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EMPLOYEE PARTICIPATION AND FIRM

PERFORMANCE : A PRISONERS'

DILEMMA FRAMEWORK

by

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Employee participation and firm performance:
a prisoners' dilemma framework.

Summary

The coexistence of capitalist firms and a growing number of alternative organisational forms characterised by some degree of employee participation in decision making raises the questions whether this is consistent with equilibrium, whether coexisting firms of different types must be equi-efficient or a multiple equilibrium of non-equi-efficient firms is possible, and whether a dominant type is emerging. This paper considers these questions, and more generally the mechanism determining the nature of production enterprises by using a game theoretic approach.

The prisoners' dilemma is found to provide a fruitful framework for organising a wide range of material concerning the choice and performance of traditional and participatory forms of production enterprise. In particular this approach is useful in modelling the interplay between efficiency and bargaining strategies; it is shown that participatory organisations can be Pareto-superior to the conflictual (Nash-equilibrium) firm; the necessary conditions are discussed. Implications for empirical work are drawn from the analysis.

I. INTRODUCTION

Many western economies are witnessing a growth of alternatives to the traditionally run capitalist firm, in which operatives participate to some degree in decision-making, in the firm's financial surplus, or in both. For example, flourishing producer cooperative sectors are to be found not only in the Mondragon area of northern Spain, but also in France and Italy, as well as under central planning in Poland (Estrin, Jones and Svejnar, 1984; Jones, 1983).^{1/}

Industrial cooperatives are also to be found elsewhere, including West Germany, America and Britain (where, though cooperative organisation has historically been focussed on the distributive trades, some of the late nineteenth-century producer-cooperatives still survive, (Jones, 1982) and a new wave of cooperative development has occurred in recent years (Wilson and Coyne, 1981)). Also, co-determination laws have been extended in Germany in 1972 and again in 1976, and co-determination systems have also been introduced in other countries, including Denmark, the Netherlands, Norway and Sweden, while industrial democracy has been on the political agenda of the EEC since the Vredeling proposal of 1972. Alongside these developments, there has apparently been a widespread development of diverse, voluntary schemes for worker participation and profit sharing (see e.g. Guski and Schneider, 1977; IDS, 1984) in part but not wholly prompted by tax concessions. No-one knows how many workers are affected, though this is likely far to exceed the number actually employed in cooperatives. Finally, as is well known, inroads have been made into many Western markets by goods made in Japan, many of them produced under a distinctive, consensus system of intrafirm organisation and decision-making; and American ("theory Z") firms like Eastman-Kodak,

Hewlett-Packard, IBM, and others, who have adopted certain features of the Japanese managerial style, it is claimed, have generally been successful (Ouchi, 1982).

The development of these deviations from traditional organisation raises some searching questions about our assumptions on the nature of production enterprises. Is it possible for a variety of firm types to exist in equilibrium? If so, must they be equi-efficient, or could there be a multiple equilibrium of firms types that are not equi-efficient by conventional measures? If, on the other hand, efficiency considerations dictate convergence to a single, dominant type, does the variety of developments currently being observed represent a move from an old to a new equilibrium, or are these temporary aberrations only, shortly to be corrected? If we are moving to a new equilibrium, why is this occurring now? Above all, what is the underlying choice mechanism which determines the nature of production enterprises, and how does it operate?

These are important questions both for the theory of production and for empirical work, where knowledge of what is generating the scatter of empirical observations is critical. They have as yet to be completely answered in the literature, despite an extensive debate over the property-rights and efficiency effects of participation. This paper offers a game-theoretic explanation of how alternative production systems can arise, according to the exercise of workers' and employers' strategic choices either to cooperate in joint control over the work process, or to strive for sole control. Participation, both within conventionally owned firms and under producer cooperatives (PCs) is seen as a possible solution to a latent or manifest

prisoners' dilemma - a device by which "individuals can turn choices based on individual rationality into choices based on group rationality" (Leibenstein, 1982a). Whether, if this is so, participation's implied Pareto-superiority is due to higher physical productivity, or to non material benefits, is strictly indeterminate a priori. However, insights are gained into the methods most likely to yield empirical answers on this point.

A game-theoretic approach suggests itself because exit is costly for both workers and employers, and because neither has complete control of all decision variables; outcomes are thus uncertain and dependent on the interaction of strategic choices, in situations where both sides are locked in. Exit is costly in part because of non-trivial search costs of re-employment, but more importantly because of capital equipment, labour skills and organisational know-how which are more or less specific to the firm due to quasi-permanent association with it. This specificity of factors makes the productive potential of the firm, as an entity, greater than would be possible through 'mere casual combination of marketed factors' (Aoki, 1980). Hence, factor specificity creates organisational quasi-rent which is available for distribution among the firm's members. Any who quit forego their claim, but also reduce the total available to those who stay. It is this which gives the members both an incentive to stay and their bargaining power within the firm.

In orthodox terminology, the fact that no-one is in sole control is primarily because of incomplete contracts. For well-known reasons associated with contracting costs under uncertainty, payment

is typically specified in full, but specific tasks and effort are not; workers yield authority to employers, within limits, over job content and the shop-floor organisation of work, but retain discretion over effort and product quality (subject to monitoring and supervision).

As will by now be clear, certain simplifying assumptions commonly found in economic analysis are not invoked here. In particular, the external labour market is not assumed capable of determining an equilibrium wage for every grade of labour and every set of working conditions. Such an assumption would not only be at odds with observation and experience; it is also precluded by factor immobility, by discontinuities in marginal product schedules under alternative employment of the kind just discussed, and by signalling and free-rider problems of a public-goods nature (Dreze and Hagen 1978, Freeman and Medoff 1979, 1984). Hence, contrary to Furubotn (1976), alienation is a problem not fully assuaged by market processes, and welfare implications must be drawn from broader considerations than physical productivity alone. So far as the firm's product market environment is concerned, it is convenient to begin by allowing for all possibilities from competition to pure monopoly, though oligopoly is of course the prevailing case in practice. Later, we shall see that product market pressures are among the factors determining the game outcome and, in particular, the scope for players to trade off physical output for non-pecuniary benefits.

The analysis is developed as a two-person game, which is 'co-operative' in the game-theoretic sense that communication and contracting between the players is allowed. While production itself

is clearly a repeated activity, the game-theoretic determination of how the firm is organised is not obviously so, and both one-shot and finitely repeated cases are considered. The paper is intended primarily as a contribution to the self-management literature. The prisoners' dilemma concept is used as an organising framework to encompass a wide range of ideas and hypotheses in the literature, and with the principal aim of informing empirical work. More extensive formal development of the model and its econometric application are reserved for future work.

Previous applications of game theory to production and the firm include Aoki (1980, 1982) and Leibenstein (1982a, 1982b). Aoki's first paper models bargaining between shareholders and employees in the Zeuthen-Nash-Harsanyi tradition, and treats management's role as to evaluate relative bargaining strength, and formulate policies concerning sales price, expenditures for sales growth, and the internal distribution of rent, which lead to an organisational equilibrium of bargaining power. His second paper extends the first into an equilibrium growth model. Leibenstein focusses on Japanese vs American management 'styles' and, in particular, on the role of peer-group norms or 'conventions' as partial solutions to a latent prisoners' dilemma problem. The present analysis is closer to Leibenstein, especially with regard to the prisoners' dilemma aspect, which is considered crucial. However, unlike Leibenstein's, the present analysis is a welfare not a productivity game, and hence easier to relate to the players' underlying objectives. It also attempts to deal with a much broader class of phenomena, involving broad choices between alternative types of production enterprise.

II. PLAYERS, STRATEGIES AND OUTCOMES

The fundamental distinction among people at work is between workers and employers,^{2/} and this gives us two groups of players. Each side is treated as an entity; problems of goal-conflict and intra-group co-ordination are subsumed.^{3/} Their strategic options are (i) control over the work process, in order to maximise sectional interests and (ii) co-operation with the other side. Detailed tactics for each side and strategy are discussed later on.

The objective for both sides is to maximise utility. Various monetary and other benefits from participating in production define the players' benefit functions:

$$B_W = f(w; \Pi_W; \dot{K}_W; y_W; e_V; e_F) \text{ for workers,}$$

and

$$B_E = g(S_M; \Pi_M; D_O; \dot{A}_O; y_M) \text{ for employers,}$$

where

w = wage income,

Π_W = profits (or value-added bonus) paid out to workers,

\dot{K}_W = gain in marketable human capital,

y_W = non-pecuniary workers' benefits,

e_V = voluntary effort,

e_F = 'forced' (or unwilling) effort;

and

S_M = managerial salaries,

Π_M = profits (or value-added bonus) paid out to management,

D_O = dividend payments to shareholders,

\dot{A}_O = capital gain to shareholders (increase or decrease in the market value of the firm),

y_M = non-pecuniary managerial benefits.

The inclusion of w , s , Π_W and Π_M in their respective functions is obvious. Elsewhere, B_W incorporates a distinction between job or factory-specific human capital, and human capital which is transferable to alternative employments. Thus if workers acquire skills and knowledge which enhance their labour market status and earning power, this is caught by \dot{K}_W , and is allowed to have a different impact on their welfare than the acquisition of job or factory specific skills and knowledge. Though these also increase B_W (other than via monetary rewards captured in w , Π_M) the benefits are essentially non-portable and hence incorporated in y_W , which additionally includes job satisfaction from other sources, company-specific fringe benefits and so forth. The B_W function also separates two kinds of workers' effort, e_V and e_F . This is to capture plausibly different levels of disutility and productivity associated with a given intensity of labour input, according to whether this is volunteered or extracted via a supervision or authority system. Sign expectations are $f' > 0$ for the first four arguments of the B_W function and $f'_{e_F} < 0$. f'_{e_V} is, however, uncertain; over some range workers may feel positively towards work they have volunteered or sanctioned, though disutility of further effort must arise beyond some level. However this may be, it is assumed $f'_{e_F} < f'_{e_V}$ at any level.

The B_E function contains benefits to both shareholders (owners) and management, subscripted accordingly. y_M includes managerial consumption (perquisites and status goods), psychic income of a 'kith and kin' nature derived from satisfying owners' objectives,^{4/} goal participation and other forms of job satisfaction (which could include direct utility from the exercise of control over

the work process per se). The relative weights attached to each element are assumed to be determined by a mixture of market forces and management-owner bargaining.^{5/} Sign expectations for the B_E function are $g > 0$ in each case.

Table 1 gives an illustrative matrix of stage payoffs to each side. Since this is a welfare not a productivity game, payoffs are total utility levels (B_W, B_E) .

Table 1: Payoff Matrix

| WORKERS | EMPLOYERS | |
|-----------------|-------------------------|------------------------------|
| | E1 (Co-operate) | E2 (Control) |
| W1 (Co-operate) | 6,6 Participation | 4,7 Autocratic Management |
| W2 (Control) | 7,4 Dominant Workers | 5,5 Conflict |

The autocratic management (W1, E2) dominant workers (W2, E1) and conflict (W2, E2) outcomes resemble Stackelberg oligopoly solutions. Thus W1, E2 and W2, E1 are leader-follower equilibria, in which employers and workers respectively maximise their individual benefit functions subject to a low-level (reaction function) constraint, and W2, E2 is the Stackelberg disequilibrium case of economic warfare. In the terminology of a different literature, these three outcomes may alternatively be seen as encapsulating the class struggle - labour and capital each striving to emerge victorious from W2, E2 and move to W2,

E1 and W1, E2 respectively.^{6/}

As written the game is a prisoners' dilemma; W2 and E2 are individually rational strategies whatever the opponent does, yet the Nash-equilibrium (W2, E2) is Pareto-inferior to the cooperative (W1, E1) outcome. The argument supporting such a pay-off structure in the present context requires a closer inspection of the players' alternative strategies and the outcomes they produce.

The traditional view of employer-control has developed from the principles of scientific management and is extensively documented in the literature deriving both from Taylor (1947) and from his radical opponents (notably Braverman 1974; Edwards, 1979; and Gordon, Edwards and Reich, 1982). The principal elements are deskilling via fine division of labour, precise job descriptions, and close control of work effort through machine-pacing or hierarchical supervision. Human capital development is minimised, the cost of replacing untrained labour is low, and the practice or threat of 'hire and fire' policies are viable tactics. The choice of technique and direction of R and D effort is governed by implications for control over the workforce as well as purely technical considerations, and piecework earnings or similar, individual incentives may be used to 'motivate' workers.^{7/}

In recent years, however, some of the traditional employer-control tactics appear to have been discarded in favour of subtler methods. In particular, modest levels of profit-sharing or value-added bonus systems have sometimes been substituted for individual incentives, and found more effective because less prone to manipulation by workers (see below). Similarly, firms have found that

'human relations management', and even a measure of participation, can be useful in increasing the acceptability of employer control.

However, in the case of participation where employer control remains the aim, care will be taken to ensure there is no serious erosion of management's prerogatives over confidential, 'strategic' information, which is central to both their capacity to control and their status.

If employers seek to control and workers choose or are forced by circumstances to cooperate ('comply' might be better) we may expect high productivity and financial performance as the theoretical benefits of scientific management or its modern equivalent are realised (table 2). Product quality will likewise be high, and technical innovations (of a control-enhancing kind) will be unimpeded. Total benefits ($B_W + B_E$) will be large but unequally distributed, as in table 1. All arguments of the B_E functions will go to their maximising levels subject to low-level w , y_W constraints set by the external labour market. Π_W is not necessarily zero since, as we have seen, profit or value-added sharing incentives may be used as a control device; the observed level will thus be optimal for this purpose, and different (probably lower) than the level which would be optimal as part of a participatory arrangement. \dot{K}_W is expected to be low, driven to the minimum level required by a deskilling policy (as a further result of which average wages w will be low due to the predominance of low-grade labour). Workers will supply no voluntary effort ($e_V = 0$) but because of effective supervision and control by management, an optimally high level of e_F will be extracted to maximise B_E .

Subject to technological limits, the firm in this case will

Table 2: Enterprise Characteristics under Alternative Outcomes (Representative Firms)

| | Participatory (E1, W1) | Autocratic Management (E2, W1) | Conflict (E2, W2) | Dominant Workers (E1, W2) |
|----------------------------------|--|---|---|--|
| Participation | | | | |
| (i) Decision-making | Genuine worker involvement. Information shared. | Workers excluded or token involvement ('human relations' approach). Information withheld. | Workers excluded. Information withheld. | Workers control subordinate management. Information withheld. |
| (ii) Ownership | Up to 100% (co-ops) | Negligible for workers. Share-options confined to management | | Depends on workers' preferences. Alternative of high wages and benefits available. |
| (iii) Profit-sharing | Entailed by ownership or participation agreement | Negligible; used as group incentive only. | | |
| Human capital/technology | | | | |
| Training investment | High | Low on average; confined to 'elite' employees | | High? |
| Job design | Broad | Narrow | | Broad? |
| Job variety | High | Minimal | | High? |
| Technology | Intermediate; biased to human capital utilisation and worker satisfaction. | Extremes of high and low-technology (requiring elite staff or unskilled); choice biased to control of work-process. | | Intermediate? |
| Supervision/incentives | | | | |
| Control system | Predominantly horizontal: self-monitoring or peer-group pressure. | Tight. Predominantly vertical, narrow control span, tall hierarchy, and/or machine-pacing. | | Loose, horizontal (or union-imposed?) |
| Incentives (payment by results) | No | Yes, unless control system makes redundant. | | No |
| Workforce | | | | |
| Skill-mix | High average skills | Low average skills; perhaps polarized (majority semi or unskilled, minority highly-skilled). | | High average? |
| Unionisation | Uncertain | Low | High | Uncertain |
| Working days lost | Low | Low | High | Uncertain (acc. to income/leisure prefs.) |
| Turnover | Low | High (if alternative employment available) otherwise low | High | Low |
| Effort | 'Voluntary'; optimum for max (B _w , B _E) | 'Forced'; optimum for B _E max. | 'Forced'; low | Voluntary; high/low for max B _w (acc. to prefs.) |
| Performance | | | | |
| Productivity | High | High/inter | Low | High/low acc. to prefs. |
| Profitability | Moderate? (Special rules for co-ops.) | High | Low | Low |
| Innovation | Unimpeded; human-capital biased. | Unimpeded; control-biased. | Highly contentious | |
| Morale: workers employers | High High | Low High | Low Low | High Low |

have a tall managerial hierarchy (table 2), narrow control spans and either a capital-intensive, machine-paced technology or a high ratio of supervisors to operatives. Both the proportion of skilled workers and training investment will be low, for a given technology. Jobs will be non-rotating and narrowly defined with little variety. Unionisation, strikes, disputes, absenteeism and pilferage will all be low, but labour turnover is likely to be at or above average levels (provided alternative employment is available), since there is little incentive either for workers to stay, or for management to prevent them leaving, as their replacement cost is low. The firm's payment system could rely on time rates only, if effective control can be established by supervision alone, or otherwise feature individual or group incentives including profit and value-added sharing according to strategy. A facade of worker participation in decision-making may exist, but the firm will not be genuinely participatory. Thus in reality workers will be involved in decision-making not at all or to the minimum degree possible; the Works Council will be either ineffectual (dealing with peanut issues) or non-existent, there will be no formal participation scheme, little informal participation, and minimum disclosure of information about the company's position and prospects to the workforce.

The employer-control outcome is clearly disadvantageous to workers, who may be expected to oppose it whenever circumstances permit, and seek to substitute their own control. The methods by which workers can control production are familiar from the industrial relations literature. They most likely will include unionisation (or an equivalent form of collective organisation) and any or all of the usual forms of industrial action - strikes, slow-downs, working to

rule etc. Managerial policies for division-of-labour and incentive payments systems will be frustrated by demarcation rules and by strategic manipulation of work effort on a group basis. Labour's share of (potential) corporate product will be raised via on-the-job leisure and pilferage. Bargaining power will be cultivated by the strategic withholding of information of potential value to management, gained through shop-floor experience, and so on.

Where employers and workers simultaneously seek control, these mutually incompatible strategies will produce the conflict outcome W2, E2. This is the 'dysfunctional' case under traditional firm organisation (Cable and FitzRoy, 1980),^{8/} where both sides expend resources on a distributional struggle to the detriment of overall performance. Total benefits will plausibly be less than under unopposed employer-control or, as we shall see in a moment, dominant workers; essentially this reflects losses due to mutual obstruction. Since the W2, E2 outcome implies economic warfare, as under Stackelberg disequilibrium, the payoffs to each side are likely to fluctuate with shifts in the balance of advantage, and the values in table 1 should be treated as averages or expectations. On average each side is expected to do better than as followers, but worse than as leaders (under the W1, E2 and W2, E1 outcomes respectively) and this is essential if the game is to remain a prisoners' dilemma. Subject to this, however, the exactly equal distribution of benefits shown in table 1 is not essential to the argument.

Under the conflict outcome the firm will most likely have a Tayloristic structure, production methods and control apparatus, but not the performance characteristics which these bring under an

unopposed autocratic management. Obviously too, the conflictual outcome differs fundamentally from autocratic management in the level of unionisation, frequency of disputes and stoppages, and other indicators of labour alienation. Each side retains information that could be of strategic importance to itself or to its opponent, and such contacts as take place between the sides will be of a negotiating rather than a participatory kind.

In the case where employers co-operate (comply) with control by their workers (W_2 , E_1) many aspects of the outcome are ambiguous, because they depend on workers' preferences. High productivity, quality and technical progressiveness could ensue if workers elect for a high-effort, high-reward outcome (though probably with a qualitative difference in technical innovations compared with the autocratic management case, with no control-enhancing bias here). But workers may alternatively choose to maximise welfare in dimensions like on-job leisure and non-productivity-related job satisfaction. Either way the distribution of total benefits will be favourable to workers, managers and capital owners receiving the minimum rewards (S_M , Π_M , D , \dot{A} , y_M .) that will keep them in the firm or allow them to be replaced.

The internal organisation of the worker-dominated firm and its production technology will likewise reflect workers' preferences. Thus the firm could have a structure similar to that management would choose (though presumably with peer-group pressure replacing managerial control systems), or workers could use their influence to secure alternative, more congenial production methods, involving greater human capital development and shop-floor discretion over the work flow. In the latter case, the 'captive management' situation

under discussion in some ways begins to resemble the participatory outcome (see below). Unionisation will probably tend towards extreme values of 100 per cent or zero, according to whether workers' domination is organised through formal trades union machinery, or through alternative, probably plant-level institutions. The incidence of strikes and disputes will be low as there is no serious opposition from management to be overcome. On the other hand, absenteeism and pilferage etc. may be high or low according to whether workers choose to further their welfare via maximum exploitation of a slackly-run managerial system, or by exercising control over the distribution of material benefits (wages plus profits) which they then have a incentive to maximise. Time rates of pay seem most likely to be preferred, and the worker-dominated firm is expected to show low labour turnover, firstly because workers will favour policies calculated to maintain stability and continuity of employment, and secondly because workers will have little incentive to quit a firm they control, while management will lack the authority to dismiss them.

In the three cases discussed so far, one or both sides seeks to maximise own benefits, subject to constraints which differ from case to case (table 3). The participatory outcome (W_1 , E_1), however, where both sides co-operate, permits maximisation of joint welfare $J = J(B_W, B_E)$ by a coalition of workers and employers.

The participatory enterprise is consequently run quite differently from a traditional firm. Production methods, control structure, and decision-making apparatus are chosen so as to encourage human capital formation and utilisation. 'Negative collusion' to

frustrate managerial control under adversarial strategies to maximise factor schemes gives way to 'positive collusion' between workers and employers to increase the total available for distribution (Cable and FitzRoy, 1980). High aggregate benefits are then partly inherent in the form of work organisation chosen (benefiting mainly workers via \dot{K}_W and y_W), and partly the result of productivity-enhancing effects as described in the literature.^{9/} These include the realisation of human capital potential - a resource unexploited in traditional organisation; release by both sides of strategic information leading to improved communication and full utilisation of workers' and managers' experience in decision-making; reduction of time lost through disputes etc through the use of superior methods of conflict resolution; reduced supervision and alienation costs as peer-group pressures and 'horizontal monitoring' replace 'vertical' monitoring and control by supervisors;^{10/} greater informal training and mutual assistance among the workforce which is elicited in a high trust, co-operative work environment; and the higher productivity (as well as lower disutility) of work effort which is volunteered (e_y) rather than squeezed out by a controlling employer (e_F).

In principle, the participatory outcome W_1, E_1 may take the institutional form of either a producers' co-operative (PC) or a contractual scheme or informal working agreement between workers and employers in a conventionally owned firm. In the case of a PC it may seem that there are no longer two players, since workers also own the enterprise. But a strict separation between owners and workers is in fact not possible under any of the four outcomes; there is nothing to prevent workers buying shares even in the most autocratic or conflictual companies, if they wish. Moreover, the interests of

workers qua owners and workers qua workers have still to be reconciled, and these may continue to be seen as a composite of B_W and B_E .^{11/}

Thus the fact that workers play a dual role does not fundamentally change the structure of the game; what really happens is that in the PC case the trade-off between workers' and owners' interests is internalised. We should therefore expect to observe open conflict (W_2, E_2) or exploitive domination of either workers' or owners' interests (W_2, E_1) and (W_1, E_2) only in cases of PC degeneracy.^{12/} In practice, by no means all PCs have 100 per cent owner-membership. Thus internalisation of the worker-owner tension may be incomplete, and this will affect the behaviour and performance of PCs. Variables used in empirical work which capture the proportion of worker-members, the importance of members' loans in the capital structure, etc., (Estrin and Jones, 1983; Jones and Svejnar, 1984) may be interpreted as proxying the degree of internalization which has been achieved.

According to Oakeshott (1978) Horvat (1982a,b) and some other writers, the (non-degenerate) PC is not merely a method of securing the collectively rational W_1, E_1 outcome, it is the only credible way of achieving this. In their view, a substantial ownership stake by workers is essential to break down the traditional antagonism between labour and capital and support the required changes in working practices and social relations of production. This is not, however, a universally held view, and in principle there is no reason why similar results should not be achieved by agreement between separate groups of workers and employers just as in principle colluding oligopolists can

achieve the results of a multi-plant monopolist. Problems of trust and potential chiselling are, of course, to be reckoned with, but problems also exist in securing agreement and loyalty within PCs. This is not to say that exactly identical outcomes are to be expected from PCs and from conventionally-owned participatory firms. An important difference arises from the fact that individual PC member-workers are likely to have much higher exit costs, and correspondingly lower exit propensity, than are either workers or owners in conventional firms; because of their dual role, their exit costs are the sum of those of a worker and an owner. On the one hand this may be expected to result in a greater incentive to secure agreement within the cooperative, and prevent the necessity for exit. At the same time it may mean that the minimum values to which particular worker and owner benefits can be driven before exit occurs will be higher for participatory firms than for PCs. Consequently, the balance between owners and workers interests may have to be found within a narrower range of values of W , \dot{K}_W , D , \dot{A} , etc. in the participatory firm, and this could mean that in empirical work we will observe higher levels of physical productivity and financial performance than in PCs, whose scope to trade these off for increased worker benefits is less tightly constrained by the need to prevent employers from abandoning either the firm as a whole or, at least, the cooperative stance required to sustain the participatory agreement. In general, the foregoing discussion suggests it may be appropriate in empirical work to regard 'participation' as a continuum of institutional settings embracing both PCs and other participatory arrangements, across which total benefits to firm members, productivity and financial performance may vary according to the degree of effective participation and to the effective constraints.

Whether participation under any institutional setting can generate maximum total benefits, as in table 1, is a question partly of technological constraints, but also of strategic behavioural choices. This is the underlying theme of the present discussion, and is what calls for a game-theoretic framework. The point can be addressed more directly by considering the relevant maximands and constraints for each of the main outcomes in table 1, which are set out in table 3. For simplicity it is assumed there are two alternative, discrete technologies, non-participatory (T1) and participatory (T2); in practice we would expect a range of alternatives, with varying input quality and substitution possibilities associated with different degrees or institutional forms of participation. A further assumption is that labour and capital markets impose only low-level constraints which are always exceeded if B_W and B_E respectively enter the maximand, when the constraints will become redundant.

Table 3: Maximands and Constraints

| OUTCOME | MAXIMAND | CONSTRAINTS |
|---------------------------------------|--|--|
| (i) W1, E2 (Autocratic Management) | B_E | Labour Market; T1 |
| (ii) W2, E1 (Dominant Workers) | B_W | Capital Market; T1 or T2 |
| (iii) W2, E2 (Conflict) | $\begin{cases} B_E \\ B_W \end{cases}$ | $\left. \begin{array}{l} \text{Workers max } B_W; \\ \text{Employers max } B_E; \end{array} \right\} T1$ |
| (iv) W1, E1 (Participation) | $J = J(B_E, B_W)$ | T2 |

The conditions required for participation to yield highest benefits are most stringent when considered against the alternative of autocratic management. Then, all potential technological advantages of T1 must be matched or exceeded by the human-capital-utilising, participatory alternative technology T2 or, at least, any productivity shortfall must be more than compensated by non-material benefits. However, as we have seen, outcome (i) is the relevant comparison only where employer-control is unopposed. Where opposition exists (outcome (iii)), superior participatory performance could be achieved even though T1 is potentially substantially superior to T2, because the adversarial worker behaviour which prevents realisation of T1 potential is replaced by cooperative behaviour under T2.

The origin of much of the dispute in the economics literature over the expected effects of participation is now clear. Critics assume an idealised 'efficient' traditional organisation (W1, E2) as the alternative, whereas writers who see scope for participatory gains do so because they recognize the dysfunctional nature of traditional organisation in practice (W2, E2). Of course producer cooperatives may also fail to realise their potential, and participation schemes and agreements may be ineptly conceived or implemented. Moreover, there may exist cases where the technological potential of T1 is so overwhelming that, whether fully or only partially realised, participation cannot offer an efficient (welfare generating) alternative; such cases would then not conform to the payoff structure in table 1. The point of the present argument, however, is that participation cannot be demonstrated as inherently and universally inferior to traditional organisation, either as a matter of logic, or because it has not so far emerged as the dominant form of organisation

in two hundred years of western industrialisation.^{13/} Ultimately, only empirical tests can reveal whether on average participatory regimes can outperform traditional ones, and the circumstances, if any, under which exceptions to the general trend (either way) are likely.

One result of empirical work could be that while participation can permit maximum total benefits, this is true only after taking account of the quality of working life (including \dot{K}_W , y_W , etc), and thus at the expense of lower productivity. If so, and if these sources of welfare are considered valid, a case exists for subsidy or some form of positive discrimination towards participatory organisations, and this constitutes part of the policy-relevance of empirical work on the subject.

III. EQUILIBRIUM

The conflict outcome W2, E2 is the individually rational (Nash) equilibrium in a one-shot game, and on the equilibrium path at every stage in a finitely repeated game.^{14/} However prisoners' dilemma games are inherently unstable, with an incentive always to do other than at present; if there is Nash-equilibrium it is worth cooperating to secure the Pareto superior outcome (W1, E1) whereas under Pareto-equilibrium there is an incentive to cheat (though in repeated games the possibility of retaliation must be taken into account). Moreover experiments by Axelrod and Smale have produced results where, at least for some time, players cooperate and end up with payoffs strictly greater than under equilibrium play. Noting that in Axelrod's PD tournament, the "strikingly simple and quite natural strategy" of 'tit-for-tat' play^{15/} emerged as the winner, Kreps, Milgrom, Roberts and Wilson (1982) show that such cooperation until the last few stages of a repeated game is consistent with rational, self-interest behaviour if either it is not common knowledge that the opponent is not 'tit-for-tat', or there is two-sided uncertainty over the stage payoffs (and hence of the opponents' incentive to renege).

Incomplete information of this kind is not unlikely in the complex production game under consideration. However, the cooperation it produces occurs only in the finitely repeated game, and it is not clear whether the production game is repeated or one-shot. Though production itself is obviously a repeated activity, it may be doubted that workers and employers view determining the form of work organisation as a recurring issue, not least because of the high transaction costs involved. And while far-reaching organisational

changes do occur from time to time, it is neither obvious nor very likely that they have been anticipated at the previous stage. Hence the reality may be a sequence of one-shot games rather than a single, repeated game. In any case the level of transactions costs is such that even in a genuine repeated game, the number of repetitions within the players' time horizons must be small, whereas the cooperation discussed by Kreps et al continues only until the last few plays, and is therefore of interest only in large, frequently repeated games.

Can we nevertheless envisage situations in which participation is chosen as the solution to a latent PD problem? The existence of such situations turns on the players perceptions of (a) the probability that the opponent will renege on a participatory arrangement if established; and (b) the probability of achieving outright domination and maximising individual benefits under the relevant off-diagonal, Stackelberg leader-follower equilibrium.

Ensuring that probability (a) is low enough is a matter of establishing adequate mutual trust and security in the design of participatory institutions and contracts. Here the distinction between cooperatives and participation schemes may be important. Once the conflict between workers' and employers' interests has been internalised via large worker-ownership stakes, the incentive to revert to sectional utility maximisation is removed; this is the Oakeshott/Horvat argument. The point is of course strongest when all the workers in a PC are owner-members - there are no distinct categories of member (e.g. the original founding group and others), no non-working members, and no contracted labour. Where any or all of these are present, internalisation is incomplete and the enterprise

may begin to exhibit symptoms of 'degeneracy' including the domination of some sectional interests or open conflict between them, so that PC behaviour comes to resemble the other outcomes highlighted by the present analysis: $W1/E2$, $W2/E1$, or $W2/E2$.

Thus while the 'pure' form of PC may offer a full solution to problem (a), not all PCs will be of this type. Moreover participation 'schemes' may also have trust-enhancing features. This is particularly true where they involve mutual release and sharing of each sides' 'strategic' information. By so doing each side signals its willingness not to revert to sectional behaviour and, indeed, forfeits an important strategic advantage were it to attempt this. Similarly, profit-sharing schemes introduce a further element of 'bonding'. For example, if employers renege on a participatory arrangement and succeed in maximising B_E , workers at least receive monetary compensation via Π_W . Conversely, if workers defect, the financial loss to employers is mitigated by reduced Π_W payments. However, the strength of the bonding effect is clearly a function of the amount of profit-sharing (more specifically the ratios $\Pi_W/(w + \Pi_W)$ and $\Pi_M/(\Pi_M + D + B)$), which in practice is often small.

In sum, it appears that both PCs and participation schemes may be routes to the Pareto-superior outcome $W1, E1$. But there is nothing automatic in this, and whether they are or not will depend on the institutional or contractual arrangements in specific cases.

With respect to (b), the perceived probability of one side achieving outright domination,, it is important to recognise that in life, as opposed to theoretical and experimental games, the

availability to each player of a choice of strategy is not absolute, but a function of environmental factors. Thus if there is heavy unemployment and acute domestic or international competition; if government policies curb union organisation and activity (e.g. by removing closed shops, restricting picketing, increasing unions' legal liabilities over disputes, enforcing 'contracting in' to political levies, and so forth) and at the same time reduce unemployment benefits and strikers' social security; and if social attitudes emphasize respect for material and private property and deference to hierarchical authority; then the chances of worker domination will be perceived to be small and those of employers correspondingly large. Conversely, the opposite economic, political and social environment will generate the opposite predictions.

These effects can be captured in the model by attaching the players' subjective probabilities to the payoffs in table 1, where these probabilities are then a function of the prevailing economic, political and social environment.^{16/} When the probability of one player being able to play his 'control' strategy falls below a certain level (in the limit zero), the game simply collapses to a single leader-follower outcome (W1, E2 or W2, E1), one side having no option but to comply.

In certain cases, environmental factors may have an overriding influence in ruling out particular outcomes. For example, the pathological, low performance Nash equilibrium W2, E2 may be viable only in a favourable economic climate, such as an economic boom, or under tariff protection or monopolistic advantage, and be driven out under economic adversity. Experience in the UK in the post-1979

recession is of interest here showing evidence of a polarized response to the crisis - some firms reverting to strong managerial control but others, despite the presence of a government policy favourable towards reassertion of managerial prerogatives, seeking a participatory solution.^{17/} Also, as we have already seen, technological imperatives may rule out an effective participatory solution in certain cases, most especially when they dictate giant plant size, extremes of machine-pacing etc (though as has also been seen, we should be wary of treating technology as truly exogenous, when the nature and direction of R & D effort may have been biased towards work-control enhancing technologies).

The upshot is that we can envisage circumstances in which any one of the four outcomes in table 1 will be observed. Contrary to some observers,^{18/} the outcome depends not just on underlying (technical) efficiency (which in any case is not truly exogenous) but also on economic, social, political and technological determinants of each side's chances of establishing outright control, and, where the participatory option is open, the ability of the participants to solve problems of institutional or contract design. Thus, in answer to the questions raised in section I, we can envisage an equilibrium in which different organisational forms co-exist which are not necessarily equi-efficient on conventional measures. If technological imperatives are important, there should be a discernable industrial pattern of firm organisation, that is repeated across economies that are in other respects similar. Differences in the economic, social and political environment, on the other hand, should produce discernible patterns and trends in international comparisons and over time.^{19/} Finally, however, it must be remembered that there are significant transactions

costs of changing the organisation of work. Hence at any particular time we may expect also to observe, in given conditions, firms which would be considered as not 'optimally' or 'appropriately' organised if setting up from scratch, but for whom the benefits from reorganisation (to either side or to both jointly) are less than the costs of securing them. In this way, forms of work organisation may persist, perhaps for long periods, after their underlying rationale has disappeared, and perhaps until a crisis precipitates action.

IV. IMPLICATIONS FOR PRODUCTIVITY COMPARISONS

Estimates of the sign and gradient of the relationship between participation and productivity are important magnitudes for public policy. If they indicate a resource cost - that is, if they show that employee-participation is possible only at the sacrifice of potential, material productivity - an evaluation of non-material benefits in the quality of working life is then called for, to determine whether a subsidy or other form of positive discrimination is justified, and if so at what level. If, on the other hand, participation is found to have a neutral or positive effect on material productivity, the next policy question is to identify the impediments to its introduction, in order to explain why it has not been more widely adopted.

Previous empirical studies that go beyond the comparison of sub-sample means and simple regression have mostly attempted to estimate augmented production functions of the general form:

$$Y = X \beta [+ Z \alpha + W \delta] + u$$

where Y = output vector,

X = factor-input matrix,

Z = matrix of augmenting variables,

W = matrix of interaction terms.

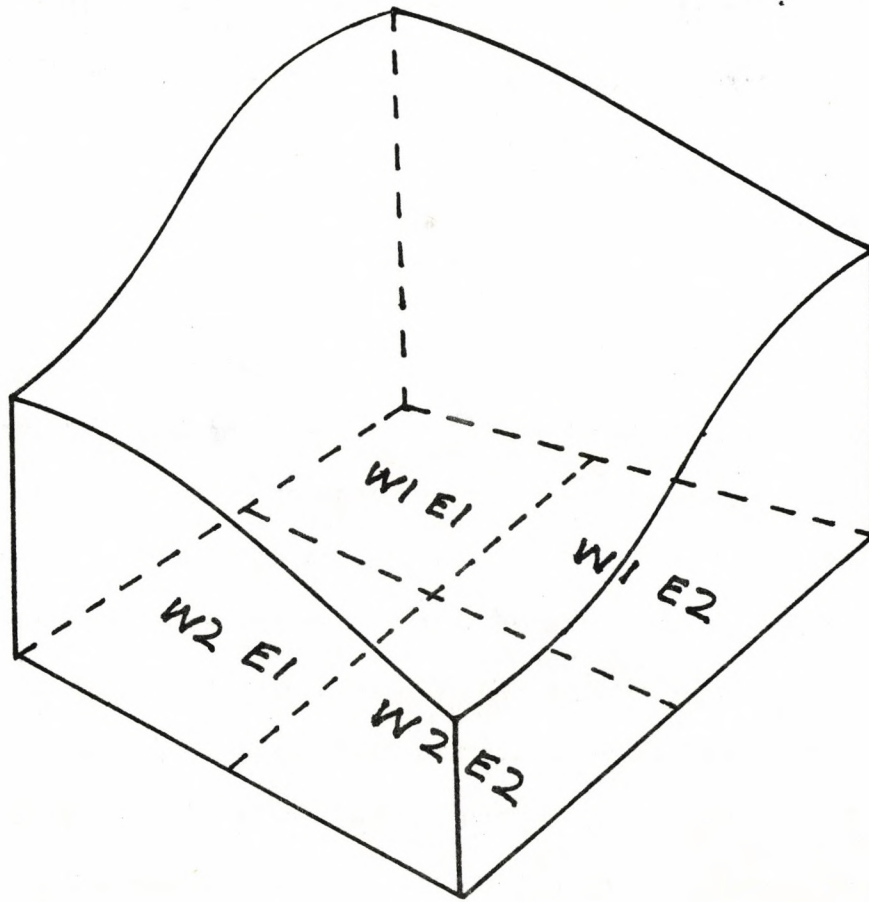
$X \beta$ is typically specified as Cobb-Douglas, CES or translog and $Z \alpha$ includes measures of the degree of participation and other firm-specific and contextual variables. W captures interactions

between the augmenting variables and factor inputs, and is thus important for picking up embodied productivity effects. When Z and W are omitted the models reduce to orthodox production-function specifications.

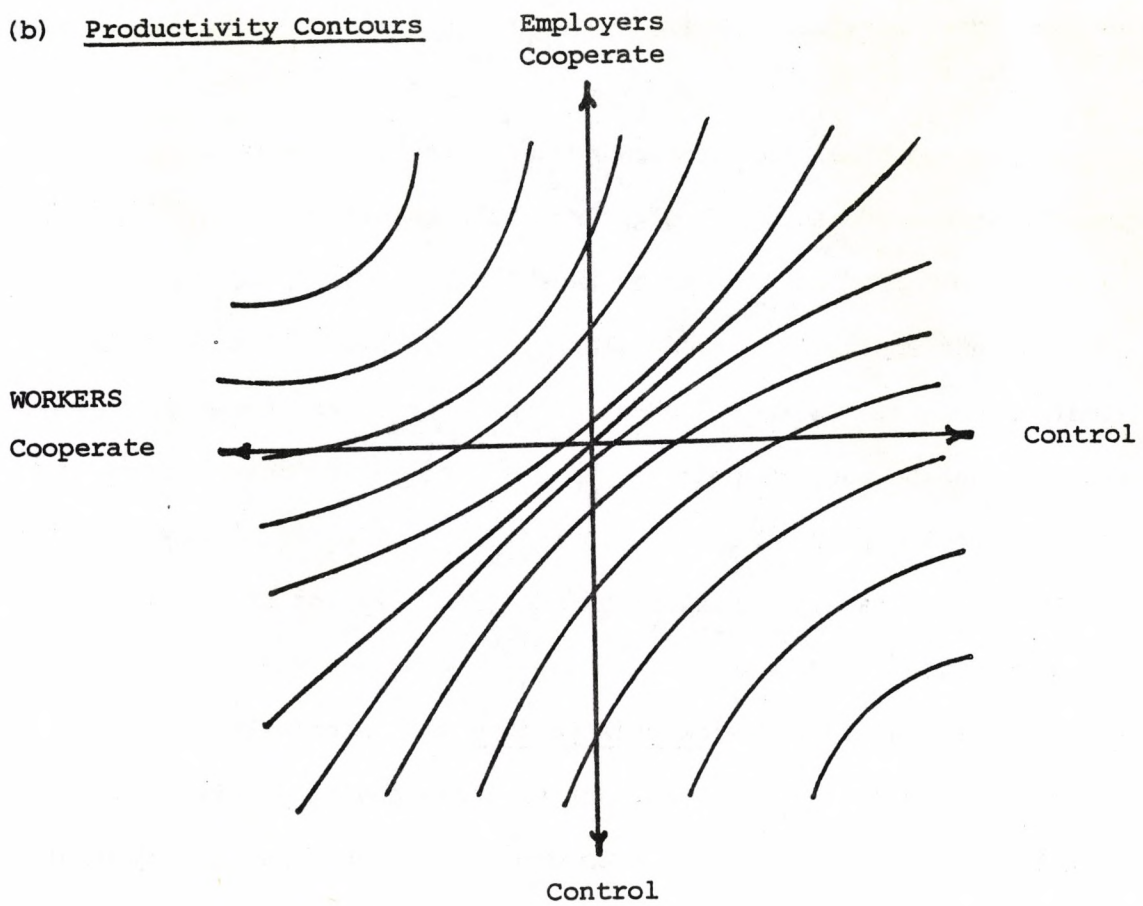
The implication of the arguments in preceding sections of this paper is that, due to the nature of the underlying organisational choice mechanism and the transactions costs of organisational change, an empirical sample may contain observations of all four outcomes in table 1, and the co-existence of these alternatives must be allowed for in estimation. Of course, the discrete alternatives shown there are merely stereotypes, and greater realism may be introduced by making the payoff-space continuous. Thus in practice we would expect to observe a continuum of firm types with clusterings around the focal outcomes previously analysed.

The empirical task is now revealed to be to estimate a productivity surface, which might resemble the general shape sketched in figure 1. If direct measures were available of the degree of workers' and employers' cooperation/conflict, estimation would be straightforward. As they are not, firm-specific characteristics as in table 2 must be used as proxies, in order to locate observations in conflict/cooperation space. The principal estimating problem is then likely to be parameter instability across subsamples of firms operating under alternative regimes. For example, whereas productivity may increase ceteris paribus with narrowness of control-span and, perhaps, reliance on individual incentives in traditional firms, different, even opposite effects may be expected

Figure 1(a) Productivity Surface



(b) Productivity Contours



under participation. Since the number of variables involved may be large, resort to slope dummies and other interaction terms may prove unmanageable. Also, where participation yields embodied productivity effects, factor output elasticities will differ between sub-samples clustered around the focal outcomes of table 1.

Thus varying parameter models may be called for, in particular the switching regressions model used by Quandt (1958) and others. In a very simple example, this allows for the existence of alternative 'regimes':

$$y_t = \alpha_1 + \beta_1 x_t + u_{1t} \text{ for } 1 \leq t \leq n_0$$

and
$$y_t = \alpha_2 + \beta_2 x_t + u_{2t} \text{ for } n_0 < t < n,$$

with the parameters of the model varying above and below the critical value x_{n_0} . This value is found experimentally by successive partitioning of the sample according to x_t , until the critical value is found which minimises the sum of the two residual sums of squares for the separate regressions. Clearly this model is especially useful where, as in the present case, the alternative regimes cannot be identified with confidence a priori. The main distinction to be found is most likely that between participatory firms and the rest (i.e. firms of type W1, E1 as opposed to W1, E2; W2, E2 and W2, E1) or possibly between 'traditional' firms (W1, E2 and W2, E2) and others. The remaining problem concerns the choice of discriminating variable. Profit-sharing and some index of workers participation in decision making seem the likeliest candidates. Problems of deriving continuous measures of decision-making participation from qualitative data are considered elsewhere.^{20/}

V. CONCLUSIONS

The prisoners' dilemma game provides a framework for organising a wide range of material concerning the choice and performance of traditional and participatory forms of production enterprise. In particular it aids analysis of the interplay between underlying efficiency considerations and the ability, or bargaining strength, of economic agents in pursuing alternative strategies. Its usefulness in the present context suggests scope for further development and application in the current 'power vs efficiency' controversy in the theory of internal organisation.^{21/} Because the choice of form of enterprise depends on relative power, and hence indirectly on the political social and economic environment, 'Darwinian' claims for the superior efficiency of the traditionally-organised firm on conventional measures may be discounted. Participatory organisation could be Pareto-superior to the conflictual, Nash-equilibrium either because of higher physical productivity plus non-pecuniary but welfare-enhancing aspects concerning the quality of working life, or because of the latter only. In the latter case, a rationale for subsidy or other forms of positive discrimination may exist, and this lends direct policy relevance to empirical work on enterprise performance under alternative regimes. The necessary conditions for participatory firms to outperform others in terms of physical production alone are most demanding when the alternatives are firms under more-or-less unopposed employer control. But this is the relevant comparison only under unusual conditions, and the requirements are much weaker when the alternative is the conflictual (Nash-equilibrium) firm which is more often to be expected. Differences in the basis of comparison are the source of much present

controversy in the literature. Producer cooperatives may be regarded as a subset of a broader class of participatory institutional arrangements, rather than as a wholly separate category; theories of the labour-managed firm would be enriched by substituting objective functions capturing the range of workers' interests qua workers and qua owners for simple proxies such as income per worker. Cases of any or all the main alternative forms of production enterprise analysed in this paper may be expected to appear in randomly drawn empirical samples, and allowing for parameter instability between alternative regimes should be a prime consideration in empirical work. The rationale for including a range of firm-specific characteristics in augmented production function estimates is as proxies for the degree of workers' and employers' cooperation and control.

FOOTNOTES

- 1/ For a bibliography of the rapidly growing literature on cooperatives and participatory firms see Jones and Svejnar (1982).
- 2/ 'Employers' will always include owners and top management, and may reach down to middle and more junior management at least to departmental head level. Though the huge variety of hierarchical structures and nomenclatures makes generalisation impossible, the distinction is usually easy to make in specific cases.
- 3/ In particular, we suppress discussion of managerialism (shareholder control over their agents, management) and of trade union organisation and representation. While these are important issues, they are not the prime focus of the present analysis, though distributional aspects are touched on in discussion of each side's objective function (below).
- 4/ c.f. Marris, 1964.
- 5/ Intra-group conflicts of interest clearly are involved, though may be no more severe than those assumed capable of resolution within the household in conventional consumer theory. Similar conflicts of course exist on the workers' side.
- 6/ Except that private capital remains as an institution under W2, E1. Following Bradley and Gelb (1983) we might envisage a further stage where stock values are reduced to zero via worker-controlled commercial and distributive policies, and capital is then 'bought out' at zero market price.
- 7/ Bradley and Gelb (1983), however, argue that resort to payment-by-results represents a failure of the supervisory aspect of scientific management.
- 8/ Only the conflict (W2, E2) and cooperative (W1, E1) outcomes are considered by Cable and FitzRoy.
- 9/ See in particular, McCain (1982).
- 10/ For formal analyses see FitzRoy and Kraft (1984), Reich and Devine (1981).
- 11/ A corollary is that the theory of the labour-managed firm would be enriched if the maximand $J = J(B_E, B_W)$ were substituted for present alternatives such as income per worker.
- 12/ As, for example, in the case where Furubotn (1976) considers domination by an original, founding group of members.
- 13/ See also the next section.
- 14/ The logic is similar to Selten's backwards induction in the chain-store game. By contrast, in an infinite game "any average payoff vector in the intersection of the positive orthant and the convex hull of the four possible stage payoff vectors can be achieved through a perfect equilibrium" (Kreps, Milgrom, Roberts and Wilson, 1982).

- 15/ 'Tit-for-tat' play requires co-operation at first, which is then continued only if the opponent also co-operated at the previous stage.
- 16/ There are now two kinds of uncertainty in the model, one concerning rival's behaviour and one (mutual) uncertainty about stage payoffs (c.f. Kreps et al).
- 17/ Source: spokesman for West Midlands Engineering Employers Federation. The opinion is substantiated by empirical data collected by Nick Wilson for the UK Work Organisation project.
- 18/ In default of reliable empirical evidence for their case, Furubotn (1976), Jensen and Meckling (1979) and others invoke 'Darwinian' arguments in support of traditional organisation, arguing that the failure of any serious rival to appear in 200 years of industrialisation is sufficient testimony of its superiority. They ignore the fact that for the majority of the relevant period, and especially the formative early part, economic, political and social factors strongly favoured employer control. They also, of course, fail to recognise that the recent appearance of alternatives which they so deplore may be the beginnings of the counter-evidence they claim does not exist.
- 19/ The outstanding example of political impact is perhaps the case of Chile under the short-lived Allende government (see Espinosa and Zimbalist, 1978). Striking examples of politico-social are also to be seen in developing countries.
- 20/ Cable (1984).
- 21/ See the recent conference volume, Francis et al (eds.), 1983.

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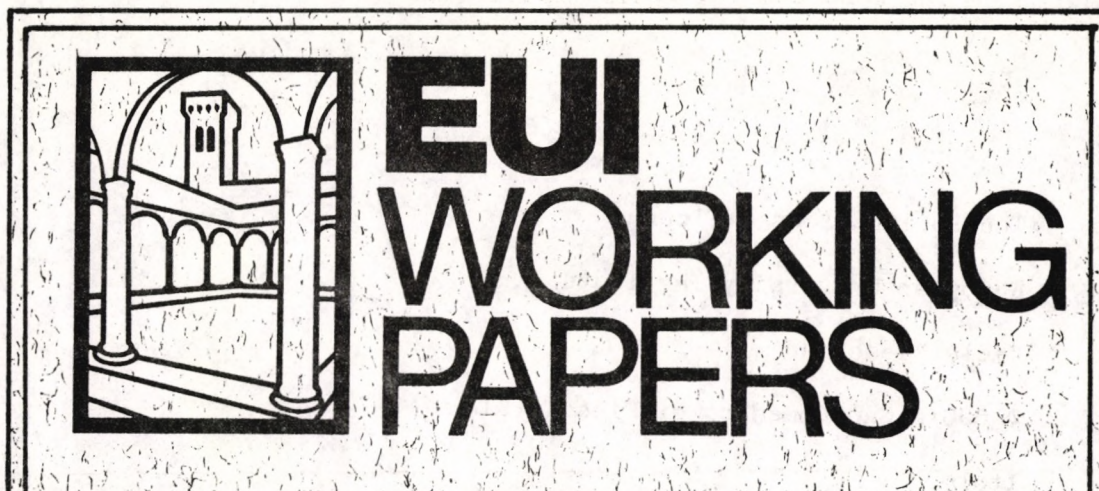
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