Incentives in manufacturing: the carrot and the stick

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To what degree do different incentives substitute for or complement each other in the manufacturing sector? Although this question has received considerable attention on the plant level, relatively little information is available on the subject for the U.S. manufacturing sector as a whole. This study presents the results of a small survey designed to elicit information so as to determine the contours of this important problem.

The study focuses on both positive and negative incentives, that is, the carrot and the stick. *Positive* incentive plans tie the compensation of the individual workers directly with the work that is done and are of two basic types: *Individual incentives* include piecework or various types of bonuses for exceeding norms; *Group incentives* tie the bonus to the performance of the group as a whole, for example, profit-sharing plans, stock ownership plans, bonuses based on aggregative indicators such as production or productivity. *Negative incentives* are threats or actual use of punishment, including financial penalties. These include the hiring of additional supervisors to monitor the performance of workers or firing workers for poor performance. Although some borderline cases can be cited for which it is difficult to determine whether a particular incentive is positive or negative, in most cases the distinction should be relatively clear.

For the most part, both positive and negative incentives are unilaterally imposed, that is management-controlled (but often constrained by union contracts), in contrast to quality circles and labor-management committees which are bilateral or cooperative efforts. I do not analyze these latter measures because they raise a set of considerations far from the major theme of this study.

Because both positive and negative incentives serve many of the same ends, they can be substitutes for each other. However, it is also possible that some incentives are complementary to each other. For instance, a high rate of supervision may lead to a high rate of firing (a conjecture not supported by the data below) or individual and group incentives may accompany each other (a proposition which does receive support). Current economic theory tells us little about such relations of complementarity or substitution; such an analysis must, therefore, be carried out primarily on an empirical level.

The sample

A questionnaire consisting of about 65 questions was sent in the summer of 1981 to a stratified random sample of 2,050 U.S. manufacturing establishments and addressed to the production manager.[1] The questions focused on hourly plant employees and covered not only questions about incentives but also the opinions of the managers about the effectiveness of particular incentives and about the changes in the intensity of work.[2] Three hundred and sixty usable replies were received, and the final sample represents plants employing slightly less than 86,000 production workers (about 0.62 percent of total manufacturing workers). Although the survey is too small to offer conclusive results, a number of propositions are generated which warrant more extensive testing.

The characteristics of the plants in the sample parallel reasonably closely the characteristics of the total universe of U.S. manufacturing plants. The breakdown by two-digit industries (Standard Industrial Classification) is roughly similar to the United States as a whole.[3] The size distribution of plants is quite close to that of the total universe of American plants with 100 workers or more; however, workers in plants with 50 to 99 employees are underrepresented by 40 percent. Therefore, the results obtained should be considered only as reflecting conditions in larger plants and more impersonal working conditions. Geographical distribution of the plants in my survey appears quite similar to the country as a whole[4] and the percentage of unionized workers appears roughly the same as the entire manufacturing sector. In sum, although the sample is not perfect, it appears to reflect the broad structure of the U.S. manufacturing sector except, as intended, for very small plants.

The data collected differ from the compensation surveys of the Bureau of Labor Statistics in two important aspects. The BLS data focus on a narrow range of incentives at the level of the worker, whereas my data focus on a broad range of incentives at the level of plant (for any production workers within the plant).

Positive incentives

Plant managers were asked if they had an incentive plan system for a large proportion of their hourly plant workers and, if so, which of a variety of specified methods they used. Summary results concerning the usage of such plans are presented in table 1.

Problems in presenting the data arise because many plants have more than one positive incentive plan; and in the most disaggregated classification (not given), those plants having plans with positive incentives averaged 1.4 different plans per plant. In the more aggregated classification presented in the table, roughly 30 percent of the plans report more than one type of incentive plan, and 16 percent of all plants (which cover 22 percent of the workers) have both personal and group incentive plans. This multiplicity of various positive incentive plans within a single plant suggest that *at the plant level*, such incentive systems are complementary. It appears likely, however, that *within the plant* different groups of workers may participate in different types of incentive

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Table 1. Reported usage of incentive plans for production workers[1]

[In percent]

Plans	Plants	Production workers
All plants	100	100
Plants with any incentive plans	54	59
With personal incentive plans	31	38
Piecework	16	17
Bonuses for exceeding norms[2]	16	23
Other[3]	2	1
With group incentive plans	32	33
Profit sharing or profit bonuses	21	12
Stock purchase	4	7
Bonuses based on aggregative indicators (production, sales, shipments)	9	14
Sharing cost savings, productivity increases	3	3
With miscellaneous plans	1	0

[1]The data for each category are presented net of all duplications. Hence, the sums of the parts are larger than the reported total, with the differences reflecting the extent to which various plants have several types of plans.

[2]These include plans based on "standard hour" or "standard day" as well as "individual production bonuses."

[3]These include bonuses for good attendance and base-pay increases for "good work."

schemes. For instance, assembly line workers might have group bonuses, while those in subsidiary activities might have individual bonuses.

If we examine the percentage of plants with positive incentive plans by industry, we find enormous variations in both personal and group incentives. In trying to understand this variation, I investigated a number of causal variables and the results can be briefly summarized.

- *Influence of labor unions*: There appears to be no significant relationship between the presence of a labor union and the existence of personal incentive plans; however, group incentive plans (especially profit-sharing or stock-ownership plans for blue-collar workers) are less likely to be found in plants with labor unions. For example, only 19 percent of plants with a majority of hourly workers which are unionized offered a group incentive plan, compared with 44 percent of plants with a majority of nonunion hourly workers.
- *Size of plant*: No interesting relationships were found except that profit-sharing or profit-bonus plans are used mostly in smaller plants.
- *Technology*: I asked the production managers to classify the technology of their plant into one of six types: traditional hand technology, general machining, assembly line, continuous flow technology, machine tending, and other. Only a few significant relations were found (for example, plants using continual process technologies have fewer personal incentive plans). I found no evidence to back Norma W. Carlson's contention[5] that personal incentive plans are less likely to be found in machine-paced production, although the difference in our results may lie in the fact that I tried to classify technology of individual plants, while she characterized the type of technology using an industrial classification.
- *Cost effectiveness of such plans*: It is difficult to determine the cost effectiveness to the manufacturer of using such plans. However, it is noteworthy that the rank order of industries using piecework or personal incentive plans is highly correlated with a similar rank ordering of industry in France.[6] This suggests that use of certain technologies in the production of particular types of goods strongly influences the cost effectiveness of personal incentive plans.

Negative incentives

I asked each manager to designate the number of hourly plant employees for each immediate supervisor. The results (which can be obtained from the author) show a statistically significant and positive relationship between the number of workers per supervisor and the size of the plant. For instance, 21 percent of the plants with fewer than 100 workers had 17 or more production workers per immediate supervisor, while 33 percent of plants with more than 500 workers had this low a degree of supervision. Other factors such as the degree of unionization, the type of technology, and so forth were not found to be statistically related to the degree of supervision.

Among the questions, I asked the production managers to rate the effectiveness of various types of incentives for increasing productivity. Of the 11 different measures provided in the list for that question, "more supervision of workers" numbered among the least effective. However, they did rank "more training of supervisory personnel" the single most effective measure to achieve higher productivity. This suggests that the managers consider the positive help that supervisors can give to their subordinates much more effective in raising productivity than the police role that the supervisors may play.

In addition, I asked the production managers to provide the percentage of workers "fired in the past year for poor job performance." The quantitative results examined by industry are quite similar to previously unpublished BLS surveys on the phenomenon.[7]

The most important causal factor underlying the rate of firing appears to be the degree of unionization. For instance, in plants with a majority of production workers unionized, 5 percent or more workers were annually fired in only 25 percent of the plants; among plants with a majority of nonunion workers, this percentage was 44 percent. Such results parallel the findings of Charles Brown and James L. Medoff[8] and Richard B. Freeman[9], who present quite different types of evidence showing that unionization is inversely related to labor turnover. This phenomenon is more dramatically seen when we examine changes in the rate of firing poor workers when the unionization status of workers has changed. For instance, in my sample, the rate of firing poor workers

increased over the last decade in 33 percent of the plants which are not unionized now but were unionized a decade ago; while this rate increased in only 20 percent of the plants which are now unionized but which were not unionized a decade ago. These results cannot tell us, however, whether the cause of this inverse relationship between labor turnover and unionization is due to the greater "voice" which union workers receive (an explanation offered by Freeman [1980], Brown and Medoff [1978] and others) or is due to union efforts to reduce the rate at which workers are fired.

Are the two types of negative incentives complements to each other (as are the two types of positive incentives) or substitutes? At a particular time, such a relationship cannot be easily seen; however, the time series data suggest strongly that they are substitutes. For instance, where the ratio of supervisors to production workers has increased over the last decade, the rate of firing increased in only 24 percent of the plants; where the degree of supervision has decreased over the last decade, the rate of firing has increased in 42 percent of them. This inverse relationship between changes in the degree of supervision and changes in the degree of firing poor workers means that if plants cannot (either because of pressure from labor unions or other considerations) encourage productivity by firing poor workers, they appear to increase the rate of supervision instead.

Positive and negative incentives compared

Analyzing the degree to which positive and negative incentives are substitutes or complements raises some problems. Because the two types of negative incentives appear to be substitutes for each other, aggregating them and comparing the results with the aggregate results of the positive incentives does not seem a fruitful way of attacking the problem. Instead, a more disaggregative approach is required.

The following is a comparison of some positive and negative incentives by presence of incentive plan and the number of production workers per immediate supervisor:

	Presence of personal incentive plan		*Presence of group incentive plan*	
	Yes	*No*	*Yes*	*No*
Production workers per supervisor				
1 through 8	37	71	37	71
9 through 16	24	97	46	75
17 and over	42	57	20	79
	$x^2 = 13.5$		$x^2 = 8.6$	

The reported chi square statistics (x^2) are uncorrected for the size of the sample. Both of the calculated statistics are significant at the .95 degree of confidence.

The above results suggest that there is a statistically significant inverse relationship between the use of incentive plans (particularly, individual incentive plans) and close supervision of workers. That is, the greater the use of incentive pay systems, the lower the degree of supervisor, and *vice versa*. The relationship is revealed not only at a single point in time but in other calculations where changes in the use of positive incentives and changes in the degree of supervision are examined over time.

Because intensive supervision and the rate of firing appear inversely related to each other and because intensive supervision and the presence of positive incentives also appear inversely related, we might expect to find a positive relationship between the rate of firing and the presence of positive incentives. Although this complementary relationship can, indeed, be found for *particular* types of positive incentives (for example, piecerate) and the rate of firing, such a positive relationship on an aggregative basis is not observed either at a single point in time or over time.

THIS SMALL SAMPLE SURVEY of the American manufacturing sector suggests that positive incentives (individual and group plans) are complementary to each other, that major negative incentives (the rate of supervision and the rate of firing) are substitutes for each other, and that the positive incentives and the rate of supervision are also substitutes for each other.

While it would be possible to carry out a similar survey on a much larger scale, more useful information could be gained if both plant and individual data could be obtained. That is, data on the types of workers within a given plant covered by particular types of incentives would be more useful than the plant data which I have collected. This information would provide a database permitting not only a much closer look at the suitability of particular types of incentives for particular types of workers but also would permit a closer monitoring of some important managerial efforts to increase productivity. Combined with data on plant performance, we could also begin the important task of assessing the *effectiveness* of particular types of incentives. □

———*FOOTNOTES*———

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All comparisons with U.S. manufacturing plants as a whole are made with the universe of plants in 1977, the last year for which detailed data were available to me. Almost all such comparisons are made with the census of manufacturing data for that year.

[1] The names of the plants were obtained from a direct mailing company whose master list was reported to contain 86 percent of all U.S. plants. To reduce the costs of the survey and to increase its coverage of total workers, the questionnaires were sent only to plants with more than 50 reported employees.

[2] The latter results are reported in Frederic L. Pryor, "Some Economics of Sloth," *The Social Science Review*, 5, No. 1 (Fall 1983), pp. 82–102.

[3]The average coverage of production workers is 0.624 percent; the standard deviation of this ratio among the 20 two-digit manufacturing industries is 0.242. The most underrepresented industry in the sample is leather and leather products (SIC 31), followed by rubber and plastic products (SIC 30), and then printing and publishing (SIC 27). The most overrepresented industry is electrical machinery (SIC 36), followed by stone, glass and clay products (SIC 32) and then tobacco and tobacco products (SIC 21). The last industry, although overrepresented by the number of workers, is represented only by one plant. In most of the statistical work underlying this study, I combined the most underrepresented industries into one group.

[4]The Northeast region is somewhat underrepresented and the Deep South is somewhat overrepresented. Otherwise, the representation of the nine census regions is very close to the national distribution.

[5]Norma W. Carlson, "Time rates tighten their grip on manufacturing industries," *Monthly Labor Review*, May 1982, pp. 15–23.

[6]Of the five industries in both the United States and France with the highest percentage of workers covered under such personal incentive plans, four are the same: textile (SIC 22), apparel (SIC 23), transportation equipment (SIC 37), and nonelectrical machinery (SIC 35). Of the five industries in each nation with the least usage of such plans, four are the same: chemicals (SIC 28), rubber and plastic products (SIC 30), food and tobacco (SIC 20 and 21 combined), and wood and furniture (SIC 24 and 25 combined). The French data come from Elisabeth Vlassenko, "L'enquête sur la structure des salaires," *Economie et statistique*, No. 131 (March 1981), pp. 23–35; and *La structure des salaires dans l'industrie et les services en 1978* in *Les collection de l'*INSEE, Séries M., No. 90–91 (March 1981).

[7]A former plant manager raised an interesting objection at this point—namely, that neither my data nor the BLS data on firing are very accurate because of ambiguities arising from treatment of the probationary period that each new worker serves. Before the end of this period, any worker can be "released" with ease; and it is unclear whether such actions are included in either the BLS or my data on fired workers because personnel on the probationary period are not, in a very real sense, regular workers.

[8]Charles Brown and James L. Medoff, "Trade Unions in the Production Process," *Journal of Political Economy*, 86, No. 3 (June 1978), pp. 355–78.

[9]Richard B. Freeman, "The Exit-Voice Tradeoff in the Labor Markets: Unions, Job Tenure, Quits, and Separations," *Quarterly Journal of Economics*, 94, No. 4 (June 1980), pp. 643–74.

Carnegie-Mellon honors BLS Commissioner

Commissioner of Labor Statistics Janet L. Norwood received an honorary Doctor of Laws degree May 14 from Carnegie-Mellon University. The citation read in part:

Economist and statistician, methodological innovator, manager and government leader . . . As Commissioner of the Bureau of Labor Statistics in this its Centennial year, she is the guardian of the nation's two most important statistical series—the unemployment rate and the consumer price index . . .

Her own words and actions present to us the model of a dedicated civil servant and true professional: a commitment to objectivity and fairness, an insistence on candor at all times, protection of confidentiality, the constant pursuit of improvement and a willingness to change, and finally the maintenance of the highest standards of performance at all times . . .