	0.482	2126	dummy variable = 1, if firm practices team production,
time management	0.502	0.5	2520	dummy variable =1, if output market strategy relies on an appropriate time management policy,
year control			2686	dummy variables for year of observation (1993, 1994, 1995, 1996, 1997).

[a] monetary figures: industry price deflated values (basis: DM).

The next section summarizes the results of the presented analysis and suggests important topics for future research on the organization of work.

7 Conclusions and further Research

This paper has empirically investigated the hypotheses on optimal work organization and co–existence of different organizational types, which can be drawn from the seminal theoretical approach developed by Lindbeck & Snower. Particularly Lindbeck & Snower (2000) has been confronted with the empirical evidence.

This approach concentrates on the polar cases *holistic vs. Tayloristic organization of work.* Underlying factors are recent developments in information/communication technologies, growing incidence of flexible production systems, increases in human capital versatility. In addition, altered worker attitudes, thus preferences towards versatile work and incomplete specialization are supposed.

The empirical investigation relies on data from a representative survey of privately–owned enterprises in the manufacturing sector in of one of the Federal States of Ger-

many. Three hypotheses have been confronted with the data. First, it has been studied, whether in fact the two postulated polar forms of work organization and the respective firm types exist. The empirical evidence is compatible with this. Second, the two types were inspected with respect to their endowment with sophisticated instruments of human resource management policy and with elements of modern or flexible production. We also found support for the hypothesis that holistic types utilize more elaborated systems.

Third, the complementary system hypotheses of the work organization model has been analyzed. Here we found only weak support for the statement that the productivity enhancing effects of productivity enhancing instruments rise with the system comprehensiveness, i. e. that respective effects should be higher in holistic firms. Altogether, the results on the complementarity effects hypothesis are not yet convincing.

Thus, further research is needed. On the one hand it is questionable, whether the polar case of (equilibrium) work organization is in fact sufficient. The result on the – at least partially – substitutional link between functional flexibility/ multi tasking and time flexibility/hours transfers has to be inspected further. Thus it has to be proven, whether more than two organizational equilibria coexist.

One the other hand, future research should additionally control for unobserved firm specific heterogeneity, thereby following the reorganization process contemporaneously. Unfortunately, some of the important variables are only available once in the data base, which has been used in this study. Consequently, augmented data bases on work organization are needed, thus appropriate panel estimates could be applied.

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