SOME TESTS OF EMPLOYEE PARTICIPATION INDICES*

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I. INTRODUCTION

Empirical research on self-managed and participatory firms faces a major difficulty over the measurement of the key, participation variable. Indicators such as the proportion of workers belonging to a cooperative, workers' financial stakes in the firm, the existence of a Works Council, the number of worker directors, and so on, which feature in previous work, capture only aspects of the phenomenon. But the extent of employee involvement in the actual running of the firm - "workers' ability to directly influence or form the management and work process in an enterprise"[(1)] - can vary extensively under both cooperative and conventional production arrangements, in ways not necessarily caught by variables such as these.

Where previous researchers have attempted to measure participation in the direct sense, they have typically assembled continuous indices by imposing a weighting structure on qualitative, survey-response or observed data. Espinosa and Zimbalist's (1978) work on Chilean cooperatives remains perhaps the most elaborate example. Their index takes account of the range of the firm's activities over which workers have influence, their role in the decision making process, and the degree of influence they are able to exert. Conceptually, the derivation of their index may be seen as calibrating the vector OP in figure 1.

In the Chilean circumstances considerable variation was to be expected up to high values on the Y axis of figure 1 (the magnitude of workers' presence). In surveys including conventionally-owned firms, however, we might expect to observe relatively slight variation in this dimension, at a comparatively low value. In any case, survey responses will often at best be able to reveal the type or form of worker involvement in making certain specified decisions.

Thus the raw data is typically in the form of qualitative information on the XZ plane of figure 1. Participation responses to survey questions might, for example, permit firms to be classified at participation category $j = 1,2,...m$ in decision area $i = 1,2,...n$. The data for each firm can then be represented by an $n \times m$ matrix of binary variables in which each element p_{ij} has unit value if the firm is classified in the j'th category for the i'th decision and zero otherwise, as in table 1. The index method then awards points based on a weighting structure for each level and decision, and sums over levels and decisions, yielding an index value

$$P_t = \sum_{i=1}^{m} \sum_{j=1}^{n} w_{ij} \, p_{ijt}$$

where the w_{ij} are the weights and $t = 1,2,...v$ denotes a sampled firm.

The drawback with this method is that the weighting structure is arbitrary and must be imposed by the researcher. Thus subsequent analysis is no longer based solely on observation, and there is a danger that researchers may unwittingly <u>impose</u> the relationships they subsequently 'find'. Where the indices are then incorporated in regression models (e.g. Cable-FitzRoy, 1980; FitzRoy-Kraft, 1984), the assumptions implied by the weighting structure can be spelt out as linear, homogenous restrictions and tested directly. In this way the validity of a given index can be evaluated. A suitable test procedure is outlined in the next section. In section 3 the procedure is carried out in three cases for which the relevant data is available. The concluding section 4 summarises the test outcomes and discusses their implications for further research.

2. A TEST PROCEDURE

Suppose that participation data in the form of table 1 is to be included in a regression analysis. The least restricted model which is available would include dummy variables for each element in (all but one column of) the participation data matrix.(2) For example, in an analysis of the participation-productivity relationship we would have

$$V_t = \sum_{h=1}^{\ell} \alpha_h X_{ht} + \sum_{i=1}^{n} \sum_{j=2}^{m} \beta_{ij} P_{ijt} + u_t, \qquad (1)$$

where V_t is, say, log value-added for firm t and $\underset{\sim}{X}_t$ is a vector of other explanatory variables called for by the relevant theory.(3) This specification does not, in itself, provide a suitable basis for empirical work. It is too cumbersome for use with interaction terms, and is an unsuitable basis for switching regressions. The large number of P-dummies both consume degrees of freedom and render the model impracticable for analysis of participation determinants and for simultaneous models, where participation is endogenous. It is to progress in these directions that an overall index or scale of some kind is required.

The implied assumptions when an arbitrarily weighted index P_t is substituted for the terms $\sum_{i=1}^{n} \sum_{j=2}^{m} \beta_{ij} P_{ijt}$ can be best illustrated by reference to previous work. For example, Cable and FitzRoy (1980) and FitzRoy-Kraft (1984) used a linear weighted system with weights 0,1,..,3 for 'no participation', 'prior information given', 'workers consulted' and 'full participation', and gave each decision equal (unit) weight. With, say, four decision areas, firms would then be placed on an integer scale with a P-score of between zero and 12.[4] The implied assumptions are that:

A (i) all decision areas are equally important;

A (ii) the impact of having a higher degree of participation is the same across all decision areas;

A (iii) the appropriate index has a specific (arbitrarily imposed) gradient of unity.

These are typical of the index-building assumptions which we wish to test. With no loss of generality we continue to consider a case with four participation levels and four decision areas. Working from the unrestricted model (1) we can identify and test the parameter restrictions implied by A(i) -

A (iii) as follows.

First, the constant incremental weights assumption (A (ii)), which is widely used in constructed indexes, requires $\beta_{i3}/\beta_{i2} = \lambda$, $\beta_{i4}/\beta_{i2} = \mu, \forall i$, where λ and μ are constants. Imposing only this restriction we write

$$V_t = \sum_{h=1}^{\ell} \alpha_h X_{ht} + \sum_{i=1}^{4} \beta_{i2}(p_{i2t} + \lambda p_{i3t} + \mu p_{i4t}) + u_{2t} \qquad (2)$$

Non-linear estimation is required to yield the separate 'base' coefficients for each decision $\hat{\beta}_{i2}$, and the constant incremental weights $\hat{\lambda}$ and $\hat{\mu}$.

Next we can impose the additional constraint that all decisions are equally important, i.e. $\beta_{i2} = \phi \ \forall i$, obtaining:

$$V_t = \sum_{h=1}^{\ell} \alpha_h X_{ht} + \phi(\sum_{i=1}^{4} p_{i2t} + \lambda \sum_{i=1}^{4} p_{i3t} + \mu \sum_{i=1}^{4} p_{i4t}) + u_{3t} \qquad (3)$$

If non-linear estimates of ϕ, $\hat{\lambda}$ and $\hat{\mu}$ are obtained, likelihood ratio tests are then available to test the restrictions in (3) and (2), against the unrestricted equation (1).

Finally, we can test all three assumptions A (i) - A (iii), the 'Kyklos' assumptions used in Cable-FitzRoy's pilot study, by imposing $\lambda = 2$, $\mu = 3$ on equation (3) to give

$$V_t = \sum_{h=1}^{\ell} \alpha_h X_{ht} + \gamma\{\sum_{i=1}^{4} p_{i2t} + 2\sum_{i=1}^{4} p_{i3t} + 3\sum_{i=1}^{4} p_{i4t}\} + u_{4t} \qquad (4)$$

where the bracketed term $\{\cdot\}$ reduces to a scalar participation index, denoted P_t. Since OLS may be used to estimate both (4) and (1), an F-test may be used in this case.

3. RESULTS

(i) VW Sample (Cable-FitzRoy 1983)

Tables 2 and 3 report the relevant coefficients and summary statistics from empirical estimates of equations (1)-(4). The twelve participation-dummy coefficients in the unrestricted equation (1) display a mixed sign and significance pattern that is not readily susceptible to interpretation (table 2). However, a significant overall participation effect is present; testing $H_o: \beta_{ij} = 0, \forall_{i,j}$ yields $F_{12,92} = 3.23 > F^{.05} = 1.88$.

Each of the restricted equations (2)-(4) (table 3) is rejected. In the case of equations (2) and (3) the likelihood-ratio test yields $LR = 16.41 < \chi^2_6 = 12.6$ and $LR = 36.97 > 21.7$ respectively at the 5 per cent level. An F-test similarly rejects equation (4) yielding $F_{11,93} = 5.82 > F^{.05} = 1.91$. Thus as Cable-FitzRoy report, the P_t index is incompatible with the data in this case.

(ii) VW Sample (FitzRoy-Kraft, 1984)

FitzRoy-Kraft report a further analysis of the VW database using an index based on the above weighting structure. However, since their specification of the $\underset{\sim}{X}$ vector differs slightly from Cable-FitzRoy, and since they also delete survey responses relating to wage-setting (decision area III), the foregoing results do not automatically carry over. Thus a further test is required, modifying the $\underset{\sim}{X}$ vector, deleting p_{3j}, V_j from equation (4), and testing against a correspondingly truncated equation (1) in which β_{ij}, V_j are constrained to zero. FitzRoy-Kraft themselves report no test outcomes, and the following results were obtained from reestimations.

At first sight, deleting the data seems to have done the trick. Testing with the modified versions of (4) and (1) described above yields $F_{8,93} = 0.80 < F^{.05} = 2.04$, so that the restrictions embodied in the index are apparently valid. However, further investigation reveals that in the modified unrestricted equation <u>none of the individual participation dummies are significant</u> (table 4). Thus the index restrictions appear acceptable only because the 'true' values of the relevant unrestricted coefficients are zero. An F test confirms that there is no jointly significant effect of the participation dummies as a group in the FitzRoy-Kraft model; the hypothesis $H_o: \beta_{ij} = 0$ (with i = 1,2,4 and j = 2,3,4) is not rejected ($F = 0.74 < F^{.05} \simeq 2.01$).

(iii) <u>Pilot Sample (Cable-FitzRoy 1980)</u>

In this early pilot study the weighting structure is as in the two preceding cases, but the survey-response data covered eight decision areas: investment, price, product-design, advertising, wage-system, production methods, job-design, and piece-rates. Participation dummy coefficients for an unrestricted model corresponding to equation (1) are set out in table 5. Once again signs and significance levels follow an erratic pattern, as in the VW analyses (c.f. tables 2 and 4).

Once again, too tests of assumptions (i)-(iii) produce the same outcomes. Thus, testing for constant incremental effects (A(ii)) alone with a modified equation (2) yields an LR statistic of 27.59 which compares with a critical χ^2 value of 23.7 at the 5 per cent level. When A(i) and A(ii) are tested together using a modified equation (3), we obtain LR = 42.6 > χ^2_{21} = 38.9, while the F test inevitably rejects the combined index assumptions, yielding $F_{23,89} = 4.82 > F^{05} = 1.68$. Relevant coefficients and summary statistics are set out in table 6. Finally, as in Cable-FitzRoy though not FitzRoy-Kraft, we find that though the index is unreliable, there is a significant overall participation effect; testing the restrictions $\beta_{ij} = 0, \forall ij$ in the pilot study case yields $F = 5.37 > F^{05}_{24,89} = 1.66$.

(iv) <u>Subindices</u>

In the preceding test sequence the constant incremental weights assumption (A(ii)) appears to violate this data less than the equal weights assumption (A(i)). This suggests that it may be useful to experiment with participation subindices for groups of decisions falling within broader decision-making areas. Having the most decision areas, the pilot study data lends itself most readily for this purpose.

Two experiments were carried out. For the first, individual decisions were grouped accordinging to an ILO classification scheme thus:

Area	Description	Decisions	
I	Social, administrative and personnel	Wage system Piece rates	(5) (8)
II	Technical and production	Product design Production methods Job design	(3) (6) (7)
III	Economic and financial management	Investment Price Advertising	(1) (2) (4)

Subindices for each area were then formed, imposing equal weights for decisions within a given area ($\beta_{i2} = \beta_{j2}$ for all ij within the area), but allowing different weights as between areas ($\beta_{i2} \neq \beta_{j2}$ for any i, j in separate areas). The estimating equation for this experiment was accordingly

$$V_t = \sum_{m=1}^{n} \alpha_m X_{mt}$$

$$+ \gamma_1\{(p_{52}+p_{82}) + \lambda(p_{53}+p_{83}) + \mu(p_{54}+p_{84})\} \quad (5)$$

$$+ \gamma_2\{(p_{32}+p_{62}+p_{72}) + \lambda(p_{33}+p_{63}+p_{73}) + \mu(p_{34}+p_{64}+p_{74})\}$$

$$+ \gamma_3\{(p_{12}+p_{22}+p_{42}) + \lambda(p_{13}+p_{23}+p_{43}) + \mu(p_{14}+p_{24}+p_{44})\} + u_{5t}$$

where $\gamma_1 = \beta_{52} = \beta_{58}$; $\gamma_2 = \beta_{32} = \beta_{62} = \beta_{72}$ and $\gamma_3 = \beta_{12} = \beta_{22} = \beta_{42}$, and the bracketed terms $\{\cdot\}$ are the three area subindices embodying identical but non-imposed, constant incremental weights γ and μ.

The second experiment followed a similar procedure, but utilised a simple dichotomy between 'strategic' and 'job-related' decisions. Strategic decisions were taken to include investment, price, product and advertising decisions, and the job-related category was thus wage system, production methods, job-design and piece rates. The estimating equation for this case was then

$$V_t = \sum_{m=1}^{n} \alpha_m X_{mt} + \delta_1\{\sum_{i=1}^{4} p_{i2} + \lambda \sum_{i=1}^{4} p_{i3} + \mu \sum_{i=1}^{4} p_{i4}\}$$

$$+ \delta_2\{\sum_{i=5}^{8} p_{i2} + \lambda \sum_{i=5}^{8} p_{i3} + \mu \sum_{i=5}^{8} p_{i4}\} + u_{6t} \quad (6)$$

Non-linear procedures were again used to estimate equations (5) and (6) to permit likelihood-ratio tests of the restrictions embodied in them against the unrestricted equation (1'). The LR statistic values were found to be 39.9 and 35.8 for equations (5) and (6) respectively, compared with critical χ^2 values of 30.1 and 31.4 at the 5 per cent level. Thus, at the conventional level neither set of participation subindices is compatible with the data.

4. CONCLUSIONS

A simple test procedure can be applied to the parameter restrictions embodied in indices of employee participation as used in previous econometric work. In a series of tests, indices spanning all decision areas were found to be invalid, in each case considered, where a significant overall participation effect was present in the relevant unrestricted model. Subindices for related subgroups of decisions were also rejected. These results call into question previously published estimates which have relied on index measures, in particular of the participation - productivity relationship. They also cast doubt on the suitability of such measures for future work. In any event, tests of the underlying assumptions should be carried out.[5] In the circumstances, there would seem to be a strong case for explcring alternative measurement techniques, one of which - Guttman Scales - is considered in a separate paper (Cable 1985).

FOOTNOTES

(2) Espinosa and Zimbalist, 1978.

(2) Since row dummies sum to unity column 1 is dropped to avoid singularity. Thus the $\hat{\beta}_{ij}$ capture deviations from the base ("no participation") observation.

(3) Augmented production function models are now the normal method of investigating the productivity effects of participation. See, for example, Backus and Jones 1977; Jones 1982; Jones and Svejnar 1984; Estrin and Jones 1983; Cable and FitzRoy 1980, 1983; FitzRoy and Kraft 1984. However, not all utilise participation indices, in particular for worker-cooperative samples where other measures of participation such as membership and members' loans have been used to capture, or proxy, the degree of participation.

(4) FitzRoy-Kraft subsequently discard survey responses for one decision area (wage-setting) so that $0 \leq P_t \leq 9$. See below.

(5) Some researchers have sought to justify their arbitarily weighted indices with the claim that their results are "insensitive to the choice of weights". But this tells us very little. In the first place the range of variation of imposed values is often not given. Secondly, the statement may merely reveal that one set of arbitarily chosen weights

is just as <u>bad</u> as any other. Thus all 'equally good' sets of arbitrary weights may be rejected in a test against the unrestricted equation (1); this is the correct standard of comparison for any given weighting structure, not some other, equally arbitrary alternative. A further burden entailed by the index approach is that the test of restrictions is model-specific. Thus in empirical work the index should strictly speaking be retested for every change in the $\underset{\sim}{X}$ vector or estimation method, a highly tedious procedure.

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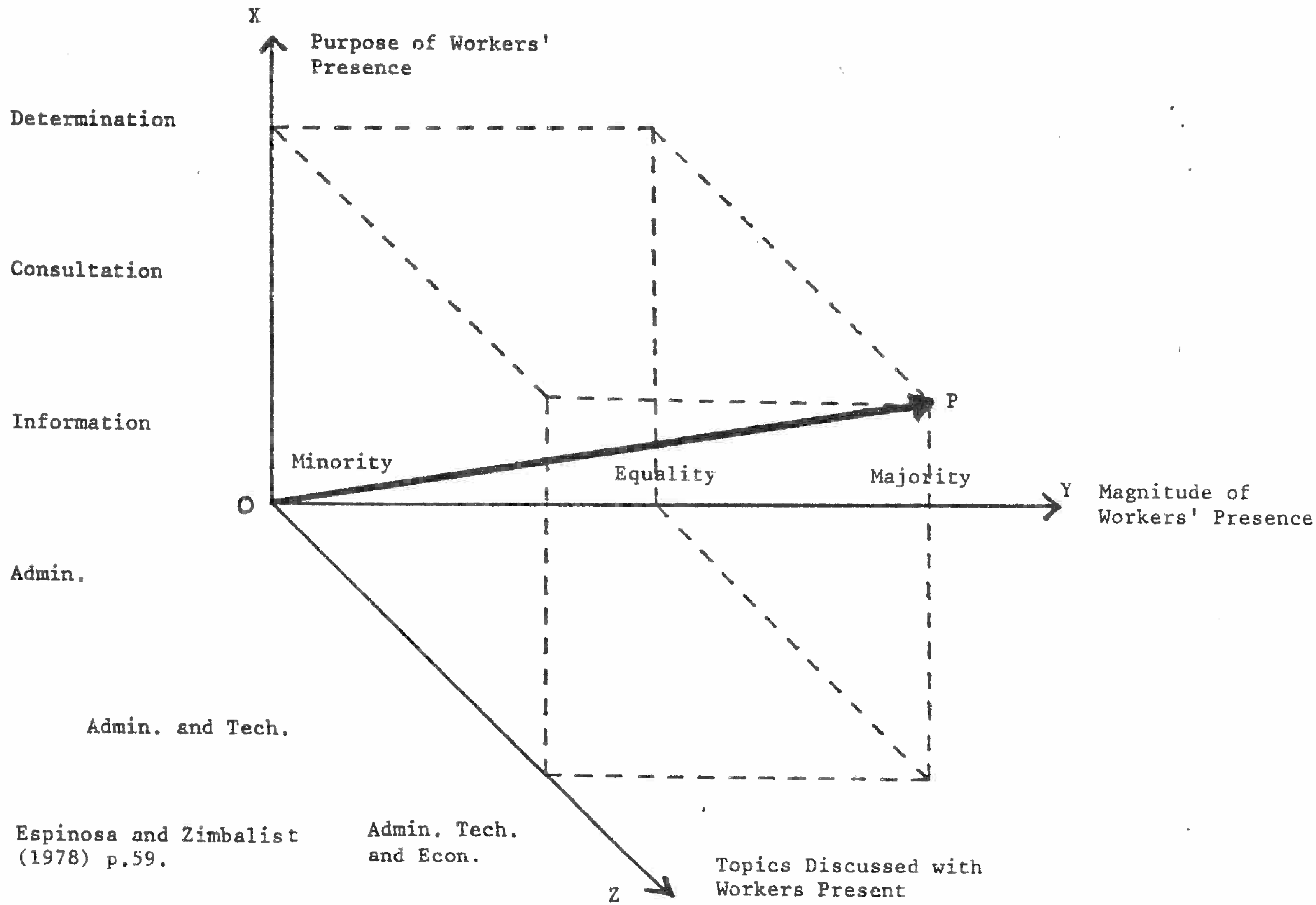
Figure 1.



Source: Espinosa and Zimbalist (1978) p.59.

TABLE 1. Participation Data Matrix

		CATEGORY						
		1	2	3	·	·	·	m
	1	0	1	0	·	·	·	
	2	0	0	0	·	·		
	3	0	0	1				
AREA	·	·	·					
	·	·						
	·							
	n							

TABLE 2. p_{ij} Coefficients (Cable-FitzRoy, 1983)

	Prior Information	Opinion Sought	Full Participation
Investment/ rationalisation	0.2088*	0.3155**	0.3302
Employment decisions	-0.0399	-0.1456	0.2399
Wage setting	0.2542**	-0.1922	-0.4122**
Job design	0.4548**	0.1202	0.1962

Note: * denotes significant at 10 per cent or better.
** " " " 5 " " " " .

TABLE 3. OLS and LSQ Estimates, Equations (1)-(4) Cable-FitzRoy, 1983.

(Cob-Douglas specification, substituting for participation dummies P11, P12,...,P43)

Equation / Coefficient	(1)	(2)	(3)	(4)
$\hat{\beta}_{12}$		0.031 (0.366)		
$\hat{\beta}_{22}$		-0.087 (-0.851)	0.112* (1.917)	
$\hat{\beta}_{32}$		0.272** (3.057)		
$\hat{\beta}_{42}$		0.586** (2.943)		
$\hat{\lambda}$		0.217 (1.273)	0.099 (0.231)	
$\hat{\mu}$		0.230 (1.330)	0.069 (0.159)	
P_t				-0.0162 (-1.191)
R^2	0.9585			0.9590
F	104.39			100.50
LLF		-27.6992	-37.9707	

Note: t values in parentheses

*) denotes significance at (10 per cent or better
**) (5 " " " "

TABLE 4. p_{ij} Coefficients (FitzRoy-Kraft, 1984)

	Prior Information	Opinion Sought	Full Participation
Investment/ Rationalisation	0.0173 (0.141)	0.1041 (0.769)	-0.0698 (-0.351)
Employment	-0.0553 (-0.386)	0.0029 (0.020)	-0.0444 (-0.231)
Job Design	0.2547 (1.189)	-0.0730 (-0.500)	0.0011 (0.008)

TABLE 5. p_{ij} coefficients (Cable-FitzRoy, 1980)

	Workers involved as		
	Observers	Advisers	Active Participants
Investment	-0.1205 (-1.334)	0.1718** (1.992)	-0.0021 (-0.024)
Price	-0.0314 (-0.584)	-0.0458 (-0.568)	-0.2381 (-1.555)
Product design	-0.1963** (-3.177)	-0.0076 (-0.067)	-0.0492 (-0.614)
Advertising	0.0812 (0.971)	0.1027 (0.917)	-0.1011 (-0.984)
Wage system	-0.0316 (-0.397)	-0.0401 (-0.308)	0.2801** (3.422)
Production methods	0.1510 (0.719)	-0.2209** (-2.416)	-0.2192** (-2.427)
Job design	0.2292 (0.9846)	0.1415 0.876)	0.1282 (0.878)
Piece rates	0.2033** (2.274)	0.0321 (0.628)	0.1074** (2.051)

Note: t values in parentheses

*) denotes significance at (10 per cent or better
**) (5 " " " "

TABLE 6. OLS and LSQ Estimates: Equations (1)-(4) (Cable-FitzRoy, 1980)

Equation / Coefficient	(1)	(2)	(3)	(4)
$\hat{\beta}_{12}$		.0280 (0.951)		
$\hat{\beta}_{22}$		-.0928 (-1.639)		
$\hat{\beta}_{32}$		.0125 (0.603)		
$\hat{\beta}_{42}$		.1050 (1.643)	-.0053	
$\hat{\beta}_{52}$		.0583 (1.611	(-0.399)	
$\hat{\beta}_{62}$		-.0152 (-0.645)		
$\hat{\beta}_{72}$		-.0596 (-1.307)		
$\hat{\beta}_{82}$		-.0028 (-0.141)		
$\hat{\lambda}$		1.826** (2.363)	-4.352 (-0.374)	
$\hat{\mu}$		2.997** (2.136)	-4.544 (-0.3866)	
P_t				.0165*** (4.487)
R^2	.995			.991
F	490.6			404.8
LLF		73.93	69.33	

Note: t values in parentheses

**) denotes significance at (5 per cent or better
***) 1 " " " "