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Working Paper

Does Work Time Flexibility Work? An Empirical Assessment of the Efficiency Effects for German Firms

ZEW Discussion Papers, No. 04-47

Provided in cooperation with:
Zentrum für Europäische Wirtschaftsforschung (ZEW)

Suggested citation: Wolf, Elke; Beblo, Miriam (2004) : Does Work Time Flexibility Work? An Empirical Assessment of the Efficiency Effects for German Firms, ZEW Discussion Papers, No. 04-47, http://hdl.handle.net/10419/24057

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Non technical summary

Flexible working hours are said to increase productivity and improve the international competitiveness of firms on one hand, and job satisfaction and commitment of the employees on the other. While the fast diffusion of flexible work hour arrangements in Germany seems to provide evidence for the hypothesis of positive effects for workers, firms and the economy as a whole, empirical research is very rare and often focused on specific aspects, such as absenteeism, turnover or job satisfaction. In this paper we suggest an evaluation criterion for the consequences of flexible working time which is more comprehensive than these single indicators usually applied and, at the same time, appears more adequate than a mere productivity measure. We argue that the adoption of flexible time schedules does not necessarily shift the production function as a whole, but rather increases the efficiency of the production process.

The goal of our paper is to investigate the impact of flexible work time schedules on firm efficiency using representative establishment data for Germany. The innovation of our analysis is to assess the impact of flextime on firm *efficiency* instead of firm *productivity*. Following the approach by Battese and Coelli (1995), we estimate a stochastic production frontier and a technical efficiency equation simultaneously, where the latter is assumed to depend on the type of work hour schedule as well as other firm characteristics.

At first glance, the results seem to indicate that firms do not benefit from flexible work time arrangements on average. This surprising finding resolves once we further control for the degree of flexibility. While the use of work time schedules with moderate flexibility is positively related to technical efficiency, using highly flexible work hour models does not yield the expected additional efficiency gains. In contrast, firms with very flexible work time arrangements, e.g. schedules allowing very long time periods within which the accounts are to be settled, achieve a significantly lower efficiency level than establishments whose employees are compensated for their overtime hours (in terms of leisure) within one month. We argue that these efficiency losses should not be interpreted as causal effects, because highly flexible work time schedules are most likely to be introduced in firms that are struggling. Hence, our main result is that while the use of work time schedules with moderate flexibility is positively related to technical efficiency, highly flexible work time arrangements are negatively correlated with an efficient organization of the work flow. The latter may partly be attributed to the negative selection of firms adopting extremely flexible work time arrangements.

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Elke Wolf and Miriam Beblo

July 2004

Abstract

In this paper we assess the impact of flexible work time schedules on firm efficiency using representative establishment data for Germany. Following the approach by Battese and Coelli (1995), we estimate a stochastic production frontier and the determinants of technical efficiency simultaneously. The innovation of our study is that we draw on technical efficiency instead of productivity to appraise the success of flexible working hours. The results indicate that while the use of work time schedules with moderate flexibility is positively related to technical efficiency, highly flexible work time arrangements seem to be negatively correlated with an efficient organization of the work flow. However, these efficiency losses should not be interpreted as causal effects, because highly flexible work time schedules are most likely to be introduced in struggling firms.

JEL code: D29, L23, M54

Keywords: Stochastic production frontier, flexible work hours, efficiency

Acknowledgement

We thank participants of the IAB-Workshop in Iphofen (December 2003) and our colleagues at the internal ZEW-Werkstattseminar for fruitful discussions and helpful comments.

1 Introduction

Multiple merits are attributed to flexible working hours, although the empirical evidence is, for the most part, anecdotal. Flexible work hours are said to increase productivity and improve the international competitiveness of firms on one hand, and job satisfaction and commitment of the employees on the other. Proponents argue that employees and firms as well as the economy and the society as a whole benefit from more flexibility in hours regulations.[1]

The diffusion of flexible work hour arrangements started in the US in the early sixties. Since the seventies the popularity of flextime hours has grown constantly (Owen, 1977). At first, flextime allowed the employees to deviate from the standard 9-to-5 working day without a special supervisor approval, though most workers were still required to work 8 hours per day (Moss and Curtis, 1985). In the mean time, flexible work hour schemes have become much more diverse. They are now widely applied in most industrial countries.

Collective bargaining in Germany also focuses more and more on flexible hour arrangements. Several collective agreements today include provisions such as work time accounts, temporary reductions in work time accompanied by pay cuts, flexible work time arrangements or part-time work for elderly workers (Bispinck, 1998). According to the IAB establishment panel, 17 percent of all West German establishments apply some sort of accounting system where working hours are debited and credited to individual time accounts. In East Germany, the corresponding share amounts to 21 percent in 1999. Taking into account that flextime models are mainly adopted by larger firms, this figure implies that 35.3 percent of all West German employees and 32.8 percent of all East German workers are covered by work time accounts (Bellmann and Ludewig, 2000).

While the fast diffusion of flexible work hour arrangements seems to provide evidence for the hypothesis of positive effects on all sides, workers, firms, and the economy, empirical evidence is very rare and often focused on just one aspect of possible consequences, such as absenteeism, turnover or job satisfaction (see e.g. Pierce and Newstrom, 1980, 1982). Many studies are based on management perceptions rather than on hard performance measures. All existing studies that do investigate the effect of flextime on productivity refer to the US (see e.g. Owen, 1977; Schein, Maurer and Novak, 1977; Kim and Campagna, 1981, Ralston, Anthony and Gustafson, 1985, and Shepard, Clifton and Kruse, 1996). The results of these studies are inconclusive, albeit there is some evidence for positive productivity

[1] Press release of the German Ministry of Labor, Bundesministerium für Arbeit und Sozialordnung, 29.5.2002.

effects of flexible working hours. However, the final conclusions often suffer from small sample sizes and the lack of important control variables, such as other human resource practices applied.

In this paper we suggest an evaluation criterion for the consequences of flexible work time which is more comprehensive than single indicators and, at the same time, appears more adequate than a mere productivity measure. We stress the concept of technical efficiency. Technical efficiency gauges the use of resources within a firm relative to the best practice frontier that denotes the maximal ratio of input to output. We argue that the adoption of flexible time schedules does not necessarily shift the production function as a whole, but rather increases the efficiency of the production process. In other words, the distance between the current output and the firm's maximum production level possibly decreases. As the distinction between maximum and actual output is ignored in conventional estimations of the production function, they are likely to yield biased results of the determinants of productivity growth if inefficiency exists.

The goal of our paper is to investigate the impact of flexible work time schedules on firm efficiency using representative establishment data for Germany. The innovation of our analysis is to assess the impact of flextime on firm *efficiency* instead of firm *productivity*. Following the approach by Battese and Coelli (1995), we estimate a stochastic production frontier and a technical efficiency equation simultaneously, where the latter is assumed to depend on the type of work hour schedule as well as other firm characteristics. To date, frontier models have been almost exclusively applied to estimate the efficiency level or efficiency change of firms or whole industry sectors. We think that they provide a very appealing framework to evaluate the efficiency impact of all kinds of managerial practices (see for example Amess, 2003). With regard to working time, Schank (2003) compares the efficiency of German establishments using and not using overtime. To our knowledge the following study represents the first empirical application evaluating flexible working hours in terms of efficiency gains.[2]

At first glance, the results seem to indicate that firms do not to benefit from flexible work time arrangements on average. This surprising finding resolves once we further control for the degree of flexibility. It is striking to see that the use of work time schedules with moderate flexibility is positively related to technical efficiency. Highly flexible work hour models do not yield the expected additional efficiency

[2] Schank (2003) presents a production frontier estimation to assess the efficiency differences between overtime plants and standard-time plants and uses the percentage of employees with flexible work time schedules as an explanatory variable. In contrast to our approach, his model is based on the assumption that flexible working hours are related to the production possibility frontier instead of the efficiency level of the firm.

gains, though. On the contrary, firms with very flexible work time arrangements, e.g. schedules allowing very long time periods within which the accounts are to be settled, achieve a significantly lower efficiency level than establishments whose employees are compensated for their overtime hours (in terms of leisure) within one month. We attribute this result to a negative selection process of firms adopting highly flexible work time arrangements. Given that these work time schedules are very likely to restrict individual time sovereignty and even diminish job satisfaction, we argue that employees may not be willing to accept these drawbacks unless their jobs are unsecured and likely to be laid off due to economic difficulties of the employing firm. In this case, the use of flexible work time arrangements allowing a maximum of flexibility to the firms is highly endogenous and its effects on efficiency should not be interpreted as causality. Hence, our main result is that the use of work time schedules with moderate flexibility is positively related to technical efficiency.

The remainder of the paper is organized as follows: In Section 2 we discuss the concept of efficiency versus productivity and argue why adopting flexible work hour arrangements may lead to efficiency rather than productivity gains. In Section 3, we reflect on the relationship between flexible work hours and technical efficiency. The empirical model for estimating efficiency effects is outlined in Section 4, the data set is described in Section 5 and the estimation results are presented in Section 6. Section 7 concludes.

2 The concept of efficiency versus productivity

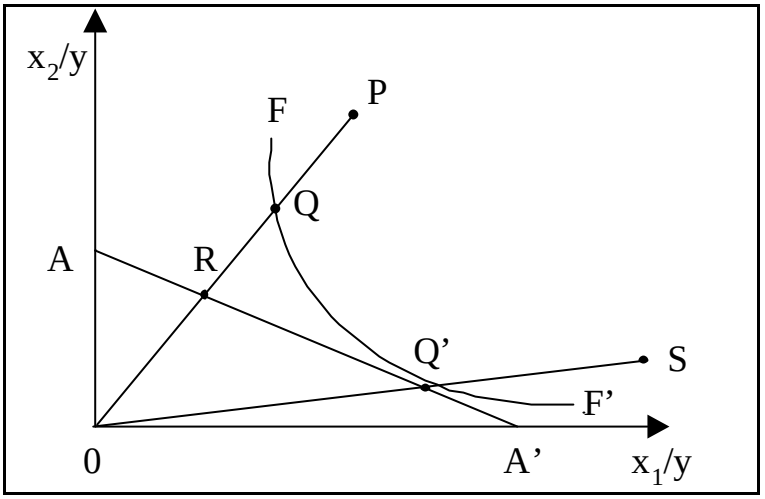
Modern efficiency measurement was triggered by Farrell (1957), who defined *total economic efficiency* as the product of *technical efficiency* and *allocative efficiency*. While technical efficiency reflects the ability of a firm to obtain maximal output from a given set of inputs, that is, the distance to the technology frontier, allocative efficiency describes the optimal proportion of inputs, given their respective prices. An increase in total factor productivity of a firm can be decomposed in an improvement of total economic efficiency and a shift of the underlying production technology frontier.

Farrell illustrates his approach with a simple example of an input orientated efficiency measure.[3] Take a firm which uses two input factors (x_1 and x_2) to produce a single output (y) under the assumption of constant returns to scale. The fully efficient unit isoquant is represented by FF' in Figure 1. If a firm requires more input to produce the same output, its production process is inefficient (point P). The

[3] The input and output oriented measure will provide equivalent measures of technical efficiency when constant returns to scale exist (Fare and Lovell, 1978)

technical inefficiency of that firm can be represented by the distance QP, where Q denotes the input/output ratio of an efficient firm operating on the production frontier. Technical efficiency is commonly measured by the ratio 0Q/0P ranging between zero and one.

Figure 1: Technical and allocative efficiency



Provided that input prices – or at least the input price ratio (AA') – are known, allocative efficiency can also be determined. In the setting of Figure 1, Q is the technically and allocatively efficient point. In contrast, S is allocatively efficient – because the input ratio x_1/x_2 in S is equal to Q' – but not technically efficient – because it requires more input to produce a given amount of output than a firm operating at point Q'. The allocative efficiency of a firm operating at point P is defined as the ratio 0R/0Q. Total efficiency, that is, the product of technical and allocative efficiency is then equal to 0R/0P. This measure describes what can be gained by economizing with the material and choosing the optimal proportion of inputs given the input price ratio. Since both, technical and allocative efficiency, range between zero and one, it is clear that total economic efficiency is also bound by zero and one.

Traditional approaches to productivity measurement ignore any kind of inefficiency and assume that the output observed is "best practice" or frontier output, implying that any change in total factor productivity is interpreted as a change of the production frontier. If inefficiency exists, total factor productivity growth does not necessarily result from technological change, though. It may also be due to an efficiency change in the production process, for instance, the use of flexible working hours. Hence, ignoring inefficiency may yield biased coefficient estimates of the productivity effects of flextime.

For this reason, the distinction between efficiency and productivity is crucial when conducting empirical analyses. In order to assess the total factor productivity effects

of flexible work time arrangements correctly, it does make a difference whether their use affects the efficiency of production 0Q/0P or the technology of production FF'. Nishimizu and Page (1982) define technological progress as the change in the best practice frontier. All other productivity changes - for example due to learning by doing, knowledge diffusion, improved managerial practices or short-run adjustment to shocks external to the enterprise - are denoted as efficiency changes. Accordingly, we argue that flextime does not shift the production function but may take the firm closer to its production frontier. The nature of the relationship between flexible time schedules and technical efficiency is discussed in more detail in the following section.

3 How does flextime affect efficiency ?

Flexible work time arrangements allow the weekly working hours to vary from one period to another (within a certain range) without any consequence for monthly wage earnings. Hence, actual weekly working hours are not fixed to contracted weekly hours any more. Often the deviations from contracted working hours are debited or credited to an individual work time account that has to be settled within a given time period. The maximum number of hours that may be debited or credited is usually limited.

Although there is no comprehensive theory formalizing the effects of flexible working hours, the existing literature – mainly within the behavioral and management science – points to various effects on labor productivity, capital utilization, employee turnover, job satisfaction or personnel problems, such as absenteeism or lack of skilled workers. The channels whereby the use of flexible time arrangements may affect the efficiency of the corresponding firm are twofold. On one hand, it is argued that flexible time schedules allow the firm to adjust quickly to shocks and seasonal *demand fluctuations.* The presupposition then is that mainly the employer benefits from increased time flexibility. On the other hand, it is also conceivable that the employee benefits from an innovative work time arrangement in terms of more *time sovereignty*.

3.1 Better adjustment to demand fluctuations

The traditional argument to opt for flexible working hours in manufacturing is based on the fact that product markets are subject to seasonal fluctuations. In principle, a firm has three options to react to short-term demand fluctuations: holding stocks, or adjusting either the number of employees or working hours. In contrast to manufacturing, firms in the service sector can hardly hold stocks, as this may be rather costly depending on the good. Flexible working hours are one opportunity to adjust labor input without causing additional costs for hiring and firing skilled employees. In addition, the adjustment of working hours to the actual work load

prevents overtime hours – which cause expensive overtime premiums - and reduces storage costs. Furthermore, flexible working hours may reduce slack in times of negative demand shocks, because the employees can be asked to work less than their contractual working hours. As a consequence, firms require fewer workers to produce a given output and technical efficiency increases. Furthermore, the load factor of capital goods improves if operation time is extended beyond the 8 hours day, since operation time is not necessarily linked to employees' working time any more.

These positive effects may be exterminated by the resistance of the employees, though. If they are not willing to accept the increasing uncertainty with respect to their weekly working hours, e.g. because they are not sufficiently compensated for this loss in workplace quality, the actual efficiency effects may be much smaller than the potential effects. Another hurdle for the flexible work time schedules to become efficient is the implementation. If employers do not succeed in reducing actual working hours in times of low demand, e.g. because employees tend to work many overtime hours in order to take more time off, the gains from flextime are very limited.

3.2 Increasing employees' time sovereignty

Beyond the need of balancing demand fluctuations firms face an increasing desire of their employees to balance work and family life – especially by dual-income households (OECD, 2002). The required amount of individual time sovereignty renders work time arrangements a crucial issue for employees. Hence, even firms which are not subject to seasonal effects may adopt flexible working hours in order to increase their employees' time sovereignty. If, for example, the individual can decide when and how many hours to work, flexible working hours facilitate the reconciliation of work and family life and help to accommodate personal preferences and motivate responsible employees. Another advantage is that commuting time can be reduced because commuting is no longer restricted to the rush hour.[4]

Some advocates point to the fact that firms which give their employees more freedom to allocate their working time may have less difficulties in attracting skilled employees (Evans, 1973, Schultes-Jaskolla and Stitzel, 1993) – a factor which is particularly advantageous in times of skill shortage (Bolch and Galvin, 2001). Rau and Hyland (2002) find that the attractiveness of these arrangements depends on the job seekers' family background and the perceived conflict between work and family.

[4] Lucas and Heady (2002) for instance show that commuters with flextime reported less driver stress and fewer feelings of time urgency than those without flextime.

Golembiewski and Proehl (1978, 1980) classify the potential consequences of flexible work hours into behavioral and attitudinal effects, though very few empirical analyses refer to the behavioral measures. The behavior of employees might change with respect to the use of sick leave or the tendency of absenteeism, tardiness, job turnover or overtime hours. Moss and Curtis (1985) analyze the effects of flexible working hours and show that economic theory does not necessarily predict a decrease in absenteeism. According to the empirical literature, however, flexible time arrangements seem to be an efficient means to reduce tardiness and absenteeism (see e.g. Dalton and Mesch, 1990). The evidence on a reduction of the turnover rate is rare, but mainly positive (Golembiewski and Proehl, 1978, 1980; Pierce and Newstrom, 1980, 1982). The attitudinal effects which summarize all kinds of "soft" outcomes, such as employee satisfaction, morale etc. are predominantly positive (Golembiewski and Proehl, 1978, 1980).

And how do these arguments relate to the efficiency of establishments? According to Nishimizu and Pages (1982), all productivity changes other than shifts in the best practice production frontier, for instance induced by new managerial practices and organizational innovations which make employees more productive, shall be denoted as technical efficiency changes. This classification is based on the assumption that firms using innovative human resource practices require less employees to produce a given output. Shepard, Clifton and Kruse (1996) argue, however, that the positive effects of flexible time schedules on management efficiency depend also on the production process, the size of the plant and the specific monitoring requirements. If, for example, the production activities do not require constant monitoring or if the productivity of individuals or teams cannot be easily observed such that controlling is outsourced anyway, managers' productivity may benefit from increased flexibility for the same reasons as that of other employees. On the other hand, the administrative work load may increase substantially with flexible working time and teamwork may become more complicated to manage which may counteract the efficiency effects described.

4 The empirical approach to assess efficiency effects

The production function of a fully efficient firm is not known a priori, and thus, must be estimated from the data. Once the best practice frontier is identified (see FF' in Figure 1), a deviation from this frontier is denoted as inefficiency.

Studies examining the impact of managerial experience or other firm-specific variables on firm-level efficiency traditionally use a two-step approach, first estimating a stochastic frontier model in order to calculate firm-level efficiency and then using this measure as the dependent variable in the second step. A crucial drawback of this procedure is that the assumptions about the distribution of the inefficiency effect are inconsistent in the two estimation stages (Kumbhakar, Gosh

and McGuckin, 1991). We therefore follow the simultaneous approach proposed by Battese and Coelli (1995), where the firm-level inefficiency is expressed as an explicit function of a vector of firm-specific variables. This approach imposes efficiency of factor allocation and permits panel analysis. Provided that inefficiency effects are stochastic, both technical change in the stochastic frontier and time-varying technical inefficiencies can be estimated simultaneously. The stochastic frontier production function for panel data can be written as follows:

$$\ln(Y_{it}) = X_{it} b + u_{it} - u_{it}.$$

The output Y_{it} of firm i at time t is described by a function of input factors and other firm characteristics X_{it} of firm i at time t. ß is the vector of parameters to be estimated. n_{it} are idiosyncratic errors and u_{it} are non-negative random variables denoting technical inefficiency of production in firm i at time t. The latter are assumed to be *iid* errors truncated at zero of the $N(m, s_u^2)$ distribution. Hence, the truncated errors are not identically distributed any more. Battese and Coelli (1995) propose to express the technical inefficiency effects u_{it} as an explicit function of a set of explanatory (firm-specific) variables z_{it} and an error term w_{it}:

$$u_{it} = z_{it} d + w_{it}$$

Note that w_{it} is defined by the truncation of the normal distribution with zero mean and variance σ^2 such that $w_{it} \geq -z_{it} d$. d denotes a vector of unknown parameters. By imposing further restrictions on the model, a number of special cases can be derived: First, if the technical inefficiencies (u_{it}) were assumed to be constant over time, heterogeneity in inefficiency among firms would be captured by firm-specific fixed or random effects. In a fixed effects estimation the impact of time-constant variables would be taken up by the fixed firm inefficiency effect. However, all firms would have the same influence on the shape of the production frontier. A random effects estimation, on the contrary, requires independence of inefficiency and the input level. Second, if all elements of the unknown vector of coefficients δ were equal to zero, technical inefficiency would not be related to the z-variables and the half-normal distribution $N(0, s_u^2)$ would be obtained.

Battese and Coelli (1995) propose the method of maximum likelihood to estimate the parameters of the stochastic frontier and those of the technical inefficiency, respectively efficiency, effects simultaneously. We apply the same method and refer to technical efficiency of production for firm i at time t, defined as:

$$\mathrm{TE}_{\mathrm{it}} = \mathrm{e}^{(-z_{it} d - w_{it})}.$$

We estimate TE_{it} separately for establishments in the manufacturing and the service sectors since production processes and work time requirements are expected to differ between these two industries. We use FRONTIER 4.1, a Fortran program for stochastic frontier and cost function estimation provided by Tim Coelli (Coelli, 1996).

5 Data

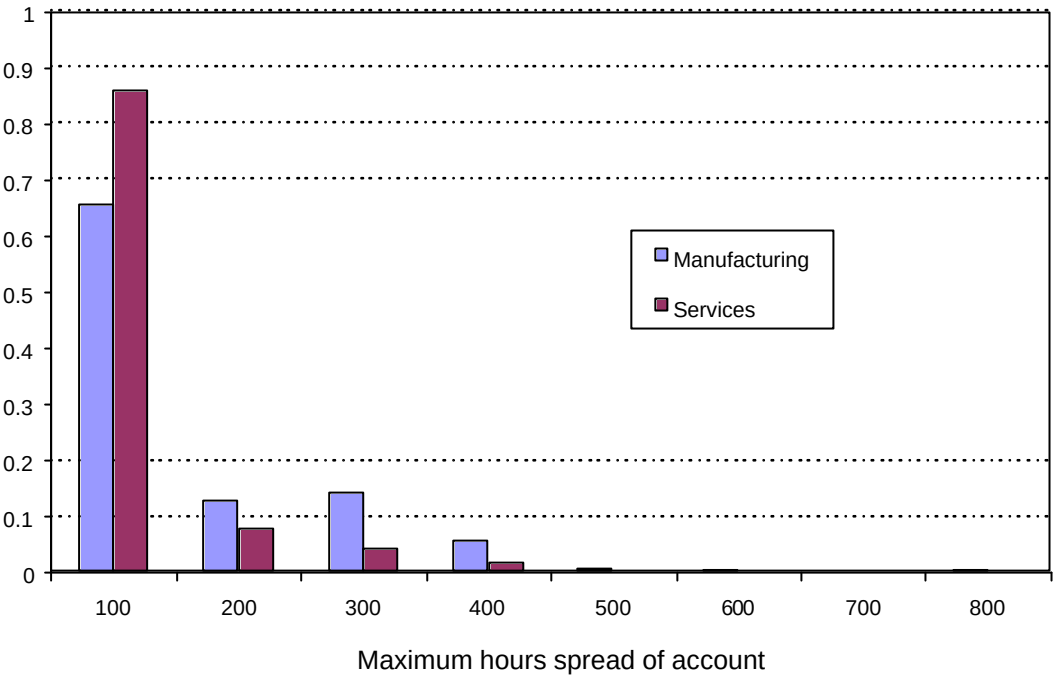
We draw on German data from the IAB establishment panel covering the years 1999 to 2002.[5] The establishments participating in this survey are randomly selected from the parent sample of all German establishments with at least one employee who pays social security contributions. Thus, self-employed and establishments with employees not covered by social security (mineworkers, farmers, artists, journalists, etc.) as well as public employers with only civil servants, do not belong to the original sample. Since 1993 (and since 1996 in East Germany) establishments are questioned annually about turnover, number of employees, personnel problems, apprenticeship training, investments, innovations, and business strategies. In specific years, additional topics, such as working hours, training and personnel measures, are covered by the questionnaire.

In 1999, detailed information on the use of work time arrangements was gathered: Firms were asked whether they apply flexible work hour schemes, and if so, the maximum size of the time accounts (flextime variation), the period of time within which the accounts are to be settled (flextime balance) and the percentage of employees covered by the schemes (flextime employees). The distributions of these variables among firms offering flexible work hours are illustrated in Figures 2 to 4, for the groups of manufacturing sectors and service sectors respectively. The majority of firms (about 65 percent of the firms in manufacturing and 85 percent in the service sectors), allow a maximum spread of 100 hours between debit and credit hours on the account. In manufacturing firms with flexible work time schedules, another 25 percent, tolerate an hours spread of 200 to 400. According to Figure 2, the flexibility with respect to the number of work hours that can be shifted from one time period to another is smaller in the service sectors. This also holds for the time period within which the time account has to be settled (see Figure 3). In manufacturing, almost half of the accounts have to be settled within half to one year. The corresponding figure amounts to 33 percent in the service sectors. It is interesting to note that the percentage of firms that do not specify a time limit to the settlement is very similar in both sectors (about 23 percent). From Figure 4 we conclude that, if a flexible work hour scheme is offered it applies to all employees in almost half of the establishments (42 percent of the firms in manufacturing and 47

[5] Descriptions of this data set can be found in Bellmann (1997) and Kölling (2000).

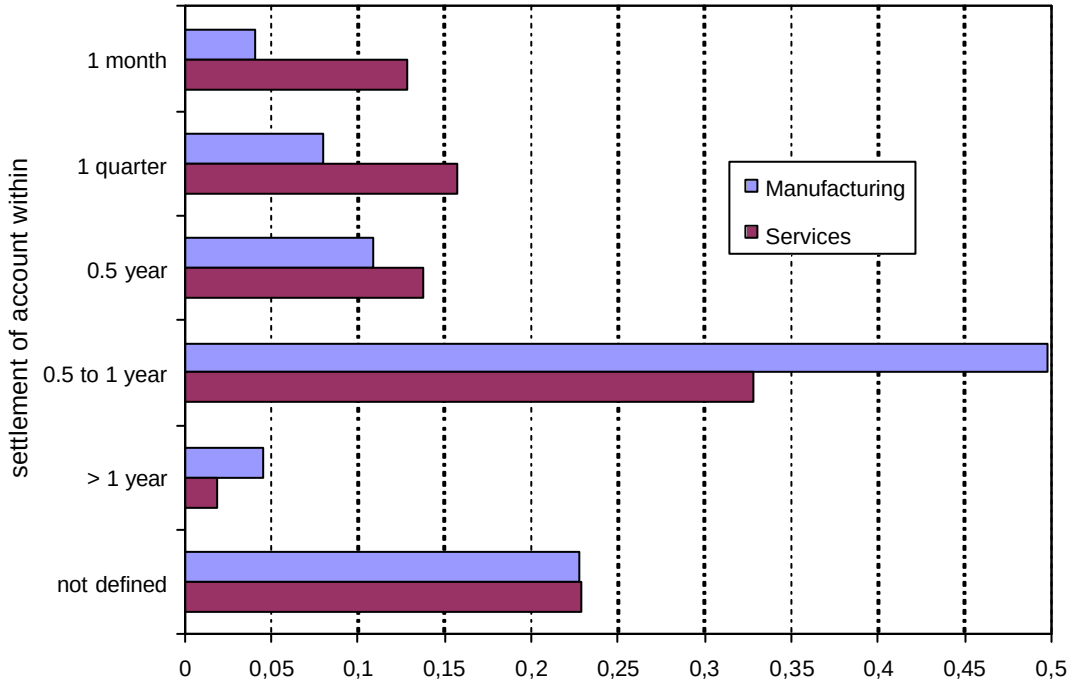
percent in service sectors). In 80 percent of the firms at least half of the workforce is covered.

Figure 2: Maximum number of working hours on work time accounts



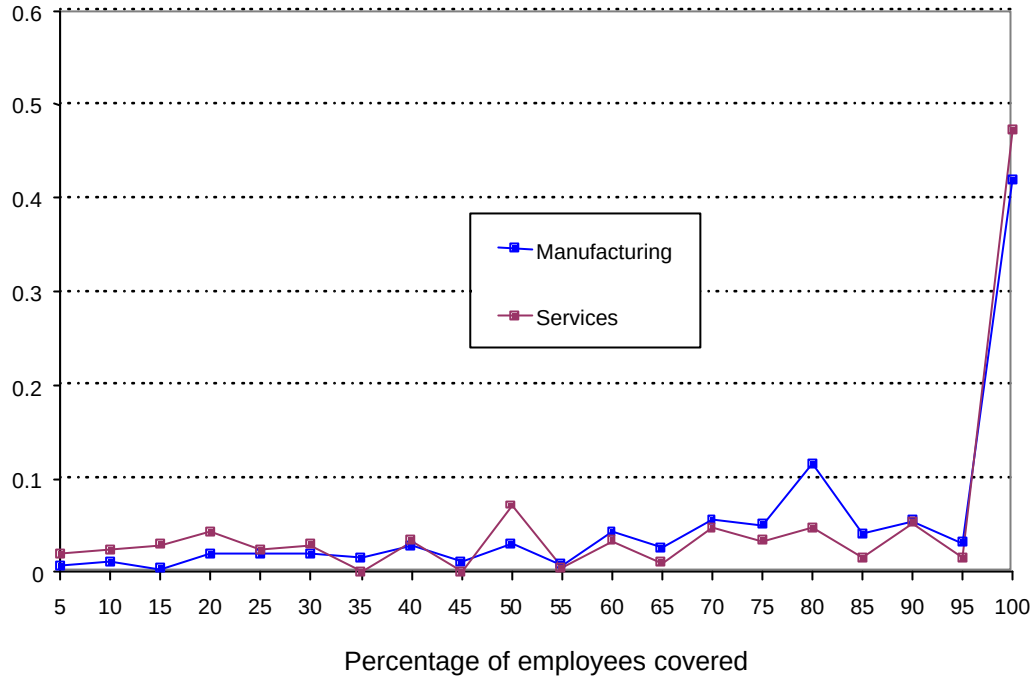
Source: IAB establishment panel, 1999.

Figure 3: Balancing period of working hours accounts



Source: IAB establishment panel, 1999.

Figure 4: Share of workforce covered by working hours accounts



Source: IAB establishment panel, 1999.

In addition to these flextime variables, we use information concerning other human resource practices. We construct dummy variables that indicate whether an establishment transferred responsibility and authority to lower hierarchical levels, whether teamwork and/or independent work groups were introduced until the end of 1999 (organizational change). Furthermore, we use questions from 1999 indicating whether the establishment offered employee share ownership and profit sharing (financial incentives). The answers to these questions cover several dimensions of lean management reorganizations and incentive wages, which are regarded as the main characteristics of high performance workplaces (Osterman, 1994; Ichniowski, Shaw and Prennushi, 1997; Appelbaum, Bailey and Kalleberg, 2000).

The full observation period of our analysis covers the years 1999 to 2001. That is, we assume flextime and other human resource measures introduced until 1999 to be in effect during our observation period. The means and standard deviations of all relevant variables in our final sample of 5711 observations are presented in Table 1.[6] On average, firms in the manufacturing sectors are larger (with respect to the number of employees) than establishments in the service sectors. This difference also shows up in the average value added and capital input. Also the proportion of skilled employees is larger and, not surprisingly, the percentage of exporting firms is

[6] We include only profit oriented establishments and establishments that have not been taken over by other establishments or have bought other establishments themselves.

by 10 percentage points higher than in the service sectors. In line with previous studies, unionization is lower in services (see e.g. Fitzenberger, Ernst and Haggeney, 1999).

Table 1: Descriptive statistics of the sample variables

	manufacturing sectors		**service sectors**	
	mean	**std. dev.**	**mean**	**std. dev.**
Value added	14.79	2.04	13.96	1.89
Capital (log(replacement inv.))	11.23	2.77	10.46	2.73
Labor (log(full-time equivalent))	3.58	1.62	2.78	1.56
Share of skilled employees	.68	.24	.62	.30
East Germany (1 = yes)	.63	.48	.56	.50
Exporting firm (1 = yes)	.33	.47	.11	.31
ICT investment (1 = yes)	.71	.45	.75	.43
State of technical equipment (1 = very old, 5 = new)	2.13	.75	1.98	.75
Industry sector				
Agriculture and forestry	.06	.23		
Mining and basic materials	.20	.40		
Chemical industry	.06	.24		
Mechanical engineering	.17	.37		
Electrical engineering	.13	.33		
Consumer goods	.16	.37		
Construction	.23	.42		
Trade	-	-	.28	.45
Transport, communication	-	-	.11	.32
Banking, finance	-	-	.00	.02
Insurance	-	-	.01	.08
Private services	-	-	.14	.35
Education	-	-	.06	.23
Health sector	-	-	.12	.32
Business-related services 1	-	-	.17	.38
Business-related services 2	-	-	.11	.31

Table 1: continued

Organizational characteristics				
Flextime dummy	.49	.50	.28	.45
Flextime variation	2.64	4.96	.67	2.09
Flextime balance	2.02	2.25	1.02	1.86
Flextime employees (in %)	.39	.44	.21	.37
Part-time employees (in %)	.07	.12	.19	.24
Limited contract employees (in %)	.04	.10	.04	.11
Organizational change	.59	.88	.56	.84
Financial incentives	.17	.42	.16	.41
Training (1 = yes)	.63	.48	.65	.48
ISO 9000 (1=yes)	.31	.46	.16	.37
Work council (1 = yes)	.33	.47	.20	.40
Pay agreement (1 = yes)	.82	.38	.70	.46
Firm size				
< 20 Employees	.37	.48	.57	.49
20-199 Employees	.46	.50	.34	.47
200-499 Employees	.10	.30	.06	.23
500-999 Employees	.03	.17	.02	.13
> 999 Employees	.03	.18	.01	.12
Number of observations	3,598		2,113	

Note: Flextime variation represents the maximum range of the working hours account calculated as maximum excess hours minus maximum minus hours re-scaled by division by 20. Flextime balance combines six categories (see Figure 3) on a scale from one to six. Flextime employees gives the percentage of employees to whom flexible working hours apply. Note, that these numbers refer to all firms, not only to those providing flextime.
Source: IAB establishment panel, 1999-2002.

It is interesting to note that the use of flexible work hours is much more popular in manufacturing (49%) than in the service sector (28%). According to Figure 2 to 4 it turned out that the time schedules implemented in the manufacturing sector also seem to be more flexible. That is, the possible deviations from the number of contractual hours are larger and the time period to settle an hours deficit or surplus is longer.

6 Estimation results

The technical efficiency effects of flexible working hours are evaluated applying a stochastic production frontier approach to panel data of German establishments. We follow Battese and Coelli (1995) by estimating the production function and the technical efficiency equation simultaneously. Our stochastic production function represents a linearized version of the logarithm of the Cobb-Douglas production function of capital and labor. The observation period covers the years from 1999 to 2001. Output is measured as value added[7], capital input is approximated by replacement investments and labor input is defined as the weighted number of employees (in full-time equivalents).[8] In addition to capital and labor, further information about the type and "quality" of these two input factors have been added as explanatory variables to the Cobb-Douglas production frontier. We expect that the share of qualified employees, investments in information and communication technology as well as the state of the technical equipment[9] are related to the productivity possibilities of the establishment. East German establishments may still have lower productivity, and differences between the business sectors are captured by 16 dummy variables. The legal status of the establishment is included as a further set of control variables.

We run separate estimations for establishments belonging to manufacturing and service sectors because structural differences – not only with respect to the production process but also concerning the efficiency effects of flextime – may be substantial. [10]

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[7] Value added is constructed as turnover minus costs for purchased materials and services (for example rent, raw materials, insurance premia, travel costs, license costs etc.).

[8] The definition of this measure is based on the assumption that productivity does not vary with the number of working hours. Given that the relationship between the number of working hours and productivity is not definitely clear and presumably depends on the type of task, we argue that the assumption of constant productivity is justified.

[9] This variable is based on the question whether the technical equipment – compared to others firm within the same sector – is completely outdated (=1), up to date (=5).

[10] The sector groups consist of: Manufacturing = Agriculture and forestry, mining and basic materials, food, consumer goods, production goods, investment goods, construction; Services = trade, traffic and communication, credit and insurance, hotels and restaurants, education, health and social affairs, electronic data processing and research and development, business consulting and other business services and other personal services.

Table 2: Estimation of the production frontier for the manufacturing sectors

	Model 1		Model 2		Model 3	
	Coeff.	**T-stat.**	**Coeff.**	**T-stat.**	**Coeff.**	**T-stat.**
Constant	10.859	161.67	10.859	165.02	10.859	156.64
Ln(capital)	0.075	13.49	0.075	13.20	0.075	13.59
Ln(labor)	0.955	90.53	0.958	89.72	0.958	98.08
Share of skilled employees (%)	0.418	8.69	0.418	8.63	0.417	8.61
East Germany	-0.323	-13.13	-0.325	-12.94	-0.324	-13.46
ICT investment	0.031	1.20	0.032	1.21	0.033	1.28
State of technical equipment	-0.089	-6.14	-0.089	-6.19	-0.088	-6.15

Note: Additional control variables include the legal status of the establishment (3 categories) and 6 sector dummies.
Source: IAB establishment panel, 1999-2002, 3598 observations from 1817 firms.

The estimation results of the production frontier equations for the manufacturing and service sectors are displayed in Tables 2 and 3. The three models differ with respect to the choice of work time-variables in the efficiency equation. Model 1 only uses a single indicator for establishments using any kind of flexible working hours. In Model 2 and three, we add more variables describing the degree of flexibility enhanced by the work time arrangement. The results indicate that the establishments in all three set-ups produce with constant scale elasticities and with a capital intensity of around 7 to 8 percent. The low capital coefficient may be a consequence of the approximation of capital by replacement investments. The measurement errors incurred by this method lead to the well-known bias of the capital coefficients towards zero (Griliches and Mairesse, 1998). The share of skilled employees, ICT investments and the state of equipment all have the expected positive effects on the productivity of the enterprises. Both the use of information and communication technology and up-to-date equipment shifts the production frontier to a higher level. Furthermore, firms employing more qualified employees are able to produce more – everything else being equal. The productivity gap between establishments operating in East and West Germany is still persistent, and the productivity differentials between sectors are jointly significant. Finally it is notable that only minor

differences exist between manufacturing and service firms. For instance, investment in ICT yield significantly higher returns in the service sector.[11]

Table 3: Estimation of the production frontier for the service sectors

	Model 1		Model 2		Model 3	
	Coeff.	**T-stat.**	**Coeff.**	**T-stat.**	**Coeff.**	**T-stat.**
Constant	10.600	105.66	10.641	95.21	10.631	96.44
Ln(capital)	0.073	10.79	0.071	8.85	0.072	9.30
Ln(labor)	0.846	48.48	0.843	42.73	0.840	41.03
Share of skilled employees (%)	0.244	4.02	0.234	3.63	0.239	3.84
East Germany	-0.346	-9.37	-0.350	-9.46	-0.349	-9.49
ICT investment	0.138	3.14	0.138	3.11	0.136	3.09
State of technical equipment	-0.089	-3.84	-0.090	-3.78	-0.089	-3.79

Note: Additional control variables include the legal status of the establishment (3 categories) and 6 sector dummies.
Source: IAB establishment panel, 1999-2002. 2113 observations from 1155 firms.

The estimation of the technical efficiency equation is meant to take account of all other output determinants that do not shift the production frontier, but rather affect the organization of the work flow and hence the efficiency level of the firm. First of all, the use of flexible work time arrangements is supposed to determine an efficient use of the input factors. Therefore, various measures of the extent to which flextime is used are defined. In Model 1, we only include a dummy variable indicating whether any sort of flexible work hour scheme is applied in the firm at all (*flextime dummy*). In Model 2, we further control for the flexibility with respect to the maximum size of the time accounts, that is the number of hours that can be shifted (*flextime variation*), the maximum length of time within which a time account may be settled (*flextime balance*) and the proportion of employees per firm affected by flextime (*flextime employees*). We use three indicators equaling one if the work time arrangement is very flexible in the respective dimension. That is, *flextime variation* equals one, if more than 20 hours can be shifted from one time period to another.[12]

[11] At this point, it may be argued that these estimation results do not justify separate regressions for manufacturing and service sector firms but Tables 4 and 5 will reveal that differences are much more prevalent with respect to the determinants of technical efficiency.

[12] Work time arrangements that allow only few hours to be shifted from one week or month to the other are generally denoted as "Gleitzeit" and differ significantly from highly flexible time schedules.

Flextime balance equals one, if the time period within which a time account may be settled comprises at least one year and finally, the *flextime employees* dummy indicates whether more than 95 percent of the employees are covered by the work time arrangement. In Model 3, we use a cumulative measure for all three dimensions of flexibility to accommodate possible multi-collinearity effects.

Since flexible work hour schemes are often implemented together with other organizational innovations, the identification of flextime effects requires additional information on the human resource practices applied in the specific firm. In contrast to Shepard, Clifton and Kruse (1996) our data provide detailed information about other human resource practices. Therefore, we use indicator variables capturing the effects of employee involvement, profit sharing and training as additional controls.[13] Firm characteristics, such as the proportion of employees working part-time and those having limited contracts, indicate the flexibility of the firm and may hence be important determinants of firm efficiency. The existence of an ISO9000 plan, indicating a high management standard, as well as the existence of a work council and wage agreements are also accounted for. Finally, firm size categories are added to the set of control variables.[14]

Table 4 and 5 reveal the efficiency effects of work time arrangements and all other explanatory variables in manufacturing respective service firms. As long as we ignore the specific features of the work time schedules (Model 1), the results indicate that flextime firms are not more efficient than establishments without flexible work time arrangements. In the service sectors, flextime firms seem to be even less efficient than establishments without flexible work time arrangements. Note that the information about the time schedules refers to a single observation in 1999. Provided that some of the firms may not have used flexible working hours during the whole observation period, this effect can be interpreted as a lower bound of the resulting efficiency gains.

[13] We construct cumulative indices “organizational change”, “incentives” and “training” that sum up the use of single HPW measures listed in the questionnaire (training refers to only one item in the questionnaire).

[14] Since information on the load factors of capital and labor is not available during the whole observation period, we have no indication whether the input factors are used to capacity.

Table 4: Estimation of the technical efficiency TE equation in the manufacturing sectors

	Model 1		Model 2		Model 3	
	Coeff.	**T-stat.**	**Coeff.**	**T-stat.**	**Coeff.**	**T-stat.**
Constant	-13.343	-13.68	-13.656	-11.83	-13.108	-12.79
Flextime dummy	0.051	0.43	2.877	8.21	1.816	3.54
Flextime variation	–	–	-0.874	-3.60	–	–
Flextime balance	–	–	-2.995	-9.74	–	–
Flextime employees	–	–	-0.003	-0.01	–	–
Flextime high	–	–	–	–	-1.038	-4.36
Part time, % of employees	4.362	5.69	5.575	8.42	5.522	8.13
Limited contract, % of employees	6.040	7.24	6.035	7.52	5.841	9.21
Organizational change	0.024	0.42	0.051	0.52	0.108	1.24
Incentive schemes	-0.656	-5.16	-0.770	-3.14	-0.958	-2.52
Training	0.108	0.85	0.050	0.45	0.087	0.77
ISO 9000	-0.005	-0.03	0.380	2.18	0.620	2.45
Work council	-6.467	-25.95	-6.097	-13.22	-5.747	-10.53
Pay agreement	1.328	10.67	1.238	7.01	1.260	4.10
20-199 Employees	1.809	10.75	2.037	6.55	1.736	8.55
200-499 Employees	-0.791	-2.22	-0.136	-0.20	-0.386	-0.79
500-999 Employees	-1.368	-3.43	-1.112	-1.75	-1.395	-1.97
> 999 Employees	-0.381	-0.63	0.317	0.32	-0.760	-1.31
σ^2	6.593	13.94	6.649	12.52	6.412	13.30
γ	0.965	327.11	0.965	285.64	0.963	272.90

Source: IAB establishment panel, 1999-2002. 3598 observations from 1817 firms.

Once we take into account the heterogeneity of the work time schedules, the effects become more diverse (see Model 2). It estimation results indicate that efficiency gains seem to depend on specific features of the flextime scheme and the respective group of employees covered by this scheme. In the manufacturing sector, it turns out that a high number of work hours which can be “saved” or “borrowed” on the work time account and a long balancing period hampers efficiency. Even though, the percentage of employees concerned with flexible work hours does not affect the efficiency gains. The positive coefficient of the flextime dummy indicates, however, that work time arrangements with moderate flexibility actually improve the efficiency of the work process. The results are slightly different in the service sector. Whereas work time arrangements covering a high share of employees seem to reduce the technical efficiency of the establishment as well as fixing long periods

within which the work hour account has to be balanced, the number of work hours that may be shifted has no significant effect in the efficiency equation. These results lead one to conclude that the use of flextime should be well-directed. It may be conceivable, that flexible work hours, if generally applied, evoke high coordination and transaction costs, such that the potential efficiency gains are offset.

A uniform result is, that the coefficient of *flextime balance* is negative and significant in both industries, implying that very long balancing periods offset the efficiency gains of moderate flextime arrangements. Although long balancing periods seem to be convincing in theory, the implementation often fails due to undesirable hour hoarding. If, for example, the management does not succeed in reducing the actual work hours of the employees in the doldrums, work time accounts tend to show high work hour savings. Since long balancing periods do not frequently force the managers to reduce overtime hours, the average credit of work hours tend to be higher compared to flextime arrangements with short balancing periods. But what happens to these overtime hours at the end of the balancing period? One possibility is that the hours credit expired without any compensations. In this case, employees may be discouraged and work less with reduced effort. Another way to balance the work hours account is to pay out all accumulated hours at the end of the balancing period or to shift them to a sort of work life hour account, which can be used to finance an early pension. The problem is then that the efficiency gains from flexible work hours are completely offset.

The results of Model 2 suggest that highly flexible work time accounts yield less efficiency gains than arrangements allowing moderate flexibility. In order to test this hypothesis, we use a cumulative measure of highly flexible work time schedules defined as the sum of the three flextime variables in Model 2 (see Model 3). As expected, the corresponding coefficient is negative and significant in both sectors. As long as the implemented work time model is highly flexible in only one dimension (hour variation, balancing period or, percentage of employees), the overall effect is still positive. If, however, two of the three indicators equal one, the efficiency effect of the flextime model becomes negative. Thus, flexible work hour arrangements only lead to a more efficient production to capacity if they allow moderate flexibility but they are not a tool to be applied in an extreme sense and for all employees.

Table 5: Estimation of the technical efficiency TE equation in the service sectors

	Model 1		Model 2		Model 3	
	Coeff.	**T-stat.**	**Coeff.**	**T-stat.**	**Coeff.**	**T-stat.**
Constant	-2.130	-2.29	-1.860	-2.44	-2.014	-2.29
Flextime dummy	-0.525	-2.50	0.523	2.26	0.465	1.91
Flextime variation	–	–	0.268	0.71	–	–
Flextime balance	–	–	-1.207	-2.87	–	–
Flextime employees	–	–	-1.224	-2.88	–	–
Flextime high	–	–	–	–	-0.872	-3.31
Part time, % of employees	1.483	3.65	1.438	3.79	1.458	3.74
Limited contract, % of employees	1.283	2.46	1.042	2.07	1.065	2.09
Organizational change	-0.054	-0.82	-0.032	-0.51	-0.033	-0.51
Incentive schemes	-1.560	-3.13	-1.357	-3.40	-1.369	-3.21
Training	-0.562	-2.83	-0.501	-2.92	-0.530	-2.97
ISO 9000	-2.853	-2.93	-2.781	-3.15	-2.715	-3.02
Work council	-1.063	-2.92	-1.156	-3.21	-1.217	-3.11
Pay agreement	0.055	0.46	0.072	0.60	0.076	0.64
20-199 Employees	-0.040	-0.22	-0.107	-0.59	-0.082	-0.46
200-499 Employees	0.822	1.84	0.755	1.25	0.906	1.82
500-999 Employees	2.106	3.05	1.856	2.83	1.907	2.89
> 999 Employees	2.199	2.73	2.181	2.74	2.066	2.75
σ^2	2.000	4.79	1.866	5.49	1.953	4.75
γ	0.769	15.28	0.750	15.18	0.761	14.30

Source: IAB establishment panel, 1999-2002. 2113 observations from firms.

Alternatively, our diverging results may be interpreted as evidence for endogeneity of flextime hours. It cannot be ruled out that the introduction of flexible work hours arrangements may be endogenous, meaning that those firms performing particularly well or badly are more likely to make use of flextime. According to March and Simon (1958) or Cyert and March (1963) organizational and strategic changes that would improve performance are often adopted in times of economic hardship. Anecdotal evidence in recent years supports this notion. Hence, we argue that the use of highly flexible work time arrangements is most likely to occur in times when the future of the firm is uncertain and employees fear to loose their jobs.

The literature on the economics of organizations provides various economic arguments to explain why employees engage in so called „influence activities" aiming at preserving the status quo (see e.g. Milgrom 1988, Milgrom and Roberts, 1988). Schaefer (1998), for instance, argues that the resistance against changes is lower in a survival-threatening crisis, because the value to the job-related quasi rents is increasing in the firms' prospective. This implies that if the firm is likely to go bust, employees cannot benefit from their regulated working hours anymore, because they are laid off. In this setting, they might prefer a loss in time sovereignty compared to job loss. As a consequence, highly flexible work time arrangements that allow little time sovereignty presumably are adopted when firm performance is low such that influence activities are limited. The estimated coefficient on highly flexible work time schedules is therefore likely to be biased and should not be interpreted in a causal way.

Furthermore, it may be argued that instituting flextime is just a general reflection of the workplace quality, that is the flextime variables capture the overall quality of the work process organization and not the efficiency gains from flexible work time schedules. We therefore try to accommodate for the impact of heterogeneous workplace characteristics by including several control variables, such as organizational change or financial incentive schemes.[15] While organizational changes aiming at increasing the participation of employees seem to make firms more efficient in the service sector, no significant effects can be determined in both sectors. This result may partly be attributed to the fact that firms doing badly are more likely to change their organizational structure. As a result, the effect of organizational changes is likely to be underestimated (see e.g Nickell, Nicolitsas and Patterson, 2001 or Wolf and Zwick, 2002b).

Rather surprising is the result that the use of financial incentive schemes decreases the efficiency of manufacturing and service establishments. Even if the results of Wolf and Zwick (2002a) suggest, that the productivity effects of financial incentive programs are often overestimated, because firms performing relatively well are more likely to apply financial incentive programs, the negative coefficient is rather striking. One explanation may be that our observation period covers the most disastrous years at the stock markets. The German stock market indicator DAX lost about 1520 points between 1999 and 2001 which refers to a reduction of stock market assets of almost 30 percent. In the following year 2002, the DAX lost another 45 percent. Given that stock option plans are one of the most common measures in Germany to share the profit or assets among the employees, the negative effect on firm efficiency and hence, also on firm productivity, is not that

[15] If firm heterogeneity is not adequately captured by these variables, the estimated coefficients may be biased. Unfortunately, the statistical package in use (Frontier 4.1) does not allow to incorporate IV-estimates in the efficiency equation.

implausible any more. Furthermore, it is interesting to note that skeptical voices about the advantages of performance related pay are increasing in number. Opponents argue that the prospect of huge amounts of financial incentive payments give rise to maximizing short-term profits which may be detrimental to the long-term growth of the firm (Lambert, Laner and Larcker, 1989, Johnson, Ryan and Tian, 2003, Frey and Osterloh, 2004). Another, rather established, argument against performance related pay is that monetary incentive crowds out intrinsic motivation. As a result, employees may focus solely on rent-paying acitvities and thereby neglect other tasks, such as the diffusion of knowledge (for a comprehensive overview of the empirical evidence see Frey and Jegen, 2001).

Hiring part-timers or employees with limited contracts provide alternative ways to adjust the production to seasonal demand fluctuations. The result that the percentage of part-time employees or workers with limited contracts improve firm efficiency is therefore in line with our expectations. Meeting the requirements of the management certificate ISO9000 has the expected positive effect in manufacturing firms (see Model 2 and 3), but unexpectedly not in the service sectors. Also surprising is the effect of training. While the corresponding coefficient is positive – but insignificant – in the manufacturing sector, the efficiency of service sector firms seem to suffer from training activities. The non-positive effects might be due to the fact that extensive training activities hinder the organization of the work flow and hence deteriorate the technical efficiency in the short run.

In contrast to the findings of many papers studying the effect of work councils on productivity, our estimates indicate that the institutionalized involvement of employees does not increase value added but rather hampers efficiency. However, Schank, Schnabel and Wagner (2002) as well as Addison et al. (2003), who estimate fixed effects frontier production functions with the same data we use, do not find clear-cut evidence that work council plants are more efficient than their counterparts without councils, either. In practice, work councils may prevent flexible adjustments to demand fluctuations, since they have to agree to unusual temporal extensions of work hours. The results on the efficiency effects of pay agreements support the hypothesis that fixed rates for wage and salaries avoid costly and inefficient debates about wages within the firm. The coefficient on the pay agreement dummy is positive in both sectors, but not significant in the service sector.

Finally the effects of firm size differ between the two sectors. The efficiency of manufacturing firms decreases with the number of employees. This may indicate that larger firms suffer more from slack, higher organizational transaction costs and presumably free riding. Large service firms, on the contrary, seem to benefit from economies of scale.

The parameter $s^2 = s_u^2 + s_u^2$ is reported for both sectors and describes the variance of the stochastic terms in the production function, u_{it}, and the inefficiency term u_{it}. g is a measure of efficiency which ranges between zero and one. If g is equal to zero, the model reduces to a mean response function in which all variables of the efficiency equation add to the production function. In our case, this parameter is close to one in both sectors and significantly different from zero. Another test of the underlying error structure is provided by the LR statistic whether the error term n_{it} is one-sided, that is, whether the frontier model is superior to the OLS model. The test statistic is highly significant in both sector groups which we interpret as a justification of the frontier approach.[16]

7 Conclusions

The use of flexible work hour arrangements is often praised as an efficient mean to boost firm performance and employees' time sovereignty. Though to date, the theoretical and empirical evidence is not conclusive, and often focuses on specific aspects of work time flexibility only. While several papers cover the attitudinal and behavioral consequences of flextime, there exists no study for Germany investigating the effects of work hour arrangements on technical efficiency at the firm level. We argue that the adoption of flexible time schedules does not necessarily shift the production function, but rather increases the efficiency of production.

We assess the impact of flexible work time schedules on firm efficiency using representative establishment data for Germany. Since our data provide detailed information on other human resource practices in the firm as well – often implemented together with work time schedules – we can disentangle the diverse effects resulting from flextime and other human resource innovations. Following the approach by Battese and Coelli (1995) we estimate a stochastic production frontier and an equation of technical efficiency simultaneously. Firm-level efficiency is expressed as an explicit function of a vector of firm-specific variables. This way we can provide unbiased results of the determinants of productivity growth even if inefficiency exists.

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[16] Another rather indirect test of the frontier model is the comparison of a Cobb-Douglas production function including all variables z_{it} as explanatory variables and the estimation results of the inefficiency equation. The effects with respect to our flextime-indicators vary tremendously between the two specifications and most other variables are insignificant in the production function approach. This leads one so suppose that ignoring inefficiency leads to biased estimates.

At first glance, the empirical results indicate that the provision of flexible work time is negatively related to technical efficiency on average. This surprising finding is resolved once we further control for the degree of flexibility. Firms using work time arrangements allowing moderate flexibility turn out to be more efficient than establishments with fixed time schedules. In contrast to that, particularly highly flexible work hour models – be it with regard to the maximum hours that can be shifted from one period to another, the time period within the hours accounts has to be settled or the share of workforce covered – do not yield the expected efficiency gains. Since work time arrangements are more flexible in the manufacturing sector on average, the efficiency gains from time schedules allowing moderate flexibility are offset. However, we argue that the use of highly flexible work time arrangements may be endogenous, as they are most likely to be negotiated in times when the future of the firm is uncertain and employees fear to loose their jobs otherwise. This line of reasoning is consistent with results from a recent survey on the employees' attitudes towards flexible work hours in Germany. As turns out, the majority of the respondents prefer rather regulated time schedules, because they fear the uncertainty about their daily or weekly work load (Eberling et al., 2004). Hence, the efficiency losses of highly flexible work time arrangements should not be interpreted as a causal effect but rather as an indicator for struggling firms trying to overcome their difficulties by implementing fundamental organizational and strategic changes.

Despite these reservations against highly flexible time schedules, one may raise the question why arrangements with moderate flexibility are adopted only by a minority of firms – given that the overall productivity effect of flexible work hour schedules seem to be positive. We can think of three arguments: (1) incomplete information about the expected efficiency effects, (2) firms that do not apply flexible work time schedules expect no or very low gains in efficiency (selection effect) and (3) internal resistance against organizational changes. A consideration of these issues would require more detailed data sets and information about the implementation processes of work time accounts and is therefore left to future research.

References

Addison, J. T., Schank, T., Schnabel, C. and J. Wagner. (2003): *German Work Councils in the Production Process*, IZA Discussion Paper No. 812.

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

Amess, K. (2003): The Effect of Management Buyouts on Firm-Level Technical Inefficiency: Evidence From a Panel of UK Machinery and Equipment Manufacturers, *Journal of Industrial Organizations*, Vol. 60(1), pp. 35-44.

Battese, G. E. and T. J. Coelli (1995): A Model of Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data, *Empirical Economics*, Vol. 20, pp. 325-332.

Bellmann, L. (1997): Das Betriebspanel, in: Hujer, R./Rendtel, U./Wagner, G. (Hrsg.), *Wirtschafts- und Sozialwissenschaftliche Panelstudien*. Sonderheft des Allgemeinen Statistischen Archivs, Heft 30, pp. 169-182.

Bellmann, L. and O. Ludewig (2000): Verbreitung von Arbeitszeitkonten in Deutschland, *arbeit und beruf*, pp. 137-139.

Bispinck, R. (1998): *Zwischen Plus und Minus: Zeitkonten in Tarifverträgen*, Informationen zur Tarifpolitik Nr. 35, Wirtschafts- und Sozialwissenschaftliches Institut der Hans-Böckler-Stiftung (WSI), Düsseldorf.

Bolch, M. and T. Galvin (2001): The Coming Crunch, *Training*, April 2001.

Coelli, T. (1996): A Guide to FRONTIER Version 4.1: a Computer Program for Stochastic Production and Cost Function Estimation, CEPA Working Paper 96/07, University of New England, Australia.

Cyert, R. M. and J. G. March (1963): *A Behavioral Theory of the Firm*, Blackwell.

Dalton, D. R. and D. J. Mesch (1990): The Impact of Flexible Scheduling on Employee Attendance and Turnover, *Administrative Science Quarterly*, Vol. 35(1), pp. 370-387.

Eberling, M., Hielscher, V., Hildebrandt, E. and K. Jürgens (2004): Prekäre Balancen. Flexible Arbeitszeiten zwischen betrieblicher Regulierung und individuellen Ansprüchen, *Forschung aus der Hans-Böckler-Stiftung 53, Berlin.*

Evans, Archibald (1973): *Flexibility in Working Life: Opportunities for Industrial Choice*, Organization for Economic Cooperation and Development, Paris.

Fare, R. and C. A. K. Lovell (1978): Measuring the Technical Efficiency of Production, Journal of Economic Theory, Vol. 19, pp. 150-162.

Farrell, (1957): The Measurement of Productive Efficiency, *Journal of the Royal Statistical Society*, Vol. A(CXX(3)), pp. 253-290.

Fitzenberger, B, M. Ernst and I. Haggeney (1999): Wer ist noch Mitglied in Gewerkschaften? Eine Panelanalyse für Westdeutschland, *Zeitschrift für Wirtschafts- und Sozialwissenschaften*, pp. 223-263.

Frey, B. S. and R. Jegen (2001): Motivation Crowding Theory: A Survey of Empirical Evidence, *Journal of Economic Surveys*, Vol. 15(5), pp. 589-611.

Frey, B. S. and M. Osterloh (2004): Yes, Managers Should be Paid Like Bureaucrats, *Working Paper, University of Zurich*.

Golembiewski, R. T. and C. W. Proehl (1978): A Survey of the Empirical Literature on Flexible Workhours: Characteristics and Consequences of a Major Innovation, *Academy of Management Review*, Vol. 3(4), pp. 837-853.

Golembiewski, R. T. and C. W. Proehl (1980): Public Sector Applications of Flexible Workhours: A Review of Available Experience, *Public Administrative Review*, Vol. 40(1), pp. 72-85.

Griliches Z. and J. Mairesse (1998): Production Functions: The Search for Identification, in: Strøm, S. (ed.): *Econometrics and Economic Theory in the 20th Century*, Cambridge University Press, pp. 169-203.

Hübler, O. (1995): Produktivitätssteigerung durch Mitarbeiterbeteiligung in Partnerschaftsunternehmen, *Mitteilungen zur Arbeitsmarkt- und Berufsforschung*, Vol. 2, pp. 214-223.

Ichniowski, C., Shaw, K. and G. Prennushi (1997): The Effects of Human Resource Management Practices on Productivity: A Study of Steel Finishing Lines, *The American Economic Review*, Vol. 87(3), pp. 291-313.

Johnson, S. A., Ryan Jr., H. E. and Y. S. Tian (2003): Executive Compensation and Corporate Fraud, *Working Paper e. J. Ourso College of Business Administration, Louisiana State University*.

Kim, J. S. and A. F. Campagna (1981): Effects of Flextime on Employee Attendance and Performance: A Field Experiment, *Academy of Management Journal*, Vol. 24(4), pp. 729-742.

Kölling, A. (2000): The IAB-Establishment Panel, *Schmollers Jahrbuch*, Vol. 120(2), pp. 291-300.

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

Kumbhakar, S. C., Ghosh, S. N. and J. T. McGuckin (1991): A Generalized Production Frontier Approach for Estimating Determinants of Inefficiency in US Dairy Farms, *Journal of Business & Economic Statistics*, Vol. 9(3), pp. 279-286.

Lambert, R. A., Lanen, W. N. and D. F. Larcker (1989): Executive Stock Option Plans and Corporate Devided Policy, *Journal of Financial and Quantitative Analysis*, Vol. 24, pp. 409-425.

Lucas, J. L. and R. B. Heady (2002): Flextime Commuters and their Driver Stress Feelings of Time Urgency, and Commute Satisfaction, *Journal of Business & Psychology*, Vol. 16(4), pp. 565-572.

March, J. G. and H. A. Simon (1958): *Organizations*, Wiley.

Milgrom, P. R. (1988): Employment Contracts, Influence Activities, and Efficient Organization Design, *Journal of Political Economy*, Vol. 96(1), pp. 42-60.

Milgrom, P. R. and J. Roberts (1988): An Economic Approach to Influence Activities in Organizations, *American Journal of Sociology*, Vol. 94 Supplement S154-S179.

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

Moss, R. L. and T. D. Curtis (1985): The Economics of Flextime, *Journal of Behavioral Economics*, Vol. 14(2), pp. 95-114.

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

Nishimizu, M. and J.M: Page (1982): Total Factor Productivity Growth, Technical Progress and Technical Efficiency Change. Dimensions of Productivity Change in Yugoslavia, 1965-78, *Economic Journal*, Vol. 92(368), pp. 920-937.

OECD (2002): *Babies and Bosses: Reconciling Work and Family Life*, Vol. 1, Organization for Economic Cooperation and Development, Paris.

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

Owen, J. D. (1977): Flextime: Some Problems and Solutions, *Industrial and Labor Relation Review*, Vol. 30(9), pp. 152-166.

Pierce, J. L. and J. W. Newstrom (1980): Toward a Conceptual Clarification on Employee Responses to Flexible Working Hours: A Work Adjustment Approach, *Journal of Management*, Vol. 6(2), pp. 117-134.

Pierce, J. L. and J. W. Newstrom (1982): Employee Responses to Flexible Work Schedules: An Inter-Organization, Inter-System Comparison, *Journal of Management*, Vol. 8(1), pp 9-25.

Ralston, D. A., Anthony, W. P. and D. J. Gustafson (1985): Employees may Love Flextime, but What Does it do to the Organization's Productivity?, Journal of Applied Psychology, Vol. 70(2), pp. 272-279.

Rau, B. L. and M. M. Hyland (2002): Work Conflict and Flexible Work Arrangements: The Effects on Applicant Attraction, *Personnel Psychology*, Vol. 55, pp. 111-136.

Schaefer, S. (1998): Influence Costs, Structural Inertia and Organizational Change, *Journal of Economics & Management Strategy*, Vol. 7(2), pp. 237-263.

Schank, T. (2003): *The Impact of Working Time on Employment, Wages and Productivity*, Beiträge zur Arbeitsmarkt- und Berufsforschung, Vol. 269, Nürnberg.

Schank, T., Schnabel, C. and J. Wagner (2002): *Work Councils – Sand or Grease in the Operation of German Firms?* Working Paper 281, Faculty of Economics and Social Sciences, University of Lüneburg.

Schein, V. E., Maurer, E. H. and J. F. Novak (1977): Impact of Flexible Working Hours on Productivity, *Journal of Applied Psychology*, Vol. 62(4), pp. 463-465.

Schultes-Jaskolla, G. and M. Stitzel (1993): Arbeitszeit-Variation – Ein Personalbeschaffungsinstrument?, in: Marr, R. (eds.): *Arbeitszeitmanagement: Grundlagen und Perspektiven der Gestaltung flexibler Arbeitszeitsysteme*, 2. Aufl., Berlin, S. 363-382.

Shepard, E M.; Clifton, T. J. and D. Kruse (1996): Flexible Work Hours and Productivity: Some Evidence from the Pharmaceutical Industry, *Industrial Relations*, Vol. 35(1), pp. 123-140.

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

Wolf, E. and T. Zwick (2002b): Reassessing the Impact of High Performance Work Places, *ZEW Discussion Paper No. 02-07.*