PROFIT-SHARING AND PRODUCTIVITY: AN INTERNATIONAL COMPARISON

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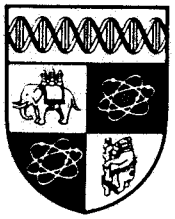

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PROFIT-SHARING AND PRODUCTIVITY:

An International Comparison*

by

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ABSTRACT

Using a common estimating framework and comparable, primary data for two samples of firms in the British and West German engineering industries, the paper reports productivity differentials of 20-30% in favour of firms practising profit-sharing in West Germany, and 3-8% in Britain. Model selection procedures reveal important interactions between profit-sharing and other firm characteristics in both cases. We infer (a) that the observed differentials therefore capture the joint effects of a set of organisational choices of which profit-sharing is one element, and (b) that from a policy viewpoint, profit-sharing must be seen as part of a more general, organisational design process, rather than as an optional, add-on extra, as in some previous work and policy discussion. However, the characteristics of British and West German profit-sharers turn out to be quite different, indicating that there is evidently no single, stereotype formula for the effective use of profit-sharing.

I. INTRODUCTION

The properties of alternative remuneration systems, in particular profit-sharing, have recently been much discussed both at the theoretical level (notably by Weitzman (1983, 1984, 1985, 1986) and Meade (1982, 1986a,b)) and in policy debate (in the UK, centred on recent government intervention to encourage profit-related-pay (HMSO, 1986)).[1/] Often the focus has been on macroeconomic questions concerning unemployment, inflation and investment, although, as Wadhwani (1987) has argued, the wage and share systems are in fact isomorphic under efficiency-wage determination. However this may be, other, microeconomic questions remain important, not least whether, as some believe, profit-sharing can have productivity enhancing effects, and if so, by what means these come about. One can also ask whether there might be a variety of possible links, rather than a single stereotype relationship, and this question takes on added interest when we consider the role and impact of profit-sharing across rather than within national and cultural boundaries.

The existing evidence on these questions is not extensive and is far from conclusive.[2/] Moreover, internationally comparative analyses are so far entirely lacking. To provide the first such analysis, this paper replicates an earlier study in the UK engineering industry (Cable and Wilson, 1988) for a sample of comparable West German firms. The UK analysis found productivity differentials of 3-8% in firms practising profit- (or value-added) sharing, with important interactions between the sharing variable and other aspects of the firms' organisation and control. The nature of these interactions then became a central focus of the analysis. Drawing on the same West German data source as ourselves, FitzRoy and Kraft

(1987) have also reported productivity gains, but did not test interactive models against their own specification (which allows only for "disembodied", Hicks-neutral shifts in the production surface). Thus their results do not offer an existing basis for comparison with our UK findings, and in fact, as we shall show, may be considered misspecified.[3/]

The common estimating structure we employ is explained in the next section of the paper, and brief details of our data and empirical samples follow in Section III. Sections IV and V contain the core of our comparative analysis, respectively outlining differences in the characteristics of profit-sharing and other firms in the two country samples, and the results of our productivity estimates. In brief, we find larger (positive) productivity differentials in Germany than those previously found in the UK, and that models incorporating interaction terms once again dominate. However, subject to caveats concerning significance levels, it appears from the parameter estimates, and from the evidence on the characteristics of profit-sharing firms in each case, that profit-sharing is being used in very different ways and contexts in the two countries.

II. ESTIMATING FRAMEWORK

Our estimates of the productivity effects of profit-sharing are taken from enterprise-level production functions, augmented to take account of the firms' remuneration systems (including profit-sharing) and their organisational characteristics, technology, and workforce composition.[4/] We employ a model-selection approach, estimating a system of restricted equations nested in the general

model:

$$Y = f(\underset{\sim}{F}, \underset{\sim}{Z}, \underset{\sim}{Q}, p.\underset{\sim}{F}, p.\underset{\sim}{Q}, p),$$

where $\underset{\sim}{F}$ is a vector of factor inputs, $\underset{\sim}{Z}$ is a vector of control variables that are a priori unrelated in profit-sharing, $\underset{\sim}{Q}$ is a vector of firm characteristics, and p is an index of profit-sharing, which may be either continuous or binary. Preliminary experiments showed that entering $\underset{\sim}{F}$ as (logarithms of) the book value of capital (K) and total employee-hours (L) was an acceptable restriction on more complex models, in particular those using numbers employed and hours per employee separately, and this parsimonious specification is retained in all reported regressions. The vector $\underset{\sim}{Z}$ comprised time and sub-industry intercepts and an estimated Herfindahl index of seller concentration in the firm's principal market. Appendix 1 lists the variables which make up the important, firm-characteristics vector $\underset{\sim}{Q}$ in the British and German analyses. Given the wide range of variables available to us from our databases, we were able to specify this vector with a view both to a priori relevance and to comparability of the eventual results for each country. In all reported regressions, the p-variable is a binary index indicating the existence or otherwise of a profit-sharing scheme.[5/] The a priori argument for this dichotomous approach would be that performance differences, if present, are more likely to be revealed as between firms with and without profit-sharing (perhaps in conjunction with other aspects of organisational design) rather than according to finer distinctions in the proportion of income accounted for (which in any case tends not to vary greatly amongst profit-sharing firms). Incidental advantages are that we avoid the

estimation problems that would arise in handling a continuous variable with limited variation and a concentration of zero values, together with possible simultaneity problems to which a continuous index may be prone (insofar as, under a given sharing scheme, the amount paid out is necessarily a function of profit and, indirectly, productivity cet. par.).

With Cobb-Douglas technological assumptions, the general model allows for (Hicksian) non-neutral displacement of the production surface due to profit-sharing, as well as for neutral shifts. Moreover, in allowing for interactions with other organisational characteristics, it enables us to treat profit-sharing either as part of a jointly-determined, general, organisational-choice process, or as a separable item on the organisational-choice agenda. Tests of alternative hypotheses on these matters require only the imposition of zero restrictions on relevant subsets of parameters. In other words, we can test independently for the existence of profit-sharing effects under various assumptions about $\underset{\sim}{Q}$ and $\underset{\sim}{F}$ and vice versa, as well as for various joint effects. Table 1 summarises the parameter restrictions in our system of ten estimating equations. Figure 1, which is reproduced from Cable and Wilson (1988), sets out the ten equations schematically, indicating the relationship between them, and what the restrictions in each case signify. In passing, we note that the non-interactive, Hicks-neutral shift model (equation 2), of the same general type as used by FitzRoy and Kraft (1987), is a special case within our more general estimating framework.

III. SAMPLES AND DATA SOURCES

Our empirical data are drawn from primary databases

assembled by interview-survey methods from firms in the UK and West German engineering industries. In each case the data are in two main parts: undated, "survey" data on a wide range of qualitative and quantitative dimensions of the sampled firms; and detailed annual data on inputs and output, and on financial and economic performance. Pooling the annual data, and replicating survey variables where necessary, we formed a UK sample with 52 firms and five annual cross-sections. The equivalent West German samples consisted of two cross-sections and 61 firms.[6/] The empirical estimates reported in Section V are based on these samples, taking account of the pooled time-series, cross-section nature of the data in the choice of estimation method. In Section IV, however, we use single cross-section samples, with annual average values of the variables across all available years, in order to avoid the possibility of exaggerating t-values in the comparison of sub-sample means.

IV. CHARACTERISTICS OF PROFIT-SHARING AND NON PROFIT-SHARING FIRMS

Comparison of the differences between profit-sharing and other firms in Britain and Germany reveals some highly suggestive, and somewhat unexpected, contrasts. Though calculated mean differences in variables entering the Q vector are often not statistically significant (Table 2), in part due to small sample size,[7/] the evidence already seems to point away from, rather than towards, a common, profit-sharing stereotype.

In Germany, the general picture appears to be one in which profit-sharing is being used primarily in conjunction with, not in place of, other financial incentives, essentially as a group-bonus

device to help elicit high levels of workers' effort in relatively large firms, using relatively low-grade manual labour and machine-controlled production methods. The emphasis appears to rest heavily on financial and technical control, rather than direct hierarchical supervision and, contrary to a previous, preliminary study (Cable and FitzRoy, 1980 a,b), the profit-sharing firms are not more than averagely participatory, in terms of employee-involvement in decision-making.

Thus, in Table 2, the profit-sharing firms are seen also to place nearly 50% more reliance on individual incentive pay (I2) than others, and have around twice as much workers' capital (M2), total employment (NET) and total capital (K). They score lower in all the principal human capital dimensions of the manual workforce, significantly so in the case of skill ratios (SBYU), but also in training expenditure (TREXP) and the ratio of apprentices to operatives (APP), and they also employ nearly twice the proportion of (typically unskilled) female labour (100-PCM9) found elsewhere. In technology there is a distinct tendency away from job-production (JO) towards batch (BA) and flow (FL) production methods, i.e. away from technologies which favour individual worker-discretion and the application of human capital. Reduced emphasis on hierarchical supervision in profit-sharing firms is implied by a significantly higher value of the organisational Herfindahl (CS4, an inverse index of hierarchy), but this must be taken in conjunction with the high degree of financial and technological control in these firms.

In some ways, it should be said, these are not the circumstances in which profit-sharing might be expected to be most effective. In particular, large firm-size dilutes group incentives

and increases the incentive for free-riding, while machine-pacing reduces workers' ability to vary their work-effort. On the other hand, it may be that these effects are outweighed by other factors, in particular the fact that the circumstances described are precisely those where individual marginal products are hard to monitor and reward, and where production is more vulnerable to disruption by small groups of workers, so that the linking of workers' rewards to overall performance could be effective.

The German pattern of differences between profit-sharers and other firms is not repeated in the UK. Only very small differences appear in the firm-size (TOT, ASSET) and in skill-ratios (SKILL, APPBYOP). In contrast with their German counterparts, British profit-sharers employ relatively fewer women (100-MALE), though like them they also undertake significantly less training expenditure (TREXP).[8/] Again in contrast, the British profit-sharing firms incline towards job-production (JO) and away from batch (BA) and flow. Control spans (SPAN, another inverse indicator of hierarchy) are in the UK case only slightly, and non-significantly larger amongst profit-sharers, though this may be somewhat misleading since, in the context of more job-production, smaller spans might have been expected. Not surprisingly there is a higher incidence of share-option schemes (SHARES) in British profit-sharing firms, but in their case profit-sharing is accompanied by significantly less use of individual incentives (PIE), the incidence of which is some 29% lower than in other firms. Finally, participatory indicators for UK profit-sharers are mixed; on the one hand the group has a slightly lower proportion of participatory firms (PART), but on the other hand it has about a 30% higher incidence of quality circles (QC) and briefing groups (BG), which are commonly viewed as practices as associated with

employee-participation, and 50% more job-rotation (JOBROT), though the incidence of the latter is very low in both sub-samples.

Though the dissimilarity between the typical British profit-sharing firm and its German counterpart is fairly evident, what makes the British profit-sharing firm tick is so far not entirely clear. Other evidence suggests an underlying industrial relations/technology story. From interview responses we learned that profit-sharing had often been introduced as part of a package involving new technology, and negotiated with the workforce. Mean differences for some relevant variables reveal an interesting pattern (Table 3). Profit-sharing firms are evidently much more unionised, with significantly higher union density (PERUN) and shop-steward representation (STEW). The incidence of closed shops (UNION), joint consultative machinery (UMC) and formal job-evaluation schemes (JOBEVAL) is also very much higher, though significantly so in the case of (JOBEVAL) only. However, high unionisation in these firms is apparently <u>not</u> associated with bad industrial relations and greater levels of conflict and alienation; on the contrary, both working days lost (DYT) and labour turnover of both skilled and unskilled workers (TURNSK, TURNUNSK) are substantially lower than in non profit-sharing firms, though significantly so in the case of DYT only. Moreover, and consistently with our respondents' observations, the profit-sharers yield distinct evidence of greater technical progressiveness; the interval between major process-innovations (INNOV) is significantly less for them than for other firms, by as much as one third, and R&D intensity (RS) is more than 60% (though non-significantly) higher. Profit-sharing firms also invest nearly 19% more (INVEST), relative to their size, though the within-group variances must here also be large, since this difference is again not statisticaly significant.

Information on these matters is less complete in the German database but, where available, again suggests more contrast than similarity. Unionisation is higher in profit-sharing firms, though at very much lower levels (39.4% for profit-sharers and 32.1% for others) than in the UK. But labour turnover is also higher (0.17 vs 0.10 for skilled workers and 0.50 vs 0.19 for unskilled workers), while the investment ratio is lower (0.12 vs 0.16). Only the difference in unskilled labour turnover is, however, statistically significant at the 5% level.

V. PRODUCTIVITY ESTIMATES

Our previous UK results reported productivity gains of 3-8% in favour of profit-sharing firms. Equations incorporating interaction terms with the profit-sharing variable were found to dominate under both OLS and IV estimation methods; model-selection tests identified equation 4 (excluding only interaction terms with the factor input vector $\underset{\sim}{F}$) as the preferred model under OLS estimation, and all restrictions on the most general model (5) were rejected under IV. Rejection of the Hicks-neutral "disembodied model" (2) indicated, inter alia that more than a simple, work-effort/incentive effect was involved, and an industrial relations/technology interpretation was offered, taking into account both the evidence on the typical characteristics of profit-sharing firms, as reported in the previous section, and suggestions in the relevant parameter estimates of a large, positive intercept-shift and much increased capital productivity in profit-sharing firms.[9/] (These were regarded consistent with our explanation and, in particular, with high quality of capital and rates of capital-utilisation in profit-sharers relative to other firms.) The distribution of gains was found to favour

capital-owners rather than workers.

Details of these results are given in Tables 4 to 8, alongside new, comparative findings for West Germany. Given our pooled data, we work where necessary with a variant of Kmenta's (1975) procedure for estimating the all-coefficients constant, time-wise autoregressive, cross-sectionally heteroscedastic model.[10/] The IV estimates allow for endogeneity of labour input in the production process, but treat other variables as predetermined.[11/] OLS estimates are included for comparison.[12/]

Broadly speaking, the model-selection outcomes are the same for Germany as they were for Britain. Our procedure was to continue accepting restrictions on the general model (5) until a binding constraint was met. Where proceeding along this route left a choice between non-nested models, selection was by reference to the significance level at which each non-eliminated model would have been rejected. Testing is by conventional F-tests of the relevant sets of linear restrictions under OLS, and a version of the Wald-test under IV.[13/] With four models in each principal route from equations (1) to (5), a test significance level of 1.275% is required at each stage for consistency with an overall test at 5% (Mizon, 1976).[14/]

Turning to the German results, we again find that models incorporating interaction terms dominate. In the OLS results, all models in the set currently under study are accepted both under the Mizon formula and at the 5% level (Table 6). However, 7 is preferred to 2 (and 3), which would be rejected at 10%, and (unlike the UK counterpart equation in Table 5) is not rejected again 4. The profit-sharing effect is thus best captured exclusively in

interactions with firm-specific characteristics (whereas in the UK case, deletion of the intercept-shift due to profit-sharing was rejected). In the IV estimates, on the other hand, all departures from equation 5 are rejected at Mizon levels, as in the UK. Thus the model-selection evidence for Germany, like that for Britain, indicates that the effect of profit-sharing is related to firms' choices of technology, internal organisation and labour-force characteristics, and that profit-sharing is to that extent an element of overall organisational design, rather than a universally available, optional extra. In passing, we note that our own results for West Germany thus call into question those of FitzRoy and Kraft (1987), insofar as they allow only for disembodied shift effect, with no interactions.

Substantial differences emerge between the German and British results, however, when we consider, first, the size of the overall productivity effect in the two countries and, secondly, the way in which this appears to have come about. The output differentials predicted by our preferred models in the West German case lie in the range 20.1 to 30.1 per cent (Table 4).[15/] This is several times higher than the previously mentioned 3.1 to 8.2 percent gain estimated for the UK (though not out of line with some claims that have been made for the benefits to UK profit-sharers[16/]). With respect to the origin of these large West German gains, that is, to the way in which profit-sharing is used within the firm, and combined with other dimensions of organisational design, this is evidently something other than the industrial relations/technology story we advanced for the UK. For not only, as we saw in the previous section, does the typical German profit-sharer not have the same characteristics as its UK counterpart, but also, and subject to our earlier caveat, the parameter estimates in this case do not suggest a

positive intercept shift and capital-productivity enhancement that we would expect under this interpretation.[17/] On the contrary, we find a negative intercept-shift and lower capital productivity in the German profit-sharing firms, but greatly increased labour productivity (Table 7). Though statistical significance problems rule out strong conclusions, so far as signs and magnitudes are concerned this is in total contrast with the pattern of UK results, but would be consistent with the use of profit-sharing in German firms as a device for extracting high levels of effort from relatively low-grade labour, as our earlier analysis of the characteristics of profit-sharing and other firms had suggested.

Thus, there are signs that the productivity gains associated with profit-sharing come about in very different ways in Britain and West Germany, and it is interesting to conclude our analysis by looking for indications of a corresponding difference in the way in which these gains are distributed, in particular as between workers and capital-owners. We do this by comparing factor rewards, insofar as we know them, in profit-sharing firms and elsewhere, bearing in mind of course that, in the former, workers' income also includes their profit-share, which is a deduction from total profits available to capital-owners. The reason for looking at all factor payments is that these may include firm-specific supplements above market-determined levels, which are in effect also shares in what Aoki (1980, 1982, 1984) and others have termed "organisational rent" - which the productivity gains of profit-sharing will have enlarged. Unfortunately, however, a fully fledged analysis of this issue is not possible because our information is only partial, with nothing on the division of profits between retentions and dividends to shareholders in Britain, and no direct information on profits at all for Germany.

We also lack information on non-pecuniary rewards, and hence on total welfare payoffs, which are presumably what matter ultimately. Some hints may, however, be gleaned from the available evidence.

In our earlier work on Britain we found that, on average, workers' non-share income (i.e. earnings) was about 5% higher in profit-sharing firms (Table 8), with a slightly larger differential for manual workers (WAGE) but only around 3% for white-collar workers (SAL), whose relatively less favourable treatment may have reflected the presence of strong manual unions. The reported rate of return on capital (RR) was, however, almost exactly doubled.

In Germany, as Table 8 reports, the earnings differentials in profit-sharing firms range from an excess of around 4-9% above those received elsewhere - not much more than the UK differential, even though in this case, as we have seen, the overall productivity gains appear to be very much larger, and seem to have come about in a very different way, through increased labour productivity and effort. Interestingly, and consistently with the profile of profit-sharing firms which has emerged from our analysis, the differentials are greatest for white collar and supervisory employees (AVSAL, AVIN) and least for the relatively underutilised category of skilled manual workers (EIE). In the absence of direct information on returns to capital in the German data, it is necessary to resort to constructed measures on "capital share". Using FitzRoy and Kraft's (1986) definition,[18] we obtain a mean value for "return on capita" of 0.227 for firms with profit-sharing, and 0.183 for firms without sharing, an increase of just under a quarter. Again, this is perhaps smaller than might have been expected, given the very much larger, predicted, overall productivity gains in Germany than in Britain, and the broadly

comparable earnings differentials.

In general, we conclude that, unless outweighed by (unobserved) utility losses from increased effort or reduced job-satisfaction arising from changes in work organisation and technology, etc., mutual benefits from profit-sharing appear to accrue both to workers and to capital-owners in both countries under study. The distribution of these gains appears to be only somewhat, and not very strongly, related to the way in which they are generated.

V. CONCLUSIONS

New estimates for a sample of firms in the West German engineering industry indicate productivity differentials of 20-30% in favour of firms practising profit-sharing. This compares with previous estimates of only 3-8% for a similar sample of British engineering firms. In both cases, the analysis reveals important interactions between profit-sharing and other aspects of the firms' organisation and operation, so that the observed productivity differences must be regarded as due not to profit-sharing alone, but to a set of firm-specific factors and influences selected jointly with profit-sharing. The nature of these factors differs markedly as between countries, indicating distinct differences in the way the associated productivity gains come about. In the German sample, profit-sharing apparently tends to be used in conjunction with, not in place of, other financial incentives, essentially as a group bonus device to help elicit high levels of workers' effort in relatively large firms, using relatively low-grade manual labour and machine-controlled production methods. The profit-sharing firms are not more than averagely participatory in the decision-making arena

and, tentatively, parameter estimates suggest negative intercept shifts and lower capital productivity, but greatly increased labour productivity. British profit-sharing firms, by contrast, are of similar size to other firms, but apparently tend away from machine-control towards job production, and are highly unionised. According to respondents, profit-sharing in British firms had frequently been introduced in the context of negotiations over new technology, and parameter estimates in this case suggest a positive intercept and much increased capital productivity, but lower labour productivity than elsewhere, which would be consistent with better utilisation of newer, more technically advanced, capital equipment. Despite these differences, the results for both countries indicate mutual gains to both workers and capital-owners, at least in terms of pecuniary measures of reward, but with larger proportional gains to capital-owners in both cases.

The fact that we find profit-sharing interacting with other variables underlines the importance of treating it, not in isolation, but as an integral part of a wider organisational design process, and this is an important result for practitioners and policy makers, as well as for independent researchers. Whether the particular ways of using profit-sharing we have observed in British and German engineering firms could be adopted successfully in other contexts is unclear; the effects we have observed could, for example, depend on particular aspects of the German cultural environment and on idiosyncracies of British industrial relations. Resolution of these questions is beyond the scope of this paper. The important, general point is that, from these examples alone, there is evidently no uniquely appropriate context and role for profit-sharing. What

additional possibilities may exist, if any, over and above those investigated here, is a matter for further research.

APPENDIX: Variables Used in the Analysis

(a) Variables included in the Q vector.

UK	GERMANY	
SKILL	SBYU	Percentage/ratio of skilled to unskilled operatives.
WBYB		Ratio of white collar to blue collar operatives.
QC	-	Dummy variables for the existence of: quality circles
BG	-	Dummy variables for the existence of: briefing groups
JOBROT	-	Dummy variables for the existence of: job rotation
APBYOP	APP	Percentage/ratio of apprentices to operatives.
PART	GS4D	Participatory/non-participatory dummy (based on Guttman scale of participation[19]).
TREXP		Training expenditure for employee, (£'000 or DM'000 per head).
SHARES	-	Dummy for the existence of a share option scheme.
MALE	PCMG	Percentage male employees.
PIE	I2	Percentage/ratio of piecework pay to total earnings.
SPAN	CS4	Average control span/organisational Herfindahl.[20]
SHIFT	-	Percentage shift-working.
JO		Dummy variables for production methods: job
BA		Dummy variables for production methods: batch
FL	-	Dummy variables for production methods: flow
IT		Dummy variables for: intermediate technology
PVA	PSA	Profit/value-added sharing dummy (see also footnote 5).
-	CERT	Ratio of white collar workers with qualifications to total white collar employees.
-	HIED	Ratio of white collar workers with higher education to total white collar employees.
-	SAET	Percentage of employees with more than 10 years' service.
-	M2	Workers' capital (DM'000 per head).
-	CSTOP	Owner control (proportion of capital owned by proprietor or top management).

(b) Other variables used in the analysis.

UK	GERMANY	
TOT	NET	Total number of employees.
ASSET	K	Total capital stock (£'000 or DM'000).
PERUN	PWU9	Union density (%).
UNION		Dummy, existence of closed shop.
STEW		Ratio of shop stewards to operatives.
UMC		Dummy, existence of joint-consultative committee
JOBEVAL		Dummy, existence of formal job-evaluation scheme
DYT		Working days lost per employee.
TURNSK	ATS	Annual skilled labour turnover (% in the case of UK, high/low dummy for Germany.
TURNUNSK	ATU	Annual unskilled labour turnover (% in the case of UK, high/low dummy for Germany.
INNOV		Average interval between major process innovations (in years).
RS		R&D intensity.
INVEST		Ratio of net capital expenditure to capital stock.
EARN		Average earnings (all employees).
WAGE	MANW	Average wage (operatives).
SAL	AVSAL	Average salary (white collar workers).
RR	ROC	Rate of return on capital employed.
	AVIN	Average income of foremen, craftsmen and supervisors.
	EUE	Average unskilled earnings (per hour).
	ETE	Average skilled earnings (per hour).

FOOTNOTES

1/ Though the literature of course goes much further back. For an interesting earlier collection of papers by Samuelson and others, see the special issue of the Zeitschrift fuer die Gesamte Staatswissenschaft, (1977) edited by Heinz Sauermann and Rudolf Richfer.

2/ For a recent survey, see Blanchflower and Oswald (1987). Using Workplace Industrial Relations Survey data, these authors themselves find "no support for the basic hypotheses" (Blanchflower and Oswald, 1986). But some case study evidence is supportive (e.g. Bradley and Estrin, 1986; Oakeshott, 1986), and Bell and Hanson (1987) report large positive profitability differences in profit-sharing firms, while Estrin and Wilson (1986) find some support for the Weitzman hypothesis.

3/ FitzRoy and Kraft also neglect the fact that they are using pooled data in the choice of estimation method, and problems of the endogeneity of factor inputs in production function estimation.

4/ For a more detailed derivation, see Cable and Wilson (1988).

5/ In the case of Britain, profit or value-added sharing.

6/ To permit use of the Kmenta estimating procedure with pooled data, our samples are confined to firms present in each/all cross-sections.

7/ Many more differences are of course significant when the data is used in pooled form. While this might perhaps be justified in the case of variables for which annual observations are available, it clearly would not for the undated, 'survey' variables. We therefore err on the side of caution, and report results only for a single cross-section.

8/ Except that in the UK case lower training expenditure is accompanied by greater length of service in profit-sharing firms and hence less rapid depreciation of human capital stock.

9/ Interpretation of the parameter estimates is tentative because of multicollinearity arising from the presence of multiple interaction terms, with adverse effects on the reliability and statistical significance of individual coefficients in the complex models preferred in model selection tests. Similar caveats apply to the German results, reported below. Note that, however, this should not invalidate the model-selection tests, which depend on the overall performance of alternative models.

10/ Where tests indicate autocorrelation we carry out the first of his two transformations of the data (in effect a Cochrane-Orcutt two-step adjustment, with Prais-Winsten modification to retain the first cross-section of observations). We then rely on robust standard errors (White, 1980) in place of Kmenta's second transformation to

correct for heteroskedasticity (which requires the number of cross-sections to exceed the number of parameters in the model in question, a condition which is never met in our case). For recent reviews of alternative panel-data estimation procedures see Judge et al (1985) and Hsiao (1986). Our choice among the available alternatives was limited by the small number of cross-sections in the data. This was one reason for our preference for the Kmenta procedure over alternatives such as the increasingly common "fixed effects" model. In addition, the Kmenta model allows us to exploit the richness of our data with respect to the range of variables at our disposal, entering explicitly firm-specific characteristics that are controlled for by individual intercepts in the fixed-effects model, but not observable individually using that approach.

11/ Our models assume that the firm's capital stock, technology, internal organisation structure and workforce composition are predetermined according to the firm's planned output for a given period, and incompletely flexible within that period. The presence of profit-sharing (as opposed to the amount paid out to workers under profit-sharing arrangements), is among the variables predetermined in this way, and thus not treated as endogenous. We do not rule out the possibility of a longer term feedback from performance to profit-sharing, but would argue that the system may plausibly be regarded as recursive rather than strictly simultaneous in this respect, especially with respect to the existence of profit-sharing, etc., as captured by dichotomous variables. In any case, using a continuous profit-sharing index, FitzRoy and Kraft find only a weakly significant feedback from productivity to profitsharing, when both are treated as endogenous, and their OLS and 2SLS estimates are in other respects remarkably similar, especially insofar as the productivity equation is concerned. Thus the simultaneity problem may in practice not be as severe as might a priori be expected. For the record, substituting another continuous profit-sharing variable (profit share income as a proportion of wages and salaries), and ignoring simultaneity, does not materially affect the principal results reported here. However, we recognise that random shocks in output markets can generate output fluctuations which are transmitted to labour markets within the planning period, and allow for the endogeneity of labout input levels by instrumenting on labour-market variables, in particular wages and salaries.

12/ Hausman tests indicatd endogeneity of labour input in the case of Britain only. On this evidence, it seems, the short-run flexibility of labour input is not as great as it traditionally supposed. To cover all eventualities we report both OLS and IV estimates of our main results. As will be seen, our principal conclusions are not sensitive to the choice of estimation method.

13/ The test statistic, $CRW = n[(\tilde{e}'\tilde{e} - e'e)/u'u]$, (where n is the number of observations, $\tilde{e}$ and e are the second-stage residuals for the restricted and unrestricted equations respectively, and u are the usual IV residuals for the unrestricted equation), has an asymptotic χ^2 distribution with h degrees of freedom (where h is the number of restrictions in the relevant test). See Kiviet (1984) and Gallant and Jorgenson (1979).

14/ In the German results, as in those for the UK, equation 8-10 were always rejected and are not considered further. Mizon shows that, for consistency with significance level of α for the overal test, and treating all models symmetrically, the significance level for intermediate stage tests (ε) may be derived from the relation $(1 - \varepsilon)^n = (1 - \alpha)$, where n is the number of models in the relevant path.

15/ The predicted values are calculated using both the overall sample means, and the subsample means for profit-sharing and for non profit-sharing firms. This is to take account of the differences in the characteristics of the two groups, confirmed in the foregoing results, which imply that no single vector of means is appropriate for both types of firm. We therefore look for dominance by one group across alternative vectors of means.

16/ For example, Bell and Hanson (1987) report profitability differences of 24-50% between profit-sharing and non profit-sharing firms, for different profitability measures.

17/ See footnote 9.

18/ Gross return on capital (ROC) is defined as the ratio of cash flow to capital stock (assets) where cash flow is value-added less total labour cost and profit-shares to employees. Profitability (return on capital) is defined as the ratio of cash flow to capital stock (assets), or value-added less total labour cost plus profit-shares to employees, over book value of assets including fixed and working capital.

19/ For details of the Guttman scales, and our choice of them in preference to alternative participation indices, see Cable (1987, 1988).

20/ The organisational Herfindahl is an inverse measure of the degree of hierarchy: $CS4 = \sum_{i=1}^{n} S_i^2$, where n is the number of hierarchical levels and s_i is the proportion of employees at the i'th level.

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TABLE 1 : ZERO RESTRICTIONS, EQUATIONS 1-10
(X denotes omission)

Equation	Variable(s) Excluded			
	Interaction Terms		Other Variables	
	With factor inputs (p. $\underset{\sim}{F}$)	With firm-Characteristics (p. $\underset{\sim}{Q}$)	p.	$\underset{\sim}{Q}$
1	X	X	X	
2	X	X		
3		X		
4	X			
5				
6			X	
7	X		X	
8	X	X	X	X
9	X	X		X
10		X		X

TABLE 2 : Mean Differences in Q Variables, Profit-Sharers vs Others

VARIABLE	UK			FRG		
	PVA FIRMS (n=21)	OTHERS (n=31)	t	PSA FIRMS (n=30)	OTHERS (n=31)	t
SKILL/SBYU	42.72	44.34	-0.20	0.91	2.25	-2.27**
WBYB	0.54	0.59	-1.19	0.35	0.33	0.53
QC	0.381	0.291	0.67			
BG	0.524	0.407	0.79			
JOBROT	0.048	0.032	0.28			
APBYOP/APP	4.215	4.273	-0.12	0.10	0.15	-1.33
PART/GS4D	0.476	0.548	-0.50	0.60	0.58	0.15
TREXP	0.101	0.265	-2.18*	0.74	1.04	-1.41
SHARES	0.381	0.291	0.67			
MALE/PCM9	82.67	78.19	0.98	76.47	87.58	-1.83*
PIE/I2	16.45	23.05	-2.45**	0.13	0.09	0.77
SPAN/CS4	14.19	13.01	0.61	0.80	0.74	2.05**
SHIFT	8.52	5.86	0.79			
JO	0.143	0.097	0.50	0.47	0.55	-0.63
BA	0.429	0.452	-0.16	0.80	0.74	0.53
FL				0.30	0.13	1.64
IT	1.00	0.86	1.19	1.00	0.94	1.41
CERT				0.80	0.78	0.27
HIED				0.15	0.16	-0.24
SAET				45.19	46.39	-0.27
M2				0.53	0.22	1.30
CSTOP						
TOT/NET	1,167	1,144	0.11	872	452	1.40
ASSET/K	5,122.5	4,920.1	0.19	62,906	31,048	1.00

TABLE 3 : Mean Differences in Industrial Relations Variables : UK Firms

	Profit-sharing Firms (PVA=1)	Other Firms (PVA=0)	
	n=21	n=31	t
PERUN	87.81	72.00	2.11**
UNION	0.57	0.42	1.07
STEW	0.03	0.02	1.87*
UMC	0.52	0.42	0.73
JOBEVAL	0.48	0.26	1.63*
DYT	8.58	14.91	-2.18**
TURNSK	3.51	4.34	0.71
TURNUNSK	3.83	4.65	0.89
INNOV	4.48	6.71	-2.06**
RS	3.51	2.18	0.62
INVEST	0.19	0.16	1.09

TABLE 4 : Predicted Output Differentials, Profitsharing vs Other Firms

Output Differential Predicted At	UK		FRG	
	Eq.4 (OLS)	Eq.5 (IV)	Eq.7 (OLS)	Eq.5 (IV)
1. Overall sample means	+6.8%	+5.9%	+23.5%	+28.1%
2. Profitsharing means	+4.8%	+3.1%	+20.1%	+26.2%
3. 'Other' means	+8.2%	+8.2%	+27.2%	+30.1%

TABLE 5 : Model Selection Tests (UK): F and CRW Tests of Linear Restrictions Between Models Shown(i)

Restricted	Equation Unrestricted			
	6	5	4	3
	(a) F-Statistics (OLS)			
7	1.80 (2,215)	2.84** (3,214)	7.34**** (1,216)	
6		4.86** (1,214)		
4		0.61 (2,214)		
3		7.64**** (16,214)		
2		7.10**** (18,214)	7.94**** (4,216)	1.90 (2,23)
	(b) CRW-Statistics (IV)			
7	30.48**** (2)	53.61**** (3)	3.10 (1)	
6		27.33**** (1)		
4		51.13**** (2)		
3		130.75**** (16)		
2		169.03**** (18)	147.74**** (4)	33.18**** (2)

Note (i) Degrees of freedom in parentheses.

(ii) *, **, ****, denote significance at 10%, 5% and 1% respectively.

TABLE 6 : Model Selection Tests (Germany): F and CRW Tests of Linear Restrictions Between Models Shown(i)

Restricted \ Equation Unrestricted	6	5	4	3
	(a) F-Statistics (OLS)			
7	0.32 (2,79)	0.21 (3,78)	0.05 (1,80)	
6		0.003 (1,78)		
4		0.29 (2,78)		
3		1.61* (17,78)		
2		1.60* (19,78)	1.78* (17,80)	1.35 (2,95)
	(b) CRW-Statistics (IV)			
7	23.27**** (2)	40.14**** (3)	0.01 (1)	
6		17.99**** (1)		
4		40.14**** (2)		
		39.34 (17)		
2		82.66**** (19)	46.20**** (17)	28.66**** (2)

Note (i) Degrees of freedom in parentheses.

(ii) *, ****, denote dignificance at 10% and 1% respectively.

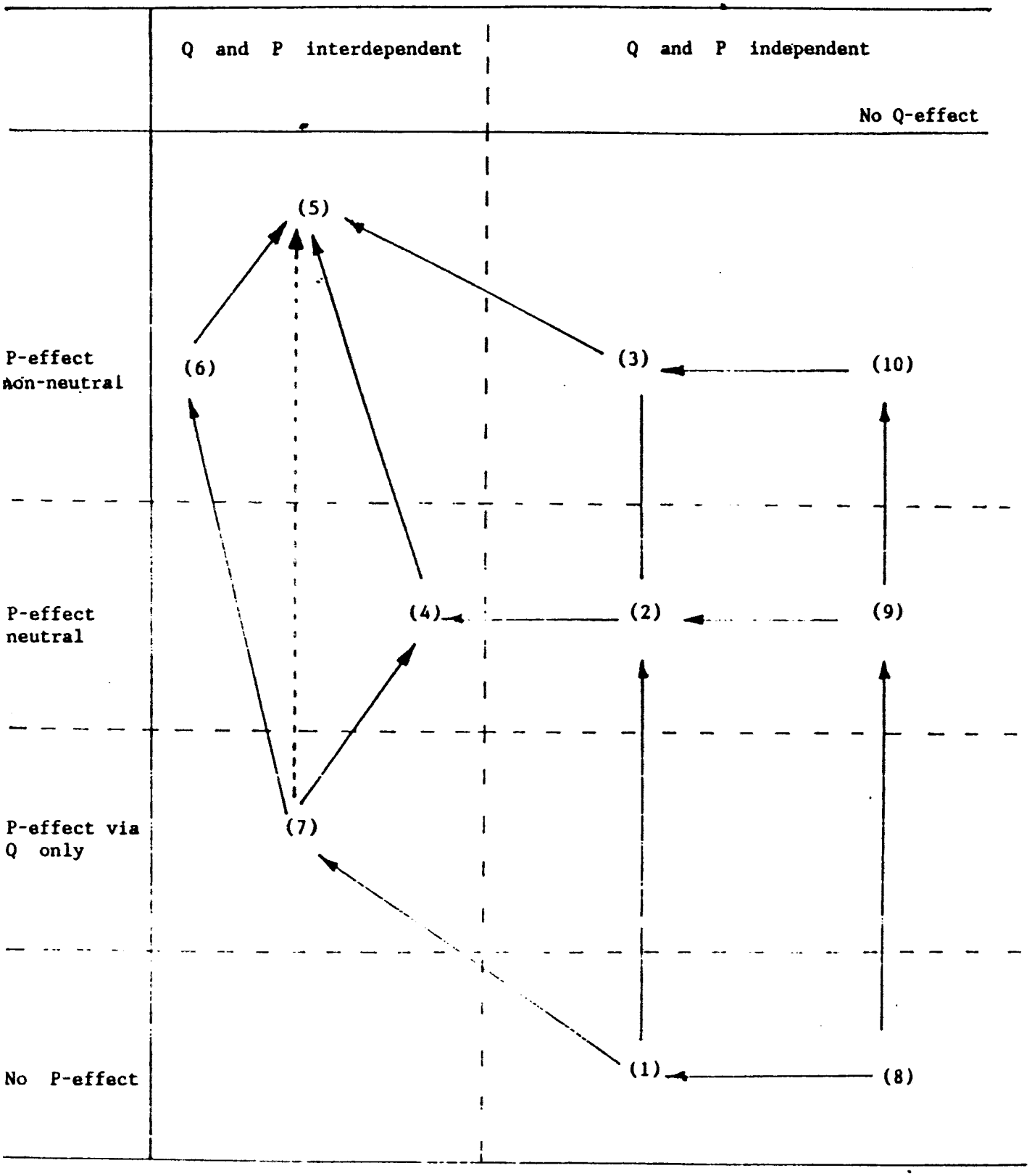
TABLE 7 : Equation 5 Coefficients, UK and Germany

VARIABLE	UK		GERMANY	
	Base Coefficient	Interaction Term	Base Coefficient	Interaction Term
SBYU/SKILL	-0.0048*	0.0160**	0.0118	0.1089
WBYB	0.0153	0.8625*(*)	-0.3596	-0.0399
QC	-0.5064****	1.0076****		
BG	0.3854**	-0.8342****		
JOBROT	-1.1757****	1.2577*		
APP/APPBYOP	-2.2203	-0.2993	-0.5693	0.2531
GS4D/PART	-0.0604	0.1741	-0.0031	0.0992
TREXP	-0.0826	-0.3830	0.3467****	-0.2330*
SHARES	-0.1734	0.8969*		
PCM9/MALE	-0.0016	0.0094	-0.0030	-0.0001
I2/PIE	-0.0069**	0.0108	0.6804	0.2720
CS4/SPAN	0.1740*	-0.0171	1.9233****	-0.7059
SHIFT	0.0104	0.0096		
JOB	0.0288	-0.4824	-0.2762	0.1937
BATCH	0.2532**	-0.6576*	0.2795	-0.4362*(*)
FLOW			-0.1347	0.1885
IT	0.3646	0.8520	-1.0032	1.9392****
CERT			-0.0211	0.2301
HIED			0.9786	-3.5468****
SAET			0.0028	0.0010
M2			-0.0017	0.0059
CSTOP			-0.0111	0.1625
Constant	-4.6757		-0.8393	
PVA/PSA		2.9522		-2.4423
K	-0.2320	0.1886	0.4777*	-0.3790
L	0.7693****	-0.5142	0.3295	0.4155

TABLE 8 : Factor Rewards in Profitsharing and Other Firms

	Profitsharing Firms	Others	t	Percent Difference
UK				
EARN	5.491	5.259	1.99*(*)	+4.4%
WAGE	5.055	4.817	1.62(*)	+4.9%
SAL	6.476	6.330	0.82	+2.3%
RR	0.188	0.082	3.60***	+129.3%
FRG				
MANW	28.83	27.12	0.54	+6.3%
AVSAL	40.28	37.18	1.51	+8.3%
AVIN	3,398.9	3,123.6	2.14**	+8.8%
EUE	1,199.1	1,143.4	1.38	+4.9%
ETE	1,463.4	1,408.0	1.55	+3.9%
ROC	0.227	0.183	0.38	+23.7%

FIGURE 1 : Estimating Framework



Notes (i) Models are numbered in their order of appearance in the text.

(ii) Solid arrows indicate nesting with a single (set of) restriction(s); broken arrows indicate a route involving more than one (set of) restriction(s). Similar routes might be taken from model (1) to model (4), (2) to (5), (8) to (2) and (9) to (3).