The Output, Employment and Productivity Effects of Profit Sharing:

A Matching Approach

by

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Abstract

We investigate the output, employment and productivity effects of profit sharing. A simple theoretical model demonstrates that positive incentive effects of profit sharing imply increased employment and output, but productivity measured as output divided by employment might be much less affected. In the second part of the paper the results of an empirical study are reported. By use of matching and conditional difference in difference methods we find that the introduction of profit sharing leads to higher growth rates, more employment but not to increased productivity levels.

Keywords: Incentives, Profit sharing, Productivity, Employment.

JEL Codes: M52, J33, C14, C25

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"*Incentives are the essence of economics"*

(Lazear, 1987, 744)

"The ultimate objective of empirical work on incentives should be to find out why firms use the compensation policies they do, and to determine the impact of such policies on productivity or welfare. (...) there is a need to develop empirical tests where productivity measures are related to compensation policies, where the source of the variation in such policies has been accounted for (...).

(Prendergast, 1996, 21)

"(...) the cross-sectional data illustrate that firms that use profit sharing have higher productivity than those that do not. In the cross-section, this could simply reflect the possibility that firms with no profits rarely introduce such schemes, so higher profitability could have little to do with the effect of such schemes .(...)"

(Prendergast, 1999, 42)

1 Introduction

Since a considerable time economists consider both theoretically and empirically the incentive effects of remuneration systems and compare fixed wages, piece rates, tournaments, profit sharing, bonus payments and others. One major question in this context is the impact of variable and output-dependent incentive systems on performance.

Quite a number of studies investigate the productivity effects of profit sharing and – as e.g. a representative survey of the Organization for Economic Co-operation and Development (1995, 160) states, *"(…) The consistency of the findings is remarkable. Profit sharing is associated with higher productivity levels in every case, regardless of methods, model specification and data used* (…) " Hence, the empirical studies are quite uncontroversial about the beneficial consequences of this incentive system. In contrast to the empirically demonstrated positive effects of profit sharing, in practice its relevance is quite limited. Although the distribution between the industrialized countries differs, it is everywhere only a minority of firms that uses this kind of variable remuneration system.

One reason for the limited application of profit sharing might be that it only works if specific preconditions are met. If this holds true, a strong selectivity effect would be present and the simple comparison of firms with and without profit sharing would be misleading. Several empirical studies try to handle the problem of selection bias. A first study by FitzRoy and Kraft (1995) reports very strong selectivity effects which considerably affected their estimates.

FitzRoy and Kraft (1995) used the Heckman selectivity model[1], which has the advantage to be rather simply implemented. This estimator has, however, been criticized for its strong distributional assumptions. An alternative non-parametric method that has gained a lot of popularity in economics recently is the matching method. First applications of this method in the field of economics were policy evaluations, like e.g. the performance of active labour market programs where the units under consideration were individuals. In the meantime, this method has also been applied to the evaluation of firms and its usage has been extended to various other fields of economics.

The aims of our study are manifold: Methodologically, we apply the matching procedure to a panel of German firms that have introduced profit sharing. We thereby avoid major problems prior studies had to deal with that were using cross-sectional data, such as selectivity and simultaneity biases which prevented a consistent estimation of the output, employment and productivity effects of profit sharing (for an overview see OECD, 1995). Application of the conditional difference-in-differences approach as an extension of the matching estimator enables us to further control for unobservable factors.

Theoretically, we develop a model with output, employment and productivity determination and endogenous profit sharing, thereby allowing for the fact that an increase in workers' productivity might also potentially lead to a rise in a firm's demand for labour and thus higher output. It remains to be cleared how labour productivity if measured as output divided by employment is affected in profit sharing versus non profit sharing firms. Put differently, we want to investigate empirically whether the original performance stimulus of profit sharing is attenuated or even disappears due to a growth of both employment and output.

[1] Heckman (1976).

The paper is organized as follows: The next section presents theoretical considerations on the effects of profit sharing. In particular, we introduce our simple model which accounts for an employment effect of profit sharing via an increase in productivity. Section three addresses the problem of selectivity. Section four gives a short introduction to the basic evaluation framework before we present our empirical analysis in sections five and six. Section seven revisits the issue of selectivity and, finally, concluding remarks are offered in section eight.

2 Theoretical Considerations on the Effects of Profit sharing

The underlying idea of an introduction of profit sharing is the employer's intention to pass on part of the profits to the employees in order to align their interests with his/her own. The expected result is an increased effort and willingness to cooperate on the employees' behalf which raises the firm's overall efficiency (Kruse, 1992).

From the employees' perspective, the incentive effect of profit sharing is basically a trade-off between the positive effect of a variable, performance-related pay and the negative one of sharing the result of any additional effort with all other employees.

Employees will increase their effort if their additional individual effort is rewarded by extra income. A prerequisite is of course that profit sharing is regarded as a fair system, balancing the interests of labour and capital. In contrast to individual piece rates, the overall profit is a clear performance indicator as long as the balance sheets are not manipulated. Profit sharing systems are also usually not changed in response to a higher than expected performance of the workforce which is frequently observed with piece rates.[2] Hence, profit sharing is a reliable and verifiable claim on a significant part of the real return to the production factors capital and labour.

The counterargument is also quite intuitive. If more than one person is employed the productivity effect of any additional effort of an individual has to be shared with every other worker. Unless the firm is not very small, there is a considerable asymmetry between the disutility from effort and the monetary reward for it. This is called the *1/N* (with N being the number of employees) or *free rider* problem. Individual incentive systems like e.g. piece rates could circumvent this problem, but considering that the

[2] Adjusting the terms of the piece rate scheme to favour the firm might result in "ratchet effects". The standard ratchet effect implies that workers may be unwilling to work hard today because they fear that the employer may infer that the workers' cost of effort is low and thus will offer a lower wage in future periods (see Lazear, 1986, Gibbons, 1987).

organization of work moves more and more away from the “tayloristic” system towards a system where work is flexibly organized and tasks are overlapping, individual output is hardly measurable and the performance of work groups comes to the fore. In such a situation piece rates or any other individual incentive systems are not useful. If a flexible reward system is considered at all, it must be some kind of remuneration scheme that is based on the output of a specific group or unit, like for example profit sharing (e.g. Holmström, 1982, Prendergast, 1999) . The *free rider* problem is also mitigated by the fact that workers usually know more about the effort of their co-workers than supervisors. If employees are aware of the negative externality and if they can effectively monitor and punish their shirking colleagues, a reaction is probable. Hence, costs for vertical supervision are reduced due to horizontal supervision (FitzRoy and Kraft, 1985, Kandel and Lazear, 1992).

Arguing from a theoretical standpoint, therefore, no definite answer can be given *a priori* concerning the beneficial productivity effects of profit sharing and it remains an empirical question which side dominates.

Aside from the productivity effect, an intensive discussion centered around the employment effects of profit sharing. In particular Weitzman (1984) started a discussion on a positive employment impact. The basic idea of Weitzman is that the originally fixed wage is decomposed into a reduced base wage and a variable profit-related part. The firm then determines its level of employment on basis of the equality of marginal productivity and the *base* wage - not the variable profit share. Hence, there is an incentive to increase employment beyond the level that would have been chosen in a traditional firm with fixed wages, as long as it is possible to reduce the base wage and compensate the workers with part of the profits.

Weitzman and others assume that profit sharing is used as a substitute for wage payments. This is an unreasonable assumption. Workers and their representatives, the unions, will hardly accept a wage reduction just for the promise of an uncertain share in profits. A modeling of the effects of profit sharing should therefore rather be based on the assumption of a fixed wage and the possible addition of a share of the profits, if this is in the interest of the firm owner(s).[3]

[3] For empirical evidence see e.g. Wadhwani and Wall (1990) or Bhargava and Jenkinson (1995).

Weitzman did not include productivity effects of profit sharing in his models. Perhaps, however, productivity and flexible remuneration have to be considered simultaneously. If profit sharing increases productivity, unit costs will decrease and if the firm can sell more on a competitive market it will make a greater profit by expanding output and employment.[4] With a declining marginal product of labour, however, the estimated productivity level might not differ very much from the one before the introduction of the sharing system. But both output and employment would be larger. In order to analyze an indirect employment effect of profit sharing via an increase in productivity, we consider a very simple model.

An explicit comparison of the employment, output and productivity effects of profit sharing

We consider a representative firm which is faced with a falling demand curve. The demand D for the produced good depends on the price P, the price elasticity η (<-1), and an exogenously determined demand factor Y. This exogenous demand factor is e.g. a result of the total income of the consumers, activities by competitors and other exogenous determinants. In particular, the following log-linear relationship is used:

(1) $$D = P^{\eta} Y$$

Inversion leads to

(2) $$P = D^{\varepsilon} Y^{-\varepsilon}, \quad \text{with} \quad 0 > \varepsilon = \eta^{-1} > -1$$

Production takes place by use of an enlarged Cobb-Douglas function with constant returns to scale, where N and K denote the production factors labour and capital:

(3) $$X = \left(N 2e^{\lambda} / (1 + e^{\lambda}) \right)^{\beta} K^{(1-\beta)}$$

The units of labour are multiplied by the efficiency factor $2e^{\lambda} / (1 + e^{\lambda})$ implying the assumption that profit sharing increases efficiency if a firm has specific advantages. The efficiency advantages are decreasing in the share parameter λ and if no profit sharing is used, the factor $2e^{0} / (1 + e^{0})$ adjusts to one and thus the employment,

[4] In case of an imperfectly competitive market the firm may still increase profits by expanding if the corresponding price decline is small (Pérotin and Robinson, 2003).

output and productivity effects of the efficiency parameter are easily compared for both firm types.

It is assumed that the product cannot be stored and thus inventories can be neglected which in turn implies that the production level is equal to demand in any period:

$$D = X$$

The firm therefore maximizes the following profit function:

(4) $$\pi = (1-\lambda)(X^{1+\varepsilon}Y^{-\varepsilon} - wN - rK) = (1-\lambda)\left[\left(\left(N2e^{\lambda}/(1+e^{\lambda})\right)^{\beta} K^{(1-\beta)}\right)^{1+\varepsilon} Y^{-\varepsilon} - wN - rK\right]$$

with w standing for the wage per worker and r indicating the factor costs of capital. The profit function is optimized with respect to employment and capital.

Employment in the profit sharing firm is then determined according to:

(5) $$N_{\lambda} = \left[\frac{w}{\left[\frac{r}{(1+\varepsilon)(1-\beta)}\right]^{\frac{(1-\beta)(1+\varepsilon)}{(1-\beta)(1+\varepsilon)-1}}(1+\varepsilon)\beta}\right]^{\frac{(1-\beta)(1-\varepsilon)-1}{-\varepsilon}} \left(\frac{2e^{\lambda}}{1+e^{\lambda}}\right)^{\frac{\beta(1+\varepsilon)}{-\varepsilon}} Y$$

and the similar relation for the optimal capital stock is:

(6) $$K_{\lambda} = \left[\frac{r}{(1+\varepsilon)(1-\beta)}\right]^{\frac{1}{(1-\beta)(1+\varepsilon)-1}} \left[\frac{w}{\left[\frac{r}{(1+\varepsilon)(1-\beta)}\right]^{\frac{(1-\beta)(1+\varepsilon)}{(1-\beta)(1+\varepsilon)-1}}(1+\varepsilon)\beta}\right]^{\frac{(\beta(1+\varepsilon))}{\varepsilon}} \left(\frac{2e^{\lambda}}{1+e^{\lambda}}\right)^{\frac{\beta(1+\varepsilon)}{-\varepsilon}} Y$$

The profit sharing effect is captured in both equations by the exponential function term.

In order to illustrate the output, employment and productivity effects of an introduction of profit sharing, we compare in the following the terms we obtain from optimization in

the case of an introduction of profit sharing as opposed to the case of non-introduction .

As is obvious from equation (5), e*mployment* will increase in the profit sharing firm by the factor $(2e^{\lambda}/(1+e^{\lambda}))^{\frac{\beta(1+\varepsilon)}{-\varepsilon}}$. Perhaps more surprising is the fact that capital increases by the same degree.

In order to derive the profit sharing effect on s*ales volume*, the expressions for employment and capital from equations (5) and (6) are inserted into the sales function

$$PX=\left[\left(N2e^{\lambda}/(1+e^{\lambda})\right)^{\beta}K^{(1-\beta)}\right]^{(1+\varepsilon)}Y^{-\varepsilon}.$$

This yields the following term for the profit sharing firm, where the “growth term” is (surprisingly) equivalent to the employment effect::

(7)
$$PX=\left[\frac{r}{(1+\varepsilon)(1-\beta)}\right]^{\frac{(1+\varepsilon)(1-\beta)}{(1-\beta)(1+\varepsilon)-1}}\left[\frac{w}{\left[\frac{r}{(1+\varepsilon)(1-\beta)}\right]^{\frac{(1-\beta)(1+\varepsilon)}{(1-\beta)(1+\varepsilon)-1}}(1+\varepsilon)\beta}\right]^{\left(\frac{((1-\beta)(1+\varepsilon)-1)\beta(1+\varepsilon)}{-\varepsilon}+\frac{(\beta(1+\varepsilon))(1+\varepsilon)(1-\beta)}{\varepsilon}\right)}\left(\frac{2e^{\lambda}}{1+e^{\lambda}}\right)^{\frac{\beta(1+\varepsilon)}{-\varepsilon}}Y.$$

Finally, we define *productivity* as sales per employee. Due to a lack of reliable data in the empirical study we do not consider real output.

Dividing sales volume by the number of employees leads to the following productivity expression:

$$\frac{PX}{N} = \left[\frac{r}{(1+\varepsilon)(1-\beta)}\right]^{\frac{(1+\varepsilon)(1-\beta)}{(1-\beta)(1+\varepsilon)-1}}$$

(8)
$$\left[\frac{w^{\frac{1}{(1-\beta)(1+\varepsilon)}}}{\left[\frac{r}{(1+\varepsilon)(1-\beta)}\right]^{\frac{1}{(1-\beta)(1+\varepsilon)-1}}(1+\varepsilon)\beta}\right]^{\left(\frac{((1-\beta)(1-\varepsilon)-1)\beta(1+\varepsilon)}{-\varepsilon}+\frac{\beta(1+\varepsilon)(1+\varepsilon)(1-\beta)}{\varepsilon}\right)-1}$$

Inserting the respective expressions, the growth effect of profit sharing totally disappears. Based on the specifications of this model, profit sharing thus leads to more employment, more output and larger productivity. The sales volume and employment both increase by exactly the same magnitude and therefore no productivity effect would be estimated in an empirical study.

What remains to be determined is the share parameter λ. For this aim, we conduct a number of simplifications. We first simplify the notation of the profit equation:

(9) $$\pi = (1-\lambda)\left[\left(C^N C^K\right)^{1+\varepsilon} f^{(1/-\varepsilon)} Y - wC^N f^{(1/-\varepsilon)} - rC^K f^{(1/-\varepsilon)}\right]$$

with

$$C^N = \left[\frac{w^{\frac{1}{(1-\beta)(1+\varepsilon)}}}{\left[\frac{r}{(1+\varepsilon)(1-\beta)}\right]^{\frac{1}{(1-\beta)(1+\varepsilon)-1}}(1+\varepsilon)\beta}\right]^{\frac{\beta((1-\beta)(1-\varepsilon)-1)}{\varepsilon}} Y^{\beta}$$

$$C^K = \left[\frac{r}{(1+\varepsilon)(1-\beta)}\right]^{\frac{(1-\beta)}{(1-\beta)(1+\varepsilon)-1}} \left[\frac{w^{\frac{1}{(1-\beta)(1+\varepsilon)}}}{\left[\frac{r}{(1+\varepsilon)(1-\beta)}\right]^{\frac{(1-\beta)(1+\varepsilon)}{(1-\beta)(1+\varepsilon)-1}}(1+\varepsilon)\beta}\right]^{\frac{((1-\beta)\beta(1+\varepsilon))}{\varepsilon}} Y^{(1-\beta)}$$

and $f = (2e^{\lambda}/(1+e^{\lambda}))^{\beta(1+\varepsilon)}$, i.e. the growth terms in equations (5) and (6) have been extracted and are now denoted by f in the profit equation in (9).

The derivative of equation (9) with respect to λ leads to:

$$(10) \qquad \frac{\partial \pi}{\partial \lambda} = -X^{1+\varepsilon}Y^{-\varepsilon} - wN - rK + (1-\lambda)\left[\frac{1}{-\varepsilon} f^{(1+\varepsilon)/(-\varepsilon)} f'\left(\left(C^N C^K\right)^{(1+\varepsilon)} Y - wC^N - rC^K\right)\right] = 0.$$

with $f' = \frac{\partial f}{\partial \lambda}$

To further simplify the calculations, we leave the first part of equation (10) unchanged. Defining the elasticity: $\chi = \frac{\partial(PX)}{\partial \lambda}\frac{\lambda}{PX} = \frac{f'\lambda}{-\varepsilon f}$ and rearrangement of (10) leads to the following expression:

$$(11) \qquad -X^{1+\varepsilon}Y^{-\varepsilon} - wN - rK + (1-\lambda)\left[\frac{\chi}{\lambda}\left(\left(C^N C^K\right)^{(1+\varepsilon)} f^{(1/-\varepsilon)} Y - wC^N f^{(1/-\varepsilon)} - rC^K f^{(1/-\varepsilon)}\right)\right] = 0.$$

This relation can be simplified to:

$$(12) \qquad \lambda = \frac{\chi}{1+\chi}.$$

The share parameter is determined by the effect of profit sharing on output and is necessarily smaller than one.

Summarizing, our simple model shows that assuming profit sharing enhances workers' productivity, firms will grow with respect to employment and output. The overall effect on productivity if measured as output divided by sales, turns out to be positive but smaller.

3 The Issue of Selectivity

> *"Selection problems pervade economic analysis, as individuals frequently choose the treatments that they undergo (...) Controlling for this problem is difficult, but without addressing it, there is little hope that the effect can be truly identified.(...)*
>
> (Prendergast, 1996, 21)

If the model describes reality (and the empirical studies are correct), most firms behave irrationally because in Western industrialized countries only a minority of all firms makes use of the instrument of profit sharing. According to the statistics of the European Commission (Poutsma, 2001) the percentage of firms with a profit sharing system in the European Union is everywhere quite low except for the cases of France and the United Kingdom which have a long tradition of encouraging financial participation through a legal framework and generous tax advantages (Table 1).[5]

Table 1 – Incidence of profit sharing in selected countries

Country	profit sharing establishments (%)
Denmark	9
France	51
Germany	12
Ireland	7
Italy	4
Netherlands	13
Portugal	7
Spain	6
Sweden	19
UK	28
USA***	16
Canada***	15

Source: Poutsma, 2001, ***OECD, 1995.

[5] Poutsma (2001) extensively discusses the country differences concerning financial participation in various member states of the European Union.

It is unreasonable to assume that the majority of capital owners are persistently unaware of the possible productivity effects of incentive systems. Hence, there must be other reasons for their reluctance to introduce apparently useful variable remuneration models. One reason might be specific advantages for some firms over others to introduce a profit sharing system.

It seems quite likely that firms have specific advantages or disadvantages with respect to alternative incentive systems. Qualification levels of the workforce, i.e. work content (simple or demanding), verification possibilities of the individual performance, i.e. work organization (team versus individual tasks), turnover, cultural differences, industrial relations, firm size and many other circumstances will be responsible for the functioning and success of profit sharing. In such a situation it is reasonable that firms with specific advantages in the application of profit sharing introduce it, while others have no interest in such a kind of incentive and rely in contrast on other motivational instruments like tournaments, piece rates, bonus payments, promotions or on dismissals as a penalty in the case of insufficient performance.

A second kind of selectivity effect is worker sorting. Given that workers' productivity is heterogeneous, most likely performance-related pay will attract the more productive ones as they tend to be more optimistic about their own individual productivity. We assume that such workers have on average a higher degree of qualification which certainly has a positive impact on communication and the coordination and organization of tasks. In addition, the rising share of productive and high-skilled employees might have a positive impact on less productive employees through mutual learning. If this holds true, such teams differ from teams in establishments paying fixed wages resulting in a difference in productivity.[6] This leads to the question of a separating equilibrium, where high-quality workers choose to work at firms with profit sharing and low-quality ones prefer firms paying fixed wages (Lazear, 1986). It remains to be cleared, under which conditions both firm types can survive. However, an explicit model on this question is beyond the scope of this paper.

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[6] It is quite realistic, that workers are risk-averse and prefer a fixed wage to a variable, performance related pay. Ignoring for the moment the argument from above, that profit sharing is a complement and not a substitute for the fixed wage, a firm with flexible pay will attract the less risk-averse workers. It is not unreasonable to assume, that these employees are also more productive.

In the presence of specific (dis-)advantages of profit sharing, selectivity effects are at work and a simple comparison of firms with and without profit sharing might be misleading. In fact, the majority of all empirical studies completely ignores selectivity problems, thus calling their results into question (including FitzRoy and Kraft, 1987).

A quite sophisticated method to deal with selectivity and that – to the best of our knowledge – hasn't been applied to profit sharing yet, is matching. The idea of the matching method is quite intuitive as it is based on the comparison of treated with non-treated observations, where the group of non-treated control observations is constructed to be as similar as possible to the group of treated units. If a non-treated unit is not similar to a specific treatment unit, it is either omitted or receives a low weight during the comparison depending on the matching estimator that is being applied.[7] The following chapter gives a short introduction to the microeconometric evaluation problem and the matching procedure before turning to the analysis of the causal effect of an introduction of profit sharing.

4 The Basic Evaluation Framework

4.1 The Microeconometric Evaluation Problem

The aim of our analysis is to assess the average gain of an establishment introducing profit sharing as compared to the hypothetical situation of non-introduction. The approach that is used as a guideline for our empirical analysis goes back to Roy (1951) and Rubin (1974) and is also known as the *potential outcome approach*.
According to Rubin (1974) the causal effect in our context is defined as the difference between the likely outcome of an establishment introducing profit sharing, Y^1, and the likely outcome in the case of non-introduction, Y^0 , given D=1:

$$\theta^0 := E(Y^1 - Y^0 \,|D=1) = E(Y^1 \,|D=1) - E(Y^0|D=1) \qquad (1)$$

where D is a binary assignment indicator determining whether establishment i has introduced profit sharing (D=1) or not (D=0). This parameter is also known as the average treatment effect on the treated and answers the question whether the introduction of profit sharing pays for those establishments that have introduced it.

[7] See Heckman, Ichimura and Todd (1997).

The so-called fundamental evaluation problem arises from the fact that the second term on the right side – the counterfactual outcome $E(Y^0|D=1)$ - is by definition not observable since it describes the hypothetical outcome of a firm that actually introduced profit sharing if it hadn't done so. The fundamental evaluation problem – which can be interpreted as a missing data problem – can be solved if an adequate approximation for the counterfactual outcome is found.

If the condition $E(Y^0|D=1) = E(Y^0|D=0)$ holds, the average outcome of firms that haven't introduced profit sharing might serve as an estimator for $E(Y^0|D=1)$. In an experiment where randomisation of treatment is given, this condition would probably hold. But as FitzRoy and Kraft (1995) have already shown and as we will show below, profit sharing and non-profit sharing firms differ with respect to their characteristics as well as outcomes.

4.2 Identification

If the characteristics which promote the establishment's decision to introduce profit sharing can be determined, the problem in equation (1) might be solved. For that purpose, Rubin (1977) introduced the conditional independence assumption (CIA), which states that treatment status and potential outcome are independent for individuals with the same observable set of characteristics X. If sample selection is solely due to observable covariates, then

$$E(Y^0|D=0, X) = E(Y^0|D=1, X) \qquad (2)$$

holds and the causal effect can be estimated using the means of the two groups (Lechner, 1998):

$$\theta^0 := E(Y^1| D=1, X) - E(Y^0| D=0, X) \qquad (3)$$

The CIA requires that all determinants that influence the decision to introduce profit sharing as well as the potential outcome are known and available for all observations. Although the validity of the CIA cannot be tested formally, we believe that the IAB Establishment Panel which will be described in more detail below covers a wide array of questions ranging from general information on the establishments to questions on

investment, business policy and development to employment-related questions serves as a good basis to fulfil this requirement.

4.3 Non-parametric Matching

Various approaches have been suggested to estimate causal effects in non-experimental settings, among them non-parametrical as well as parametrical and mixed models (Heckman, LaLonde and Smith, 1999). An estimator that has become quite popular recently is the non-parametric matching estimator. Its popularity certainly stems in part from the intuitively attractive idea of contrasting the outcomes of treated units with the outcomes of similar (i.e. ideally identical) non-treated units. Differences in outcomes between the two groups can then be attributed to the measure that has been introduced (Heckman, Ichimura and Todd, 1998).

Practically, ensuring the validity of the CIA imposes a very high obstacle since with every additional exogenous variable in the vector X the probability of finding an adequate control group decreases. Fortunately, Rosenbaum and Rubin (1983) were able to find a remedy to this dimensionality problem by introducing the concept of propensity score matching. Instead of matching on a large set of covariates, they propose to match on the propensity score which is in our case defined as the conditional probability to introduce profit sharing, i.e. the probability to introduce profit sharing given a set of individual characteristics of a firm pr(D=1|X). They are able to show that if the CIA is fulfilled one need not condition on all covariates contained in X, but only on the propensity score.

In the literature several matching methods have been proposed. The major difference between the various matching estimators lies in the weights attached to the control group observations. Typically, the more similar an untreated unit j is compared to a treated unit with respect to the covariates the higher the weight attached to it in constructing the match.[8] The estimated treatment effect for a firm i can generally be estimated as follows:

$$Y_i^1 - \sum_{j \in \{D=0\}} w_{N0}(i, j)\, Y_j^0 \qquad (4)$$

[8] The same argumentation applies to the propensity score according to Rosenbaum and Rubin (1983).

where w_{N0} (i, j) denotes a weighting function and N_0 is the number of non-treated firms with D_j=0 (Heckman, Ichimura and Todd, 1998).
The two extremes among the matching estimators with respect to the weighting function are the nearest neighbour and the kernel matching estimator.

The *nearest neighbour matching estimator* can be described as a pairwise matching as it tries to find for every treated unit i the most similar (ideally a "twin") non-treated unit and, thus, leads to the following weighting function:

$$w_{N0}(i,j) = \begin{cases} 1 \text{ if } ||X_i - X_j|| = \min_j ||X_i - X_j|| \\ 0 \text{ else} \end{cases}$$

In the case of the *kernel matching estimator*, on the other hand, the comparison group consists of *all* non-treated observations and the weighting function is specified as:

$$w_{N0}(i, j) = \frac{Gij}{\sum_{K \in \{D=0\}} G_{ik}}$$

where $G_{ik}= G((X_i – X_k)/h)$ is a kernel that downweights distant observations and h is a bandwidth parameter (Heckman, LaLonde and Smith, 1999).
The question which method to select in practice depends in particular on the degree of overlap between the treatment and control group in terms of the propensity score. When there is substantial overlap, most of the matching algorithms yield similar results (Dehejia and Wahba, 2002).

The following empirical strategy is used in order to obtain the causal effect of profit sharing on various outcome variables: In a first step the propensity score is estimated using a probit model. We first conduct nearest neighbour matching. In addition to the propensity score we match firms from the two groups additionally on the number of employees to improve the quality of matching. Having ascertained that the matching was successful, i.e. that the establishments that introduced profit sharing don't differ from the matched establishments without profit sharing, the causal effect can be

measured by comparing the means in outcomes of the two groups. To control for the robustness of our estimates, we also applied the kernel matching estimator.[9]

5 Empirical Analysis

5.1 Data and first descriptive results

Our analysis of the effects of an introduction of profit sharing on sales, productivity and employment growth is based on the German IAB Establishment Panel of the Institute for Employment Research of the Federal Labour Office. The IAB Establishment Panel is an annual representative survey of establishments employing at least one employee covered by social insurance. Each year since 1993 (1996) several thousand firms from 16 industries and 10 size classes in West-Germany (East-Germany) have been surveyed. Data are extended regularly to correct for panel mortality, exits or the foundation of new firms resulting in an unbalanced panel. The interviews are conducted by professionals in personal interviews with owners or senior managers of the establishments. Considering that participation is voluntary, a response rate exceeding 70 percent can be regarded as quite high.

As the panel was created for the needs of the Federal Labour Office detailed information is given about the demand side of the labour market. A core of questions like e.g. general information on the establishment, turnover, investments, etc. is posed every single year, whereas other topics are covered only irregularly. Information on profit sharing is provided for the years 1998, 2000 and 2001.[10]

In order to investigate the effect of an introduction of profit sharing in a first step we identified all establishments that were surveyed continuously from 1998 to 2002. Of these establishments all non-profit firms and firms not reporting turnover or with missing values for the variables used were excluded. In addition, establishments from the forestry, agriculture and fisheries and banking and insurance sector were omitted (see e.g. Bauer, 2003, Zwick, 2003).[11] The treatment group was then constructed by identifying all establishments that reported to have no profit sharing in 1998, but had introduced it by 2000 and still reported it in 2001 – summing up to 73 establishments.

[9] Matching was performed in Stata 8 using the psmatch2 command (Leuven and Sianesi, 2003).
[10] See Bellmann (1997) or Kölling (2000) for a more detailed description of the IAB Establishment Panel.
[11] Establishments from the forestry, agriculture and fisheries sector are omitted due to a differing production process, whereas banks and insurances report balance sheet totals and volume of insurance contributions instead of turnover.

The control group on the other hand comprises all those establishments that reported to have no profit sharing in either 1998, 2000 or 2001 and contains 1545 establishments.

Several dependent variables are considered in order to test the predictions of our model. We investigate whether firms introducing profit sharing have a higher growth of labour productivity, employment and sales between 1998 and 2002 as compared to the non-profit sharing control group.

Growth in labour productivity is measured by the percentage change in sales per employee. A more conventional measure of output (e.g. Wolf and Zwick, 2002) is value added which can be computed using the IAB Establishment Panel data by subtracting input costs (material and intermediate inputs) from sales. Although conceptually certainly superior we decided to stick to sales per employee due to the high rate of item non-response and our impression that the available data are rather rough guesses than precise values.[12] Employment and sales growth are measured by the percentage change in the total number of employees and the volume of sales respectively.

A first look at the mean values of the outcome variables for the treated and control establishments in Table 2 reveals that obviously establishments that have introduced profit sharing have a significantly higher sales and employment growth.

Table 2 - Mean values of growth variables for firms (not) introducing profit sharing

outcome variable	firms with profit sharing	firms without profit sharing
Sales growth	.322	.116***
Employment growth	.122	-.028***
Productivity growth	.206	.223

*/**/*** indicates that means differ with statistical significance in a two-tailed t-test at the 10%, 5%, 1% level between establishments from the two groups
Source: IAB Establishment Panel, waves 1998-2002, own calculations.

[12] Approximately one quarter of the establishments in the sample reported no data for input costs and almost two thirds reported data falling in 5%- increments, i.e. 5%, 10%, etc. Addison et al. (2003) report similar problems.

Surprising in the context of existing literature which claims positive productivity effects of profit sharing, however, seems the fact that productivity growth in both groups is almost equal. The model in chapter 2 might provide a possible explanation: Obviously, establishments introducing profit sharing seem to grow substantially faster with respect to output, but because employment is extended as well, the initial productivity advantage evaporates. Comparing the means in outcomes of the two groups, however, can serve only to give a first idea as to the direction of the effect of profit sharing. We assume sample selection and therefore look at additional exogenous variables that determine the introduction of profit sharing and thereby influence the success variables.

The identification of the determinants of an introduction of profit sharing in establishments can be regarded as a stand-alone strand within the profit sharing literature and provided the basis for our estimation of the propensity scores. A survey of the literature on the determinants of the introduction of profit sharing seems to suggest certain groups of variables like e.g. establishment size, organizational structure, industrial relations, the external environment, etc. (see e.g. OECD, 1995, Poutsma, 2001, Pendleton et al., 2003) that will be introduced in the following. Besides, we also included industry dummies into our estimation.

Establishment size

The impact of size on the introduction of profit sharing is not clear. On the one hand free rider effects are greater as company size increases, but on the other hand information asymmetries and monitoring become more difficult implying that profit sharing might be an instrument of associating workers with the aims of their employers and encouraging them to monitor each other. Moreover, larger firms usually have better information and more resources to spend on the design and implementation of various remuneration systems.

We included five size classes into our estimation to control for size effects. Table 3 seems to support the hypothesis that larger firms have a significantly higher probability to introduce profit sharing. The total number of employees is significantly higher with 423 versus 78 employees on average. The size dummies give a more detailed picture of the use of profit sharing in various size classes: Obviously,

establishments with more than 50 employees have a higher propensity to introduce profit sharing.

Organizational structure of the firm

In environments where work tasks are complex and interdependent, individual outputs are hard to measure and information asymmetries and monitoring problems could be more intense. In such a demanding environment one would expect a higher qualification level of the workforce and high investment into information and communication technology. We therefore included the ratio of qualified employees and dummies indicating the shift of responsibilities, the introduction of team work and independent work groups as well as a dummy indicating investment into information and communication technology into our analysis. Profit sharing establishments have a significantly higher share of qualified staff and seem to be more innovative concerning their organizational structure which is in accordance with the recent Human Resource Management literature. Furthermore, the share of firms investing into information and communication technology is significantly higher among the profit sharing firms.

Industrial relations

Profit sharing is easier to introduce in a consultative environment where the level of trust between employees and management is high. We use the existence of a works council to control for a cooperative climate.

The role of unions in this context in not clear. Traditionally, unions have been rather hostile to profit sharing to maintain the unity of workers. But if profit sharing is paid in addition to the base wage as is documented in a number of empirical studies (see e.g. Wadhwani and Wall, 1990, Bhargava and Jenkinson, 1995) there is no reason for unions to oppose this kind of remuneration system anymore.

The difference in means is highly significant implying that the existence of works councils and trade unions strongly promotes the introduction of profit sharing in our sample.

External environment

When profits are unstable and risky, firms have a greater incentive to set up flexible remuneration systems in order to transfer some of the risk to their employees. Therefore, exporting firms and firms on competitive or unstable markets are assumed to have a higher propensity to introduce profit sharing. A look at Table 3 shows that the share of exporters is significantly higher in the group of profit sharing firms, whereas the share of firms that report to operate on competitive markets is only slightly higher.

Table3 – Mean values of variables for firms (not) introducing profit sharing

Variable	Firms with profit sharing	Firms without profit sharing	Matched firms without profit sharing
Establishment size <20	.21	.56***	.17
Establishment size 20-49	.15	.20	.15
Establishment size 50-249	.37	.17***	.41
Establishment size 250-499	.11	.04*	.13
Establishment size 500+	.16	.03***	.15
Number of employees	423	78***	339
Shift responsibilities (dummy: 1=yes)	.36	.17***	.36
Teamwork (dummy: 1=yes)	.22	.11**	.20
Independent work groups (dummy: 1= yes)	.21	.07***	.23
Share qualified employees (percent)	.69	.58***	.71
Collective bargaining (dummy: 1= yes)	.77	.54***	.68
Works council (dummy: 1= yes)	.58	.21***	.57
Competition (dummy: 1= “high”,”medium”)	.92	.86*	.93
Exporter (dummy: 1= yes)	.44	.14***	.45
Ict investment (dummy: 1= yes)	.71	.42***	.73
Limited liability (dummy: 1= “AG, KgaA”, “GmbH”)	.74	.45***	.77
Age (dummy: 1= founded after 1990)	.40	.44	.42
East German establishment (dummy: 1= yes)	.41	.56**	.48
Propensity score	-1.23	-2.09***	-1.30

*/**/*** indicate that means differ with statistical significance in a two-tailed t-test at the 10%, 5% or 1% level between the establishments from the two groups
Source: IAB Establishment Panel, wave 1998, own calculations.

It is suggested that the frequency of use of profit sharing is higher in young and growing companies which, however, is not supported by our simple comparison of means. Moreover, Möller (2002) finds that firms located in East Germany are less likely to introduce profit sharing which can be confirmed from our analysis. Finally, we expect profit sharing to be rather introduced in companies with limited liability, i.e. joint stock companies (AG) and non-public limited liability companies (GmbH).

5.2 Estimation Results

As has been explained already the first task in matching establishments from the two groups is to reduce the problem of dimensionality by estimating propensity scores on the basis of a probit model where the decision to introduce (D=1) or not introduce profit sharing (D=0) serves as the dependent variable.

Table 4 – Results of the Probit Estimation[13]

Variables	Coefficient	t-value
Establishment size 20-49	.05	0.25
Establishment size 50-249	.52	2.39**
Establishment size 250-499	.43	1.42
Establishment size 500+	.77	2.37**
Competition	.16	0.72
Exporter	.28	1.64
Share of qualified employees	.62	2.29**
Collective bargaining	.16	0.99
Works council	.32	1.65*
Limited liability	.18	1.16
Age	.40	2.54**
East German Establishment	-.46	-2.91***
Shift of responsibilities	.15	0.95
Teamwork	-.06	-0.35
Independent work groups	.32	1.71*
Ict investment	.25	1.75*
intercept	-3.28	-5.52***
Number of observations	1618	
Pseudo R2	0.20	

***/**/* indicates statistical significance at the 1%, 5% and 10% level.

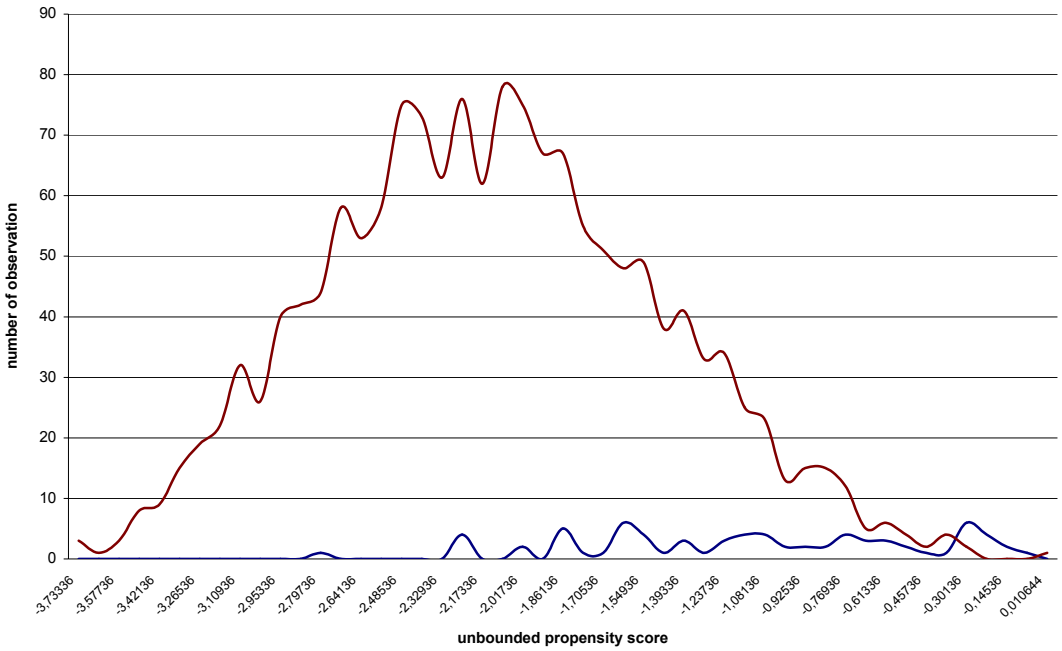
Source: IAB Establishment Panel, wave 1998, own calculations.

[13] Values for industry dummies are not included and are available from the authors on request.

Taking a look at the results of our probit estimates reveals that rather young and medium-sized or large exporting firms with a high share of qualified employees that invest into information and communication technologies introduce profit sharing. Moreover, the existence of a works council seems to foster the introduction supporting the theory that profit sharing is more likely to be introduced in an environment characterized by mutual trust. Firms that are located in the Eastern part of Germany have a lower probability to introduce profit sharing and, finally, profit sharing seems to be flanked by other organizational measures, especially the existence of independent work groups.

Lechner (1998) stresses that a fundamental requirement for a successful implementation of the matching procedure is a sufficiently large overlap between the distributions of the conditioning variables in both subsamples. Figure 1 shows the overlap for the unbounded propensity scores.[14] Since both distributions overlap to a great extent, this important assumption is fulfilled.

Figure 1 – Frequency distributions of the propensity scores



Source: IAB Establishment Panel, wave 1998, own calculations.

[14] We used the unbounded propensity score $x'\hat{\beta}$ because of its preferable distribution properties (Hujer et al., 1997). Using the bounded propensity score $\Phi(x'\hat{\beta})$ changed our results only marginally.

Due to the similar number of profit sharing and non-profit sharing establishments in the right tail of the distributions we decided to match with replacement in the case of nearest neighbour matching. Matching with replacement means that control units can be used more than once as a matching partner. Matching without replacement might run into problems in regions where the frequency of probabilities is very low for the control group compared to the treatment group. This means that in case of only few comparison units similar to the treated unit, we may be forced to match treated units to control units that are different in terms of their probability. Allowing for replacement avoids this problem as long as there is sufficient overlap in the distributions as is the case in Figure 1. The drawback to matching with replacement is primarily that the variance will be higher because fewer observations are being used for the control group (Dehejia and Wahba, 2002).

We can now proceed with presenting Table 5 which contains the results of our matching estimation. We take account of the sampling variability in the estimated propensity score by applying a bootstrap method to construct the standard errors of the estimated treatment effects (Heckman et al., 1998).[15]

Table 5 – Results from nearest neighbour and kernel matching, introduction of profit sharing

Nearest neighbour matching				
outcome variable	**treaties**	**controls**	**att**	**t-value**
Productivity growth	.21	.19	.02	0.26
Employment growth	.12	-.06	.18	2.93***
Sales growth	.32	.10	.22	2.27**
Kernel matching				
outcome variable	**treaties**	**controls**	**att**	**t-value**
Productivity growth	.21	.19	.02	0.38
Employment growth	.12	-.03	.15	3.78***
Sales growth	.32	.11	.21	2.83***

***/**/* indicates statistical significance at the 1%, 5% and 10% level.

Source: IAB Establishment Panel, waves 1998-2002, own calculations.

[15] The means of the outcome variables of the comparison group are based on an estimation and are not result of random sampling thus leading to biased t-statistics. By bootstrapping a random sample is repeatedly drawn from the original sample and the matching procedure is performed. Thereby, the distributions of the mean outcomes of the comparison group are simulated and unbiased t-statistics can be obtained (see e.g. Greene, 2003).

The results we get from nearest neighbour and kernel matching, which expectedly yield similar results, seem to support the implications of our theoretical model and the descriptive results we obtained above and thus the hypothesis that productivity increases might also result in an expansion of employment. Establishments introducing profit sharing seem to grow substantially faster with respect to sales and employment thus levelling out an additional productivity effect. This might explain why several studies do not find positive productivity effects of financial participation although using the same data set (e.g. Wolf and Zwick, 2003).

In order to ensure that the matching method was successful in balancing the two groups and thereby reducing the selection bias, a comparison of means of the exogenous variables after matching has to be conducted. Comparing the differences in the means of the exogenous variables of the matched and unmatched control group members with the profit sharing establishments in Table 3 above indicates that the application of the matching procedure leads to a substantial reduction of bias. After matching there are no statistically significant differences in the means of the exogenous variables anymore.

The results we get are quite astonishing as the empirical literature on profit sharing mainly comes to the conclusion that profit sharing increases productivity whereas the results concerning its impact on employment are not clear cut. Our results, on the other hand, indicate a substantially higher sales *and* employment growth of the profit sharing establishments levelling out any productivity effect.[16]

In order to make sure that this result is not to be attributed to the rather small number of establishments in our sample that actually do *introduce* profit sharing, we conduct the same estimations for the *existence* of profit sharing. This increases our number of matched treated establishments to 226, but does not change our results in essence as is shown in Table 6.[17] Whether nearest neighbour or kernel matching is applied,

[16] Our results are, however, in line with a number of studies that find a neutral productivity effect.
[17] We imposed the common support restriction which resulted in a drop of fourteen profit sharing firms. In our first estimation only one profit sharing firm was dropped. Heckman et al. (1998) stress that a successful implementation of matching methods is only possible inside the range of common support of the distribution of the propensity scores of the profit sharing and non profit sharing group.

the treated establishments still have a significantly higher growth in sales and employment leading to an insignificantly higher productivity growth.[18]

Table 6 – Results from nearest neighbour and kernel matching, existence of profit sharing

Nearest neighbour matching				
outcome variable	**treaties**	**controls**	**att**	**t-value**
Productivity growth	.22	.19	.03	0.46
Employment growth	.09	-.01	.10	1.97**
Sales growth	.29	.15	.14	1.99**
Kernel matching				
outcome variable	**treaties**	**controls**	**att**	**t-value**
Productivity growth	.22	.21	.01	0.28
Employment growth	.09	-.02	.11	3.18***
Sales growth	.29	.15	.14	2.86***

***/**/* indicates statistical significance at the 1%, 5% and 10% level.

Source: IAB Establishment Panel, waves 1998-2002, own calculations.

So far, information on the capital stock of firms has not been included in our estimations. The IAB Establishment Panel contains no direct information on capital, so the factor would have to be approximated by replacement investments. The idea is that the known amount of replacement investments is expected to be proportional to the unknown amount of capital stock (e.g. Möller, 2002, Wolf and Zwick, 2003). A lot of firms, however, report no data or report a value of zero which doesn't seem trustworthy to us (see also Addison et al., 2003).

To control for the robustness of our results, we nonetheless conduct the estimations including replacement investments as a proxy for capital. This reduces our sample by more than thirty percent, leaving us with 1041 control and 57 (177) treated establishments in the case of an introduction (the existence) of profit sharing. The results which are reported in Table 7 indicate that the estimates we obtained above are fairly robust as we find a significantly higher sales and employment growth in the case of sharing firms.[19]

[18] Further information on the results of the matching procedure for the case of the existence of profit sharing is provided in Tables A1-A4 in the appendix.

[19] Mean value comparisons and results of the probit estimation in the case of an inclusion of capital are not reported here. Results are available from the authors on request.

Table 7 – Results from matching, introduction and existence of profit sharing

INTRODUCTION				
Nearest neighbour matching				
outcome variable	**treaties**	**controls**	**att**	**t-value**
Productivity growth	.20	.19	.01	0.10
Employment growth	.12	-.07	.19	2.10**
Sales growth	.32	.03	.30	2.94***
Kernel matching				
outcome variable	**treaties**	**controls**	**att**	**t-value**
Productivity growth	.20	.20	.00	-0.03
Employment growth	.12	-.02	.14	2.91***
Sales growth	.32	.13	.19	2.83***
EXISTENCE				
Nearest neighbour matching				
outcome variable	**treaties**	**controls**	**att**	**t-value**
Productivity growth	0.19	0.24	-0.06	-1.00
Employment growth	0.11	-0.04	0.16	2.85***
Sales growth	0.28	0.16	0.12	1.72*
Kernel matching				
outcome variable	**treaties**	**controls**	**att**	**t-value**
Productivity growth	0.19	0.20	-0.01	-0.36
Employment growth	0.11	0.00	0.11	2.11**
Sales growth	0.28	0.16	0.12	1.80*

***/**/* indicates statistical significance at the 1%, 5% and 10% level.

Source: IAB Establishment Panel, waves 1998-2002, own calculations.

6 The Impact of Unobservable Factors

Although the quality of the matching procedure above has been assessed, the attentive reader might still object by claiming that matching accounts for observable differences only. In other words: the positive impact of an introduction of profit sharing we found above might also be due to unobservable factors. Profit sharing firms might e.g. be the ones with a better management, “better” industrial relations or a more active human resources department (e.g. Huselid, 1995, Wolf and Zwick, 2002). Our contribution to the existing literature is the application of an extension of the matching estimator, the conditional difference-in-differences approach, to address the question whether unobservable factors have an impact on the above obtained effects of an introduction of profit sharing.

In general, the difference-in-differences estimator can be regarded as an extension of the before-after-estimator which compares the outcomes of treated units after the introduction of a measure with their outcomes before the introduction. The advantage of the difference-in-differences over the before-after approach is that it takes also into consideration that changes over time can be due to reasons which are unrelated to treatment. The average treatment effect can in this case be estimated according to:

$$\theta^0 := E_i\,(Y_{1,\,t1} - Y_{1,t0}) - E_i(Y_{0,t1} - Y_{0,t0}) \qquad (5)$$

where Y_1 and Y_0 denote if the unit under consideration is treated (Y_1) or not (Y_0) and t0 and t1 represent the periods or points in time before (t0) or after (t1) the introduction of the measure. A drawback of the difference-in-differences estimator is its neglect of selection bias due to observable factors. If this method is generalized to include regressors, however, which is denoted in the literature as the *conditional difference-in-differences* method, the advantages of the matching and the difference-in-differences approach can be combined (Blundell and Costa Dias, 2000). Implementing the conditional difference-in-differences estimator means that the treatment and control group are matched with respect to their observable characteristics which was achieved by applying the matching procedure above. Thereby, the second term in equation (5) is replaced by

$$\Sigma \quad w_{N0}\,(i, j)\,(Y_{0,t1} - Y_{0,t0}) \qquad (6)$$

For our analysis this implies that aside from the above investigated treatment period we have to extend our panel by another time period prior to the introduction of profit sharing (t0). In order not to loose additional observations, we extend our sample by information on one more year only, which leaves us with 57 treated and 1158 control establishments. [20]

[20] Extending the time period t0 by one more period yields similar results at the cost of a sample reduction of both groups. Results are available from the authors on request.

Table 7 – Results of the conditional-difference-in-differences estimation

outcome variable	treaties	controls	att	t-value
Productivity growth	0,16	0,08	0,08	1,09
Employment growth	0,07	-0,09	0,16	3,44***
Sales growth	0,26	-0,04	0,29	3,44***

***/**/* indicates statistical significance at the 1%, 5% and 10% level.
Source: IAB Establishment Panel, waves 1997-2002, own calculations.

The results we obtain from the conditional-difference-in-differences estimation support the ones from the matching procedure above. Again, employment and sales growth are significantly higher in the case of an introduction of profit sharing establishments. Controlling for unobservable factors, therefore, does not change our basic results.

7 The Issue of Selectivity: revisited

As was stated in the introduction, one of the major aims of our study is the consideration of selectivity and the avoidance of a possible bias from it by use of the appropriate methodology. Our initial working hypothesis was the assumption that establishments introduce profit sharing not at random but rather if they expect gains due to specific advantages. This assumption was supported on the one hand by table 2 which indicated that profit sharing firms in our sample had on average an approximately 20 percentage points higher sales and 15 percentage points higher employment growth than their non-profit sharing counterparts in the time period 1997-2001. Table 3 on the other hand stated that firms introducing profit sharing differ considerably with respect to numerous characteristics. Due to these reasons a simple comparison seemed inappropriate and justified the use of the above explained matching procedure. Taking a closer look at the results from matching in the case of an introduction of profit sharing (table 5) and comparing them to our naive projection of average treatment effects in table 2, however, seems to suggest that sample selection is not severe, as the average treatment effects we obtain are very similar to the descriptive results from table 2. And indeed, using t-tests the null hypotheses of no difference in outcomes between the group of matched controls and controls cannot be rejected. In light of these results our matching approach turns out to be too cautious. This result was not obvious, however, at the outset of our analysis and therefore in our view testing for selectivity effects by use of this method has its justification.

8 Conclusions

The interest in human resource practices and their potential productivity-enhancing effects has risen dramatically in the last couple of years. One practice, however, that has been discussed widely for its productivity and employment effects, is profit sharing. While the employment effect still remains unclear, one could virtually speak of *common knowledge* that profit sharing increases productivity.

The merits of our paper are twofold. On the one hand we try to theoretically model indirect employment as well as output effects of profit sharing via an increase in productivity, which in turn might (at least partially) level out the initial productivity effect.

The other merit is of methodological nature. Prior research has been plagued by several problems. Among the most severe ones were the use of cross-sectional data, which causes problems with respect to the issue of establishing causation, and the neglect of selectivity and unobservable factors. Using the IAB Establishment Panel we were able to apply the data-demanding non-parametric matching method and extensions thereof which enabled us to address these issues.

The results we obtain from our empirical study support the predictions of our model. The empirical results point to significant output and employment effects of profit sharing. Although we presume that an increased labour productivity as defined by the ratio of output to employment is initially responsible for these effects, we do not find significant effects on productivity in our study. Our results thus might provide an explanation for a number of studies that find positive, but insignificant productivity effects (see Doucouliagos, 1995, for an overview).

Despite the use of a large-scale German establishment panel which surveys several thousand firms per year, our sample size is only limited. The reason is on the one hand our definition of a treatment as we investigate the causal effect of an *introduction* of profit sharing which is a rare event per se. On the other hand, the question whether profit sharing exists is not posed annually in the panel used. Matching and conditional difference-in-differences methods are very data – demanding, but we consider our approach worth a repetition as further surveys or more extensive data sets become available to control for the robustness of our results.

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Appendix

Table A1 - Mean values of outcome variables for firms with(out) profit sharing, Existence of profit sharing

outcome variable	firms with profit sharing	firms without profit sharing
Productivity growth	.23	.22
Employment growth	.09	-.03***
Sales growth	.30	.12***

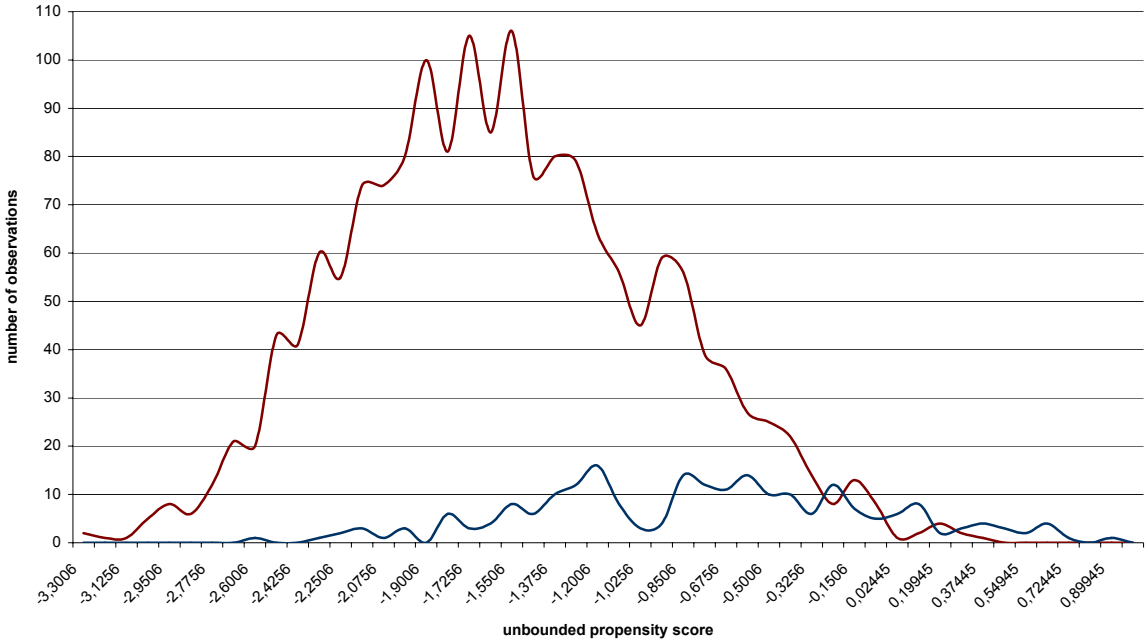
*/**/*** indicate that means differ with statistical significance in a two-tailed t-test at the 10%, 5% or 1% level between the establishments from the two groups
Source: IAB Establishment Panel, waves 1998-2002, own calculations.

Table A2: Mean values of variables for firms with(out) profit sharing, existence of profit sharing

Variable	firms with profit sharing	firms without profit sharing	matched firms without profit sharing
Number of employees	402	78***	228
Competition	.93	.86***	.94
Exporter	.41	.14***	.37
Ict investment	.67	.42***	.68
Shift responsibilities	.37	.17***	.29
Teamwork	.28	.11***	.24
Independent work groups	.23	.07***	.15
Share qualified employees	.69	.58***	.67
Collective bargaining	.76	.54***	.67
Works council	.55	.21***	.42*
Limited liability	.76	.45***	.75
Age	.39	.44	.41
East German establishment	.41	.56***	.42
Establishment size <20	.23	.56***	.24
Establishment size 20-49	.18	.20	.24
Establishment size 50-249	.32	.17***	.33
Establishment size 250-499	.10	.04***	.08
Establishment size 500+	.17	.03***	.11

*/**/*** indicate that means differ with statistical significance in a two-tailed t-test at the 10%, 5% or 1% level between the establishments from the two groups
Source: IAB Establishment Panel, wave 1998, own calculations.

Figure A3 – Frequency distributions of the propensity scores, existence of profit sharing



Source: IAB Establishment Panel, wave 1998, own calculations.

Table A4- Results of probit estimation, existence of profit sharing

Variables	Coefficient	t-value
Establishment size 20-49	.099	0.79
Establishment size 50-249	.342	2.34**
Establishment size 250-499	.273	1.27
Establishment size 500+	.516	2.32**
Competition	.326	2.11**
Exporter	.236	1.99**
Share of qualified employees	.521	2.91***
Collective bargaining	.162	1.52
Works council	.289	2.23**
Limited liability	.298	2.93***
Age	.412	3.89***
East German Establishment	-.495	-4.70***
Shift of responsibilities	.188	1.79*
Teamwork	.055	0.45
Independent work groups	.439	3.43***
Ict investment	.171	1.82*
Establishment size 20-49	-1.886	-3.76***
Number of observations	1923	
Pseudo R2	0.20	

***/**/* indicates statistical significance at the 1%, 5% and 10% level.

Source: IAB Establishment Panel, wave 1998, own calculations.