PROFIT-SHARING AND PRODUCTIVITY: AN ANALYSIS OF UK ENGINEERING FIRMS*

JOHN R CABLE
UNIVERSITY OF WARWICK

and

NICHOLAS WILSON
BRADFORD UNIVERSITY MANAGEMENT CENTRE

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(University of Warwick)

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(Bradford University Management Centre)

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ABSTRACT

The paper reports productivity differentials of 3-8% in favour of profit-sharing firms in the UK engineering industry. The estimates come from equations in which profit-sharing interacts with factor input levels and/or the firms' technological, organisational and labour-force characteristics, and imply more than a simple incentive effect on work effort, or more 'cooperative' behaviour in given circumstances. Model-selection tests reveal that these models dominate those used in previous work, where profit-sharing enters as a disembodied, Hicks-neutral shift in the production surface. A technological labour relations interpretation of the origin of the gains is suggested, which are found to be asymmetrically distributed. The results question policy measures to encourage profit-sharing which do not take account of its significance in the process of organisational design.

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I. INTRODUCTION

Recent theoretical work by Weitzman (1983, 1984, 1985, 1986) Meade (1982, 1986a,b) and others has drawn attention to the properties of alternative remuneration systems, and in particular to profit-sharing. Government intervention to encourage profit-related pay (HMSO, 1986) has considerably sharpened interest in such matters. Much previous debate has focussed on macroeconomic aspects, associated with the flexibility of workers' pay, the share economy's potential as a cure for stagflation, and its tendency to underinvest. Microeconomic aspects, concerning the effects on worker attitudes, incentives, productivity and so forth, have by contrast been treated as less focal, often separate, issues. Meade, for example, explicitly excludes them from the scope of his most recent book (1986b, p.5), as he had in his earlier treatment of the theory of labour-management (1972, p.403).

Yet, when it comes to public policy, the micro effects are crucial. Any argument for measures to encourage profit-sharing must, as always, rest on a demonstrable divergence of social and private benefits. To evaluate the degree of this divergence we must know the extent of private returns. Hence the question of whether there are significant, private, firm-level gains is of the essence.

Indeed, if Wadhwani (1987) is correct, this may be the only significant issue remaining. Adding explicit models of wage determination to Meade's analysis, Wadhwani points out that the wage and share systems are isomorphic if wages are determined according to efficiency-wage theories. Then, in his words "we can forget about the short-run excess demand for labour proposition, and the Meade investment problem and, indeed, stop making all this fuss about alternative systems of remunerating workers. The form in which you pay workers becomes irrelevant." (p.426, author's emphasis.) But Wadhwani's sweeping final sentence properly applies to the macroeconomic debate only; as long as significant productvity effects of alternative payment systems remain, the choice amongst them is an important micro-policy issue in its own right, and magnitude of the productivity effects an important determinant of that choice. Thus the microeconomic, productivity questions remain to be answered.

Existing empirical evidence on the effects of profit-sharing is both sparse and mixed.1/ Blanchflower and Oswald (1986) find no support for the basic hypotheses, using data from the Workplace Industrial Relations Survey. Individual case study evidence is, however, more favourable, e.g. in retailing (Bradley and Estrin, 1986) and in deep-sea fishing (Oakeshott, 1986). Moreover, Bell and Hanson (1987) report substantial positive differences in mean profitability, growth and investor-returns between profit-sharing and non profit-sharing firms, while Estrin and Wilson (1986) find micro-level employment/remuneration effects consistent with the Weitzman hypothesis. Outside the UK, FitzRoy and Kraft (1986, 1987) claim significant, positive effects on both productivity and profits in West Germany, but neglect the endogeneity of factor inputs (especially labour) in the production process, fail to allow for the pooled nature of their data in estimation, and use a restrictive specification, which permits only Hicks-neutral, "disembodied" productivity effects.

This paper presents production-function estimates of profit-sharing effects for the UK, using a new source of primary survey-data, collected under an ESRC project from a sample of firms in the engineering industry. Our models allow both for the endogeneity of labour input and for the use of pooled, time-series cross-section data. We also relax the assumption of Hicks-neutral, disembodied effects found in previous work. This broadens the emprirical test to include not only (non-neutral) incentive effects that are reflected in marginal products, but also possible interactions with firm-specific organisational, technological and labour-force characteristics that may have been chosen, jointly with the form of remuneration system, in firms' organisation-design desisions.

The next section of this paper outlines a model-selection framework which nests the restrictive, "disembodied" models within a more general model incorporating interaction effects. Our empirical results are reported in Section III, and our conclusions and policy implications follow in Section IV.

II. THEORETICAL FRAMEWORK

We require a model selection framework encompassing alternative models of the profit-sharing--productivity relationship allowing, in particular, for possible interactions with production-input and other organisational choices. In constructing this framework we have also to allow for organisational choice effects that may operate independently of profit-sharing or in its absence. Assuming Cobb-Douglas technology, and before introducing profit-sharing variables, we begin with the relationship

$$V_i = A_o K_i^{\alpha} L_i^{\beta} \exp\left(\sum_{j=1}^{J} \gamma_j Z_{ji} + \sum_{h=1}^{H} \phi_h O_{hi} + u_{1i} \right) . \qquad (1)$$

This simply augments the familiar two-input stochastic model $V_i = A_o K_i^{\alpha} L_i^{\beta} e^{ui}$ (where V is value-added, K is a measure of total capital stock and L is total employment) with two vectors of control variables, $\underset{\sim}{Z}$ and $\underset{\sim}{Q}$. $\underset{\sim}{Z}$ includes variables which are a priori unrelated to the profit-sharing issue, whereas $\underset{\sim}{Q}$ is a vector of input-quality and organisational variables containing potentially important interactions.2/ Following standard practice, exp(u) is assumed a log-normally distributed random variable taking values above and below one, representing the technical or productive efficiency of the firm (Wallis, 1979, p.51). The augmenting vectors $\underset{\sim}{Z}$ and $\underset{\sim}{Q}$ exert Hicks-neutral shift effects, which in their absence would show up in the unexplained residual efficiency term exp(u).

If profit-sharing exerts productivity effects which register as a wholly disembodied shift (due for example to improvements in communications and overall efficiency), we may write

$$V_i = A_o K_i^{\alpha} L_i^{\beta} \exp\left((\lambda P_i + \sum_{j=1}^{J} \gamma_j Z_{ji} + \sum_{h=1}^{H} \phi_h Q_{hi} + u_{2i}\right), \quad (2)$$

where P is a measure of profit-sharing, which can be either a binary or a continuous variable. Allowing for (non-neutral) productivity effects that are reflected in marginal products, we obtain the slightly more general model:

$$V_i = A_o K_i^{(\alpha + \eta P_i)} L_i^{(\beta + \eta P_i)} \exp\left(\lambda P_i + \sum_{j=1}^{J} \gamma_j Z_{ji} + \sum_{h=1}^{H} \phi_h Q_{hi} + u_{3i}\right) \quad (3)$$

However, both (2) and (3) still constrain profit-sharing effects to operate independently of organisational characteristics (other than factor input levels in (3)). This restriction is relaxed if we introduce vectors of interaction terms between the profit-sharing variable P and the Q vectors in (2) and (3) obtaining, respectively,

$$V_i = A_o K_i^{\alpha} L_i^{\beta} \exp\,(\lambda P_i + \sum_{j=1}^{J} \gamma_j Z_{ji} + \sum_{h=1}^{H} \phi_h Q_{ji}$$

$$+ \sum_{h=1}^{H} \mu_h P_i Q_{hi} + u_{4i}) \qquad (4)$$

and

$$V_i = A_o K_i^{(\alpha + \delta P_i)} L_i^{(\beta + \eta P_i)} \exp\,(\lambda P_i + \sum_{j=1}^{J} \gamma_j Z_{ji}$$

$$+ \sum_{h=1}^{H} \phi_h Q_{hi} + \sum_{h=1}^{H} \mu_h P_i \cdot Q_{hi} + u_{5i}) \,. \qquad (5)$$

Equation (5) is the least restricted model we shall consider. Our final two models delete the "disembodied" P-effect entirely, leaving, respectively, only interaction terms with K, L and the Q vector:

$$V_i = A_o K_i^{(\alpha + \delta P_i)} L_i^{(\beta + \eta P_i)} \exp\,(\sum_{j=1}^{J} \gamma_j Z_{ji}$$

$$+ \sum_{h=1}^{H} \phi_h Q_{hi} + \sum_{h=1}^{H} \mu_h P_i \cdot Q_{hi} + u_{6i}) \,, \qquad (6)$$

and interaction terms with Q variables only:

$$V_i = A_o K_i^{\alpha} L_i^{\beta} \exp \left(\sum_{j=1}^{J} \gamma_j Z_{ji} + \sum_{h=1}^{H} \phi_h Q_{hi} + \sum_{h=1}^{H} \mu_h P_i \cdot Q_{hi} + u_{7i} \right). \quad (7)$$

Note that the profit-sharing effect in (7) operates wholly indirectly, via interactions with organisational choice variables.

Equations (1) to (7) may be located in a more general structure of nested hypotheses with non-unique paths, which is set out schematically in Figure 1. For completeness, this includes three further equations which combine the assumption that Q-effects are unimportant with the assumption of no P-effect:

$$V_i = A_o K_i^{\alpha} L_i^{\beta} \exp \left(\sum_{j=1}^{J} \gamma_j Z_{ji} + u_{8i} \right), \quad (8)$$

neutral P-effect:

$$V_i = A_o K_i^{\alpha} L_i^{\beta} \exp \left(\lambda P_i + \sum_{j=1}^{J} \gamma_j Z_{ji} + u_{9i} \right), \quad (9)$$

and non-neutral P-effect:

$$V_i = A_o K_i^{(\alpha + \delta P_i)} L_i^{(\beta + \eta P_i)} \exp \left(\lambda P_i + \sum_{j=1}^{J} \gamma_j Z_{ji} + u_{10i} \quad (10)$$

Model selection can be carried out within this framework using procedures appropriate for the chosen estimation method to test the relevant exclusion restrictions embodied in a given model against more general alternatives. The structure is quite general, and could be used to analyse a variety of institutional determinants of productivity, other than profit-sharing. In the present case we can test independently for the existence of a P-effect under various assumptions about Q and vice versa, as well as for various joint effects. In the light of both theoretical considerations and existing results for the "disembodied shift" model, we are especially interested in the performance of equation 2, which corresponds broadly to previously estimated disembodied models, relative to equations 4-7, which allow variously for embodied productivity effects and/or organisational interactions. For consistency with an overall significance level of 5% for the overall test (e.g. 8 vs 5), and treating all models symmetrically, significance levels for the intermediate stage tests may be derived from the relation $(1 - \varepsilon)^n = 0.95$, where ε is the intermediate stage significance level, and n is the number of models in the relevant path (Mizon, 1976).

III. EMPIRICAL RESULTS

Empirical estimates of equations 1-10 were obtained for a sample of firms in the UK engineering industry, containing 52 firms and five annual cross-sections.[3/] Pooling the cross-sections over time, we work with a variant of Kmenta's (1975) procedure for estimating the all-coefficients-constant, time-wise autoregressive, cross-sectionally heteroskedastic model.[4/] 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).

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 existence of participatory decision-making, and of profit-sharing (as opposed to the amount paid out to workers under profit-sharing arrangements), are among the variables predetermined in this way, and thus not treated as endogenous.5/ 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 labour input levels by instrumenting on labour-market variables, in particular wages and salaries. In the event, Hausman tests confirmed the endogeneity of labour input.6/ For comparison, however, 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.

Preliminary investigations revealed significant first-order autocorrelation in all equations. However equations 4-7, that is precisely those which include interaction effects, were substantially less affected.7/ Interpreting the dw statistic as a diagnostic for dynamic misspecification, we conclude that the interaction terms are important in handling fixed, firm-specific effects in the data that are giving rise to the observed autocorrelation. Thus our results already tend in favour of the interactive models. This evidence suggests that the statistical significance of reported profit-sharing effects may have been exaggerated in previous estimates such as FitzRoy and Kraft (1986, 1987) where pooled data has been used without adjustment for autocorrelation. Thus in our case, the correction causes the significance level of the profit-sharing coefficient in equation 2, which corresponds broadly to their model, to fall dramatically from 1% to 10% in both OLS and IV estimates:

	OLS	IV
Untransformed	0.1523**** (2.810)	0.1527**** (2.832)
Rho-transformed	0.1518* (1.736)	0.1518* (1.736)

In model selection tests, models 8-10 (which suppress the firm-characteristics vector entirely) were always rejected, and no further consideration need to be given to these equations. As we have seen, equation 1 (which excludes profit-sharing) is on the margin of acceptability <u>vis-a-vis</u> the disembodied profit-sharing model 2. However, it is unambiguously rejected against the most general model (equation 5), at less than 1% under both OLS and IV estimation. Thus there is evidently a profit-sharing effect of some kind at work, and we focus on the remaining specifications 2-7 in order to determine its most likely form. Test outcomes for these equations are summarised in Table 1. Testing is by conventional F-tests of the relevant sets of linear restrictions under OLS, and a Wald-type test under IV. Described by Gallant and Jorgenson (1979), this test is shown by Kiviet (1984) to be equivalent to an analogue of the likelihood-ratio test also noted by Gallant and Jorgenson.8/ Since all principal routes from equation 1 to equation 5 involve four models, a test significance level of approximately 1.275% is required at each stage to maintain consistency with an overall test of 5%, according to Mizon's formula. Our selection procedure was to continue accepting restrictions on the general model 5 until a binding constraint was met. Where proceeding along different routes in this manner 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 against the all-encompassing model 5.

Table 1 shows that models incorporating interaction terms with the profit-sharing variable dominate under both OLS and IV estimation. Thus, treating labour input exogenously (table 1(a)), the disembodied model 2 is rejected against model 5 at less than 1%, as is the slightly less restrictive model 3. Models 4, 6 and 7 are all acceptable under the Mizon formula, but 4 dominates, since 6 and 7 would both be rejected against 5 at 5%, whereas 4 would not. In the IV estimates, all departures from equation 5 are rejected (table 1(b)).

Our selected models predict overall output differentials between profit-sharing and other firms of between 3.1 and 8.2 percent. To take account of the differences in the characteristics of the two sub-groups, which the models emphasise, the differentials are calculated using both the overall sample means, and the subsample means for profit-sharing and non profit-sharing firms; we then look to see if one group dominates over alternative means-vectors. The predicted output differentials are in fact always positive:

	Eq.4 (OLS)	Eq.5 (IV)
Full sample means	+6.8%	+5.9%
Profitsharing means	+4.8%	+3.1%
'Other' means	+8.2%	+8.2%

Moreover, the differentials are of plausible magnitude, more so perhaps than the very much larger, mean performance differences that have sometimes been claimed in the literature, e.g. in Bell and Hanson (1987)[9/]

Parameter estimates from the complex models which emerge from our model-selection procedure are not easy to interpret and, though the models clearly perform best overall, the reliability and statistical significance of individual coefficients may have been affected by multicollinearity arising from the presence of multiple interaction terms.[10/] Firm conclusions on the precise manner in which profit-sharing interacts with other, particular organisational characteristics, and with productivity, may therefore be hard to draw. Certainly, no simple interpretation suggests itself for the pattern of our IV estimates of equation 5, which are set out in table 2, along with the relevant subsample means and accompanying t-values for mean differences between profit-sharing and other firms.[11/] In this respect, the present results differ rather strikingly from those for a parallel study of West German firms (Cable and Wilson, 1988b).

There, it appeared fairly readily that profit-sharing was 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 appeared to rest heavily on financial and technical control, rather than direct hierarchical supervision and, contrary to a previous, preliminary study (Cable and FitzRoy, 1980), the profit-sharing firms were not more than averagely participatory, in terms of employee-involvement in decision-making. Parameter estimates indicated a negative intercept shift and lower capital productivity in profit-sharing firms, but greatly increased labour productivity.

This general pattern is not repeated in the UK. Table 2 reveals very small differences in the firm-size variables (TOT, ASSET) and in skill-ratios (SKILL, APPBYOP) between profit-sharing firms and others. 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).12/ Again in contrast, the British profit-sharing firms incline towards job-production (JO) and away from batch (BA) and flow, i.e. away from machine-pacing. Control spans (SPAN, an 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 associated with employee-participation, and 50% more job-rotation (JOBROT), though the incidence of the latter is very low in both sub-samples.

Clearly a different mechanism must be at work in the British sample, linking profit-sharing and productivity. A clue as to its possible nature may perhaps lie in informal interview responses, from which we learned that profit-sharing had often been introduced as part of a package involving new technology, and negotiated with the workforce. Incidental evidence confirms that profit-sharing firms are more unionised that others and display evidence of both greater technical progressiveness and propensity to invest.13/ The inference we draw is that the observed productivity gains in profit-sharing firms in Britain could be associated with the quality of their management and union representatives (via their joint ability to handle complex technology/industrial relations matters successfully), and their consequential better utilisation of newer, more technically advanced, capital equipment. Not directly allowed for in our models, for want of appropriate measures, these effects could be being picked up by the profit-sharing variable, and its interactions with other organisational variables.14/

Some support for this interpretation may be found in the parameter estimates for equation 5 (Table 2), subject to the interpretational caveat given above. In particular, and in contrast to the previously mentioned German results, we find a large, positive intercept-shift in profit-sharing firms, together with much increased capital productivity and lower labour productivity, even though all differences lie outside the normal significance bounds. These are consistent with our interpretation and, in particular, with high levels of quality and rates of utilisation of capital in profit-sharers relative to other firms.

To conclude our analysis we consider the apparent distribution of productivity gains as between workers and capital-owners. On average we find that workers' non-share income (earnings) is some 4.4% higher in profit-sharing firms, with a slightly larger differential of 4.9% for manual workers, but only 2.3% for white-collar workers (whose relatively less favourable treatment could reflect the presence of strong manual unions). The reported rate of return on capital is, however, 129.3% higher, i.e. more than doubled. In one sense this seemingly asymmetric distribution of overall productivity gains is as expected under marginal productivity theory, since as we have seen there is substantial capital-productivity enhancement in profit-sharing firms. It is also unsurprising insofar as, in the presence of profit-sharing, the financial surplus is shared by all. On the other hand, the capital-productivity enhancement is apparently due to labour augmentation and workforce cooperation over new technology, and in this sense attributable to labour, while labour and capital-owners do not of course share equally in profits; for workers, profit-share is only a small proportion of total income. Thus if our interpretation is correct, continuing union-firm cooperation over technology etc. is less than wholly unsurprising with such apparently unequally shared gains. However, this may be an unduly static assessment, and much depends on the profit-retention ratio; workers would no doubt be more content to see high profits in profit-sharing firms where these are used to finance their higher investment, and so secure future labour rewards, amongst other things. In the absence of direct information on payments to capital-owners, however, we are unable to draw a final conclusion on this point.

IV. CONCLUSIONS

Production-function estimates of productivity differentials between firms practising profit-sharing in the UK engineering industry and those without profit-sharing indicate overall gains of between 3 and 8 percent. These estimates come from models in which profit-sharing interacts with factor input levels and the firms' technological, organisational and labour-force characteristics. Model-selection tests reject alternative models where profit-sharing enters as a disembodied, Hicks-neutral shift in the production surface, as used in previous work, which we conclude are misspecified. In any case, we find that the results from the disembodied models weaken or collapse when corrections are made for previously neglected factors, in particular the endogeneity of labour intput, and the use of pooled, time-series cross-section data.

Thus our results indicate that something more than a simple shift in the production surface, due to increased work effort or "cooperation" in some broader sense, is involved. Rather, the effect is entwined with the firm's choice of technology, internal organisation and labour force characteristics. It follows that, contrary to what might be inferred from previous work, introduction of profit-sharing <u>cet par</u> will not necessarily have productivity enhancing effects; accompanying changes in other dimensions of organisational design may be required.

From a policy standpoint, what may be needed is a greater general awareness of alternative patterns of work organisation, in which remuneration systems (of which profit-sharing is a variant) are merely one element. The likely impact of public policy intervention, such as the recent introduction of tax incentives in Britain, must be assessed in this light. Such measures could have important attention-focussing effects in enlarging the general awareness referred to above. There is, however, a danger that firms may be encouraged simply to graft profit-sharing on to their existing organisational arrangements for tax-minimising reasons, without making the appropriate accompanying changes which our results in general suggest are required. In this sense, we join with Bell and Hanson (1987) in cautioning against the promotion of profit-sharing in firms which, in their words, are not yet ready for it; bad experience from inappropriately introduced profit-sharing schemes could easily obscure the potential benefits of properly designed applications.

FOOTNOTES

1/ For a recent survey see Blanchflower and Oswald (1987).

2/ $\underset{\sim}{Z}$ and $\underset{\sim}{Q}$ are defined in Appendix 1.

3/ Details of the survey instruments, methods and results may be found in Cable and Wilson (1984, 1988a).

4/ 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.

5/ We do not rule out the possibility of a longer term feedback from performance to participation and 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.

6/ Testing by method (Pagan, 1984), we obtained a relevant t-value of 2.495, which is clearly significant at 5%.

7/ The relevant dw statistic was derived from the approximation $dw \simeq 2(1 - \rho)$ where, with pooled data,

$\rho = \Sigma_i \Sigma_t e_{it} e_{i,t-1} / \Sigma_i \Sigma_t e^2_{i,t-1}$. Values for equations

1-10 were respectively 0.71, 0.71, 0.72, 1.21, 1.20, 1.21, 1.20, 0.58, 0.59 and 0.58. The relative improvement in models 4-7 is, however, larger than these figures suggest. Including up to 18 additional interaction terms, these models have substantially more parameters (k') and, for given n, the lower bound of the dw statistic (d_L) falls as k' increases. Hence, models 4-7 are relatively closer to the relevant d_L than would appear if, on inspection, d_L is implicitly held constant.

8/ 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 x^2 distribution with h degrees of freedom (where h is the number of restrictions in the relevant test).

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

10/ Note, however, that this does not invalidate the foregoing model-selection tests, which depend on the overall performance of alternative models.

11/ Mean differences and significance levels were calculated conservatively, using values averaged across years. The lack of statistical significance in many cases is in part at least due to small sample size (n=52). Higher significance levels would of course be obtained in most cases by using the data in pooled form.

12/ 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.

13/ Union density, the ratio of shop stewards to operatives, and the incidence of closed shops, joint consultation committees and formal job evaluation schemes were respectively 22%, 50%, 36%, 24% and 85% higher in profit-sharing firms. The average interval between major process innovations was 4.5 years, compared with 6.7 for other firms, and R+D and investment intensities were 61% and 19% higher repsectively. The differences in union density and innovation rate are significant at 5%, and in shop stewards and job evaluation at 10%.

14/ Otherwise, the disembodied models would not have been dominated in model-selection tests.

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

APPENDIX: Variables Used in the Analysis

In all reported regressions factor inputs were entered as (logarithms of) the book value of capital and total employee-hours. Very similar results were obtained using numbers employed and hours per employee separately. 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. The firm-characteristics vector $\underset{\sim}{Q}$ included the following variables:

SKILL	Percentage of skilled to unskilled operatives.
WBYB	Ratio of white collar to blue collar operatives.
QC BG JOBROT	Dummy variables the existence of { briefing groups job rotation
APBYOP	Percentage of apprentices to operatives.
PART	Participatory/non-participatory dummy (based on Guttman scale of participation[15/]).
TREXP	Training expenditure for employee, (£'000 per head).
SHARES	Dummy for the existence of a share option scheme.
MALE	Percentage male employees.
PIE	Percentage of piecework pay to total earnings.
SPAN	Average control span.
SHIFT	Percentage shift-working.
JO BA IT	Dummy variables for { job, batch } production methods; intermediate technology
PVA	Profit/value-added sharing dummy (see also footnote 5).

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TABLE 1 : Model Selection Tests: F and CRW Tests of Linear Restrictions Between Models Shown(i)

Equation				
Restricted	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.

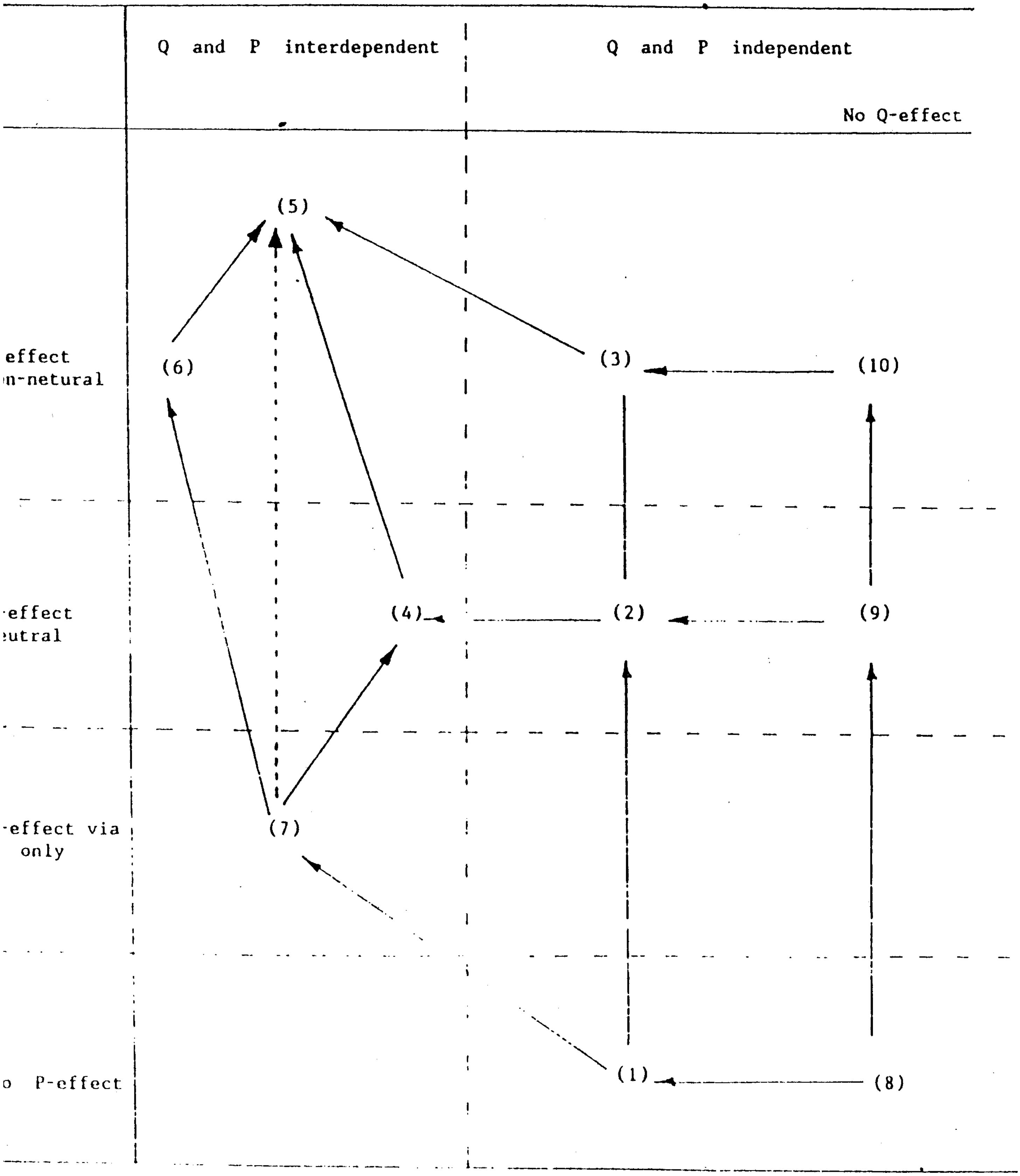
TABLE 2 : Equation 5 Coefficients (IV) and Subsample Means(i)

VARIABLE	EQ.5 ESTIMATES (IV)		SUB-SAMPLE MEANS		
	BASE COEFFICIENT	INTERACTION TERM	PSA FIRMS (n=30)	OTHERS (n=31)	t
Constant	-4.6757				
PVA	2.9522		1.00	0.00	
K	0.2320	0.1886	5,122.5(ii)	4,920.1(ii)	0.19
L	0.7693****	-0.5142	1,167(ii)	1,144(ii)	0.11
SKILL	-0.0048*	0.0160**	42.72	44.34	-0.20
WBYB	0.0153	0.8625*(*)	0.54	0.59	-1.19
QC	-0.5064****	1.0076****	0.381	0.291	0.67
BG	0.3854**	-0.8342****	0.524	0.407	0.79
JOBROT	-1.1757****	1.2577*	0.048	0.032	0.28
APPBYOP	-2.2203	-0.2993	4.215	4.273	-0.12
PART	-0.0604	0.1741	0.476	0.548	-0.50
TREXP	-0.0826	-0.3830	0.101	0.265	-2.18*
SHARES	-0.1734	0.8969*	0.381	0.291	0.67
MALE	-0.0016	0.0094	82.67	78.19	0.98
PIE	-0.0069**	0.0108	16.45	23.05	-2.45**
SPAN	0.1740*	-0.0171	14.19	13.01	0.61
SHIFT	0.0104	0.0096	8.52	5.86	0.79
JOB	0.0288	-0.4824	0.143	0.097	0.50
BATCH	0.2532**	-0.6576*	0.429	0.452	-0.16
IT	0.3646	0.8520	1.00	0.86	1.19

Note (i) Z vector coefficients not reported. *,**,**** indicate statistical significance at 10,5 and 1 percent respectively.

(ii) For ease of interpretation, figures reported are levels of total assets (£'000) and employment. In all reported regressions factor inputs were entered as (logarithms of) the book value of capital and total employee-hours (see appendix and text).

FIGURE 1 : Estimating Framework



otes (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).