COOPERATION, PRODUCTIVITY, AND PROFIT SHARING*

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Firm-specific assets generate an ex post bargaining problem over surplus-division, and rational workers may collude to obtain a surplus-share in nonpecuniary form through restriction of effort. Conversely, profit sharing should motivate cooperation to increase productivity when work organization facilitates interaction and horizontal monitoring, since productive effort yields positive externalities to workers under contractual surplus sharing. In simultaneous Tobit estimates we find a strong influence of profit sharing on factor productivity in a sample of medium-sized metalworking capitalist firms in West Germany. Proxies for human capital and organizational factors were included.

I. INTRODUCTION

Motivating work effort in the firm has traditionally been regarded as a matter of providing adequate individual incentives. This task was facilitated by the scientific management movement and collective bargains in which precise, formalized job descriptions allowed fairly objective evaluation and reward of individual performance [Hill, 1981]. Subjective effort and disutility of work are of course difficult to estimate for management, and workers have an obvious interest in exaggerating disutility to gain compensating differentials. Collusive restriction of output to maintain earnings with less effort is well documented [Gordon et al., 1982; Frank, 1984] and can be regarded as an attempt by workers to obtain a share of enterprise surplus[1] in a nonpecuniary or unobservable form. Scientific management can also be regarded in part as an attempt to inhibit unproductive collusion through appropriate job design and organization of work [Gordon et al., 1982], a "bonus" for employers that accompanied the direct reduction in skill requirements and labor costs through carefully subdivided and routinized

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1. Even in perfect competition the existence of firm-specific investments and mobility costs is likely to create an ex post enterprise surplus above total factor opportunity costs and hence give rise to the bargaining problem [Aoki, 1984; FitzRoy and Mueller, 1984].

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tasks which was already observed by Adam Smith and Charles Babbage [1835].

The relative decline of traditional mass production, and the growth of specialized production, with rapid technological and market change, have all imposed increasing demands of adaptability and skill on the modern work force. Cooperation, communication, and human capital have become increasingly important "factors" of production that are less easily monitored and motivated with traditional individual incentives and work organization [Reich, 1983; Piore and Sabel, 1984]. Declining productivity growth and stagflation have also stimulated a growing interest in improving traditional adversarial industrial relations through more flexible work organization and various forms of worker participation and profit sharing [*Business Week,* 1983]. Long-standing opposition to such potentially productive alternatives to formalized collective bargains has begun to recede, as the positive role of cooperative labor relations in such countries as Japan and West Germany attracts increasing attention [Gordon, 1982; Ouchi, 1981]. However, no generally accepted microeconomic foundation for group incentives and cooperative behavior has yet emerged, and some economists still see only a distributive role for the "voice" of labor or sharing "surplus."[2]

While these issues have been considered in the context of cooperatives and trade unions,[3] there has been very little rigorous theoretical or empirical study of group incentives and "cooperation" in the very different environment of capitalist firms.[4] In the

2. Alchian and Demsetz [1972] base their theory of the firm on perfect mobility of labor and absence of firm-specific human capital, and although they emphasize team-work, monitoring costs, and the importance of "Team spirit and loyalty," they entirely miss the connection with "voice" and participation, which was developed earlier by Hirschman [1970]. Alchian [1984] admits that costless mobility is unrealistic, but still regards "worker participation" as "a wealth confiscation scheme" [p. 46], in spite of his own recognition, two paragraphs earlier, that "any persons . . . who have human capital specific . . . to the firm will demand some control and monitoring *via* representation . . . or some other form of protection from expropriation of their specialized investment's quasi rent" [p. 46]. Similarly, Jensen and Meckling [1979] reveal no awareness of the efficiency-voice argument (based on mobility costs) for the sharing of various "rights" including team-specific surplus, or of the many ways in which Nash equilibria can deviate from Pareto efficiency.

3. See Bradley and Gelb [1981, 1983]; Bonin and Putterman [1984]; Drèze [1985]; Jones and Svejnar [1984]; Defourney, Estrin, and Jones [1985]; and Jones and Svejnar [1985] on cooperatives, and FitzRoy and Kraft [1985a, c] and Freeman and Medoff [1984] on the "voice" of organized labor and formal institutions for intrafirm cooperation.

4. Basic economics of cooperation and "horizontal monitoring" were developed in FitzRoy and Hiller [1978] and FitzRoy and Mueller [1984]. Regression results in Cable and FitzRoy [1980] were based on single-equation OLS estimates and are thus subject to simultaneity bias as well as to problems of omitted variable bias due to absence of proxies for human capital, and to difficulties with comparability across

next section of this paper we outline a theory of cooperation and show that group incentives can plausibly motivate difficult-to-observe productive activity and economize on monitoring costs. We then proceed to test this theory with detailed data from a sample of West German metalworking firms. Simultaneous WLS and Tobit estimates for factor productivity and profit-sharing are presented, and reveal a robust effect of profit-sharing and workers' capital ownership on productivity, though ultimate causality questions cannot be answered in our sample.

II. Cooperation in the Firm

The existence of mobility cost and specialized or firm-specific skills and other assets noted above creates an ex post bargaining problem for the division of the resulting enterprise surplus over factor opportunity costs. This problem is complicated by a natural informational asymmetry, since workers' subjective effort and disutility of work are inherently unobservable by management. Information costs further prohibit complete allocation via ex ante contingent contracts, prior to specialization and other irreversible investments.

To attenuate moral hazard, motivate individual effort, and foster (immobilizing) specific investments under such conditions, most organizations reward *relative* performance (which may be easier to monitor than absolute measures) by promotion and career progression. However, exclusive reliance on individual incentives under uncertainty is also likely to engender counterproductive rivalry rather than efficient cooperation and mutual assistance in team work. Formal theories of incentives have almost entirely ignored problems of this kind which are raised by team work and interaction in the work force [FitzRoy and Kraft, 1985d]. Even the more descriptive, institutional analysis of work organizations in Williamson [1985] fails to capture the role of strategic, coordinated response to individual incentives by informally or formally orga-

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the many industries represented (though intercept dummies were used). An excellent discussion of formal bargaining solutions to internal distribution problems in the firm is given by Aoki [1984], while Arrow [1974] and Williamson [1985] provide insightful introductions to many aspects of internal organization. Kleindorfer and Sertel [1979] derive Nash equilibria in the firm under individual incentives but without interaction between workers. Bradley and Gelb [1981] do emphasize interaction and "horizontal monitoring," and outline a model thereof, but they argue for restricted applicability (essentially to coops). In spite of the work norms in his title, Miyazaki [1984] explicitly *excludes* interaction between team members, and essentially rederives the familiar free-rider problem with group payment.

nized labor, in spite of historical evidence on the importance of such response in shaping work organization under low-trust, adversarial industrial relations [Gordon et al., 1982; Hill, 1981].

A traditional resolution of the bargaining problem is for workers to exaggerate the difficulty or disutility of tasks by withholding effort and output. If normal earnings are attained, workers can thus appropriate some of the enterprise surplus in nonpecuniary form by this strategy, which is reinforced by the suspicion that piece-rates may be lowered if earnings exceed normal levels. Given current piece-rates or other individual rewards, individual effort may well be suboptimal, and so this strategy must then be enforced by peer group pressure, restrictive work rules, and social sanctions against "rate busters" [Frank, 1984; Gordon et al., 1982].

In spite of the obvious gains from cooperation, this situation can be stabilized by mutual distrust. If workers believe that most of the gains from increased productivity will be appropriated by owners or managers, their best collusive strategy is to maintain their nonpecuniary benefits through limiting effort. Managers who suspect workers of collectively restricting effort may be reluctant to offer additional material rewards, and instead organize work to inhibit interaction and attempt to enforce productivity standards. This situation is thus characterized by the chronic or recurrent conflicts over rate setting and working conditions that are typical of traditional, adversarial industrial relations and collective bargaining.

An alternative to this inefficient, noncooperative solution of the bargaining problem in the firm is to seek a cooperative solution and offer workers a contractual share of surplus that provides a substantial *marginal* return to increasing effort and efficiency. When individual performance is difficult to monitor, this strategy utilizes the specific information and horizontal or mutual monitoring capability of peer groups in the following way. While a fixed surplus share provides little *direct* individual incentive in any but a very small team, a sharing scheme or group reward does generate positive externalities from effort and cooperation. Shirking or free-riding now imposes cost directly on all coworkers, so that social sanctions (which were proved feasible in the traditional adversarial strategy) now should be rationally applied against workers who deviate from the cooperative work norm of efficient effort-supply.

The viability of a cooperative solution is clearly enhanced by work organization which facilitates interaction, though this may also increase the risk of more effective collusion to restrict output

unless the benefits are credibly shared. In the context of oligopoly, Kurz [1985] has argued that some departure from strictly individualistic rationality is necessary to achieve a cooperative bargaining solution. Efficient cooperation may be stabilized by repeated plays of the game situation [Axelrod, 1984], and the reciprocal obligations of "gift exchange" can also foster goodwill and attenuate mistrust in the presence of realistically interdependent utility functions. Work norms and wages above minimum required levels are explained as gift exchange by Akerlof [1982].

While surplus sharing as an exchange of gifts has some plausibility, this interpretation misses the group incentive character of sharing that has been emphasized here. Mutual assistance and cooperation between workers can also be viewed as gift exchange, which alleviates disutility of work and thereby enhances productivity. Assuming that such cooperation is difficult for supervisors to monitor, we have shown elsewhere that two distinct Nash equilibria in work effort may exist with purely individual incentives for (observable) output. However, an arbitrarily small group incentive or profit share suffices to *exclude* the Pareto-inferior equilibrium where there is no mutual cooperation, and hence stabilize the superior solution with cooperation [FitzRoy and Kraft, 1985b].

III. Empirical Specification and Results

We investigate the relationship between profit sharing and productivity in a set of unpublished data that were obtained from 65 firms in the West German metalworking industry in extended interviews.[5] More than half the firms had no profit sharing, and it is revealing to examine initially some key ratios for the whole sample and the two subsamples, as displayed in Table I. Noteworthy is that the profit-sharing firms are larger and more profitable, as well as having higher labor productivity and lower capital intensity than firms without sharing. Our approach is to estimate total factor productivity and profit sharing income per employee (*PROSH*) simultaneously as functions of "exogenous" organizational, human capital, and other variables listed in Table II.

To this end we first estimate a pooled Cobb-Douglas equation with two years of data for value-added (V) in terms of the factors capital (CFW), total blue-collar manhours (TMH), white collar

5. Sixty-two out of sixty-five firms provided complete returns for 1979, and sixty-one did so for 1977. We use the pooled data with a dummy for 1977.

TABLE I
KEY MEAN VALUES FOR FULL SAMPLE AND SUBSAMPLES

	All firms	With profit sharing	Without profit sharing
Number employed	626	790	480
Capital intensity (1,000 DM)	66.6	65.2	67.8
Labor productivity (1,000 DM) (= value added/employment)	46.4	49.2	43.9
Return on capital	0.178	0.218	0.143
	(n = 123)	(n = 58)	(n = 65)

employees (WHC), and a $TIME$ dummy. This yields

$$(1)\quad \ln V = \underset{(-0.116)}{-0.772} + \underset{(1.77)}{0.130} \ln CFW - \underset{(6.12)}{0.526} \ln TMH + \underset{(4.19)}{0.353} \ln WHK - \underset{(-1.13)}{0.088}\, TIME \qquad R^2 = 0.93.$$

We can then use the residuals from (1) as an index of total factor productivity ($PROD$), and note that returns to scale are constant. However, since profit sharing ($PROSH$) is a limited dependent variable (zero in more than half the observations), OLS estimates will be biased and inefficient due to nonnormal and heteroskedastic errors [Amemiya, 1984; Maddala, 1983]. Simultaneous estimates of $PROD$ and $PROSH$ by two- or three-stage least squares may also suffer from similar problems, so we shall obtain simultaneous Tobit estimates as follows.

The first step in this procedure is the Tobit regression,

$$(2)\qquad PROSH = F(\Sigma\alpha_i X_i),$$

where the X_i are exogenous and F is the Tobit likelihood function. The estimated variable $\widehat{PROSH}$ can then be used as an instrument in the next stage, which is a WLS regression:

$$(3)\qquad PROD = \Sigma\beta_i Z_i + \gamma\, \widehat{PROSH},$$

where Z_i are exogenous. The coefficient γ in (3) thus describes the effect of profit sharing on factor productivity after removing simultaneous-equation bias. Similarly, we obtain a WLS estimate,

$$(4)\qquad \widehat{PROD} = \Sigma\hat{\lambda}_i X_i$$

for use as an instrument in the final Tobit regression:

$$(5)\qquad PROSH = F(\Sigma\mu_i Y_i + \delta\, \widehat{PROD}),$$

TABLE II
DESCRIPTION OF VARIABLES

Definition	Abbreviation	Mean value	Standard deviation
Capital (fixed and working, 1000 DM)	*CFW*	48,461	90,832
Total hours for workers	*TWH*	662,273	1,165,810.0
White-collar employees	*WHC*	213	394
Subsector dummy (EBM)	*ID2*	0.24	0.43
Subsector dummy (machinery)	*ID3*	0.66	0.48
Profit share income per employee (1,000 DM)	*PROSH*	1.05	4.62
Ratio of piece rates to total wages	*I*	0.10	0.29
Dummy for existence of works council	*WOCO*	0.80	0.40
Training expenditure per employee (1,000 DM)	*TREX*	0.85	0.85
Dummy for intermediate technology	*IT*	0.95	0.22
Dummy for 1977	*TIME*	0.50	0.50
Herfindahl proxy	*HERF*	0.14	0.14
Number of employees	*NEM*	626	1,020
Ratio of blue collar to white collar employees	*BLUE*	2.52	1.50
Ratio of workers' capital to total capital	*WCAP*	0.006	0.182
Proportion of work force unionized	*PWU*	0.37	0.28
Job production dummy	*JOB*	0.41	0.49
Value added (1,000 DM)	*V*	29,504	52,178
Ratio of unskilled to skilled workers	*UNSKILL*	1.99	3.23
Dummy for high turnover among skilled workers	*ATS*	0.14	0.35
Dummy for high turnover among unskilled workers	*ATU*	0.37	0.48
Average salary wage ratio	*DIFF*	1.51	0.46
Capital per employee (1,000 DM)	*CAPIN*	66.57	30.98
Dummy = 1 when top management holds at least 25% of capital	*CTOP*	0.64	0.48
Number of years since introduction of profit sharing	*AGE*	4.9	8.59

where δ describes the unbiased "feedback" from productivity to profit sharing.

The estimates of (3) and (5) are presented in Table III. The most important explanatory variable among the exogenous Y_i in (5) is the "*AGE*" of the profit sharing scheme in the firm,[6] which

6. We are indebted to a referee for suggesting the use of this variable.

TABLE III
SIMULTANEOUS ESTIMATES

	Productivity (PROD) (WLS)	Profit-sharing (*PROSH*) (Tobit)
Constant	−0.58	−2.28
	(−2.52)	(−3.63)
ID 2	0.37	
	(2.82)	
ID 3	0.12	
	(0.92)	
PROSH	0.03	
	(3.26)	
I	0.08	0.21
	(0.45)	(0.46)
WOCO	−0.20	0.49
	(−2.16)	(1.30)
TREXP	0.35	
	(4.20)	
IT	0.35	
	(2.18)	
HERF	0.08	
	(2.27)	
WCAP	5.40	0.45
	(3.00)	(0.07)
PWU	0.08	−0.006
	(2.94)	(−1.06)
JOB	−0.16	0.12
	(−2.39)	(0.40)
UNSKILL	−0.15	−0.06
	(−2.56)	(−1.60)
ATS		0.76
		(1.85)
ATU		0.54
		(1.69)
DIFF	0.22	
	(2.30)	
PROD		1.26
		(1.91)
AGE		0.14
		(8.02)
NEM		−0.0001
		(−0.86)
CAPIN		−0.001
		(−0.31)
BLUE		0.29
		(3.07)

t-values in parentheses

suggests that a significant learning process is indeed involved in encouraging cooperative behavior through group incentives. *PRÔD* was only weakly significant, and size as measured by the number of employees (*NEM*) was insignificant, so that feedback from these variables does not seem to be the prime determinant of *PROSH*. Somewhat surprisingly, both the ratio of blue- to white-collar employees (*BLUE*) and a dummy for high turnover among skilled workers (*ATS*) were significant. In the latter case one could argue that profit sharing was in part an attempt to retain skilled workers.

Turning to the productivity equation (3) in Table III, the most notable result is the highly significant coefficient of PRÔ*SH* (γ), a result that is very robust with respect to alternative specifications in our sample. The ratio of employee capital holding to total capital (*WCAP*) is also strongly significant. The large coefficient is not an elasticity because *WCAP* was zero in some firms, so we do not take the *log* of this variable or *PRÔSH*, while all other continuous variables are in logarithmic form in (3) (but linear in the Tobit regression (5)). The ratio *WCAP* is a very small number in all firms, but still seems to have a positive effect on similar lines to the more substantial profit shares that we have focused on here. In accord with human capital theory, both training (*TREX*) and the proportion of skilled workers have significant effects (we use the inverse *UNSKILL* ratio). Fewer competitors, as measured by the Herfindahl proxy *HERF*, have a positive influence on productivity presumably via price effects. The salary-wage differential and a technology dummy were also significant.

The positive effect of unionization (*PWU*) and the negative coefficient of a dummy for the existence of a works council (*WOCO*) are apparently contradictory results because the works council is the main organ of formal "voice" or worker participation at plant level in the West German system of industrial relations. We have argued elsewhere that these results are best explained by the most competent managers' ability to perform best without the legal constraints imposed by a works council, and also to offer wages and working conditions that render this institution superfluous (see FitzRoy and Kraft [1985a]). Unionization, on the other hand, is positively related to salaries and profits as well as wages, and in our view represents a response by workers under pressure from management to increase their bargaining power and obtain compensating differentials for harder work (and consequently greater productivity) [FitzRoy and Kraft, 1985c].

We also obtained subjective evaluations of informal "voice" or participation by workers in various areas of decision making. Various more or less arbitrary indexes of participation constructed from questionnaire items turned out to have rather limited explanatory power, as did dummies for individual responses, so we do not consider subjective variables any further here.[7]

Finally, we mention some related results of interest from our data, starting with confirmation of the impression from Table I that owner's profit or return on capital is greater in profit-sharing firms. Simultaneous estimates of profitability and *PROSH* indeed yielded a significant effect of *PROSH* on (gross) profitability (see FitzRoy and Kraft [1985d]). The surprising insignificance of individual incentives I (piece-rates) in our productivity equation is matched by an equally surprising lack of correlation between I and hourly earnings, though some models of incentives under uncertainty can make this result plausible (see FitzRoy and Kraft [1985c]).

All in all, the results of simultaneous Tobit estimation are quite consistent with our theoretical arguments for the influence of even small group incentives on cooperation in the firm. Corresponding single-equation estimates are given in Table IV, and indicate a more significant (but biased) feedback or coefficient of *PROD* in profit sharing, but otherwise rather similar results. The precise specifications for identification purposes are to some extent arbitrary, but the central results described here are very robust, and specification tests were used to justify various excluded variables. The main caveat is the unavoidable omitted variable bias (which affects all work in this area that we are aware of), due to lack of independent proxies for managerial quality. Farsighted managers who introduced profit sharing earliest were probably also farsighted in other matters too, and we have no way of separating the effects of their other decisions from the effect of profit sharing.[8]

IV. Conclusion

In this paper we have argued that valuable cooperative behavior which is difficult to monitor and motivate directly can be

7. In one attempt, in Cable and FitzRoy [1983], the participation index turned out to be nonmonotonic in the individual questionnaire responses and was thus not meaningful.

8. As a historical aside, it is somewhat ironic that Babbage, in many ways a forerunner of the scientific management school a century later, also urged "that a considerable part of the wages received by each person employed should depend on the profits made by the establishment" [pp. 253–54 of 1971 reprint of fourth edition of Babbage, 1835].

TABLE IV
SINGLE EQUATION ESTIMATES

	Productivity (*PROD*) (*WLS*)	Profit sharing (*PROSH*) (Tobit)
Constant	−0.65	−2.31
	(−2.84)	(−3.76)
*ID*2	0.37	
	(2.86)	
*ID*3	0.12	
	(0.92)	
PROSH	0.03	
	(3.76)	
I	0.07	0.19
	(0.39)	(0.42)
WOCO	−0.23	0.47
	(−2.42)	(1.24)
TREXP	0.32	
	(3.88)	
IT	0.36	
	(2.27)	
HERF	0.06	
	(1.90)	
WCAP	5.65	1.99
	(3.19)	(0.35)
PWU	0.09	−0.007
	(3.48)	(−1.26)
JOB	−0.15	0.06
	(−2.30)	(0.22)
UNSKILL	−0.1	−0.07
	(−1.76)	(−1.64)
ATS		0.79
		(1.94)
ATU		0.51
		(1.61)
DIFF	0.19	
	(2.03)	
PROD		0.89
		(2.51)
AGE		0.14
		(8.56)
NEM		−0.00009
		(−0.68)
CAPIN		−0.0005
		(−0.11)
BLUE		0.31
		(3.33)
R^2	0.68	
t-ratios in parentheses		

encouraged by appropriate group incentives under rather natural interdependence assumptions. The rapid growth of interest in profit sharing schemes is related to shifts in technology and work organization which favor cooperation and interaction rather than isolated and routine tasks. In our sample of medium-sized firms both profit sharing and capital sharing have strong effects on productivity (and also on measured profitability). Questions of "causality" cannot however, be answered definitively with our cross-sectional data, and there is a need for more detailed longitudinal and case studies (such as our comparison of two firms [FitzRoy and Kraft, 1984] to understand the dynamics of incentives and productivity development in relation to technology, work organization, and changes in the market environment.

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