The new Soviet incentive model

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Suppose y is a "performance indicator" for an enterprise. As examples, y might stand for output, profits, cost savings, or factor productivity. With standard piecework reward systems the manager of an enterprise will try to convince his superiors that y is likely to be small, thereby entitling him to a lower target which is easier to fulfill. A new reform in the Soviet economy is aimed at stimulating more ambitious plans by making the bonus size depend on the plan target as well as the degree to which it has been fulfilled. This novel incentive scheme is modelled in the present paper and its basic properties are analyzed. Some applications and extensions are proposed.

1. Introduction

■ Designing a good system of incentives is a problem that has been with us for a long time. In principle, such a system ought to encourage individuals to do what is right by rewarding them for carrying out socially desirable policies. Unfortunately, it is not easy to make an incentive system which is altogether flawless. Sometimes the defects are not evident at first, but they almost always make themselves known eventually.

While the incentive problem is by no means unique to a planned economy, it does take on special relevance in that context. Soviet planners have had mixed degrees of success in grappling with it over the years. Just recently there has been a major reform of the Soviet incentive structure.[1] The new system is quite unlike what went before. It is relatively sophisticated and has some intriguing properties. In the present paper I would like to stress the theoretical side, rather than concentrate on specific administrative or historical details. My hope is that an analysis of the Soviet model may be of interest to a wide audience, since similar problems of motivation and coordination occur in many contexts. Quite possibly this incentive scheme or a variant of it might be applicable to the internal management of a multidivisional capitalist firm or to the regulation of public enterprises in a mixed economy.

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[1] This reform was intended to be instituted during the Ninth Five-Year Plan and was inaugurated in 1971. Conversion over to it seems to have been spread throughout the plan period, and there are reports even now of enterprises changing over. An excellent detailed survey of the new reform, as well as of the background to it, is given in Berliner (1975). Veselkov (1968) contains a good description of the preceding debate about incentive systems. One of the earliest proposals was that of Liberman (1962).

2. The model

■ My aim is to focus directly on the analytical essence of the new reward structure. Naturally a great many other considerations not of direct relevance are going to be abstracted away in doing this.

Suppose for simplicity the planners are concerned with but a single performance indicator, denoted y. Usually y will symbolize output, but sometimes profits, or perhaps productivity, or even cost, depending on the context.[2]

There are two basic incentive problems associated with standard piecework schemes which reward quota overfulfillment and/or penalize quota underfulfillment. The immediate (and probably most important) difficulty is essentially a *static* problem. It is in the interest of the manager (or worker) to convince his superiors that y is likely to be small, thereby entitling him to a lower target and a bonus which is easier to attain.

The static incentive problem thus creates a built-in tendency for target misrepresentation. Planners and enterprises find themselves locked into the tense roles of adversaries in a gaming situation. Fixing targets is a costly procedure and the planners will typically need to hire a team of expert assessors. Even then, there will be bickering about standards on both sides. If the quota is set too low or too high, it has bad consequences all around (and the planners are never really sure, beforehand, what it ought to be).

This brings us to the second or *dynamic* incentive problem, arising out of the tendency of planners to use current performance as a partial basis for setting future targets. Enterprises may be tempted to hold back output in hopes of inducing a smaller quota next time. A target which is set too low will not ordinarily lure enterprise managers to overfulfill by a conspicuous margin because next period's plan target may start off with this period's performance as a point of departure (the well-known "ratchet principle"). Even if above-plan output is not adversely affected, such output is of little use unless it has been anticipated. Setting overtaut targets is also undesirable. Aside from the all around bad morale such action engenders, the ratchet principle may tempt enterprises to fail badly. Then there will be the inevitable supply foul-ups as the plan breaks down, with secondary and tertiary losses multiplying throughout the economy.[3]

Note that the static incentive problem biases enterprise representations of production possibilities downward to induce a lower quota, whereas the dynamic incentive problem biases enterprise performance toward lower fulfillment levels, given the quota. One could try to argue that both incentive problems would be eliminated by doing away altogether with the notion of a target and instead just setting rewards in some fixed relation to realized y. This might be all right for a situation where economic planning is superfluous in the first place, because no coordination is necessary. The primary reason for planning is the need for coordination. In order to have tightly coordinated plans, it really is indispensible to know (at least approximately) who will be producing what. This is especially critical for intermediate goods, where too little can be a disaster, and too much is practically

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[2] In the Soviet context there are currently three major success indicators: value of output, profit rate, and labor productivity. In what follows we implicitly assume that inputs and the product mix are fixed, so that the issue of changing them does not arise.

[3] Manove (1973) and Weitzman (1971) contain discussions of this problem.

worthless. So in planning situations there is a genuine need to have an enterprise reveal *beforehand* approximately what y will be. Hence the unavoidability of dealing with targets or quotas.

By making the bonus *size* depend on the plan *target,* the new reform proposes to counter the built in tendency for managers to underrepresent their potential in seeking low assignments. Analytically the new system works as follows.[4]

There are three stages. In the first or *preliminary* phase the planners (on the basis of their own best current knowledge) assign to the enterprise a *tentative* target $\bar{y}$ and a *tentative* bonus fund[5] $\bar{B}$ for meeting that quota. Also made available is a set of bonus coefficients α, β, and γ, whose role will be explained.[6]

In the second or *planning* phase, the enterprise has the option of selecting a larger (or smaller) plan target y with a correspondingly larger (or smaller) planned bonus fund for meeting it, B, according to the formula:

$$\hat{B} = \bar{B} + \beta(\hat{y} - \bar{y}). \tag{1}$$

However, $\hat{B}$ is only the *planned* bonus fund (which the enterprise *would* receive *if* it actually ended up producing the targeted amount $\hat{y}$). In the third or *implementation* stage, when the enterprise ends up producing amount y it actually receives the bonus fund

$$B = \begin{cases} \hat{B} + \alpha(y - \hat{y}) & : y \geq \hat{y} \quad \text{(overfulfillment)} \\ \hat{B} - \gamma(\hat{y} - y) & : y < \hat{y} \quad \text{(underfulfillment).} \end{cases} \tag{2}$$

The final stage is thus similar to the old system except for one important difference. In the old system $\hat{B}$ and $\hat{y}$ were fixed by the planners, in consultation with the enterprise (thus tempting the latter to understate possibilities). Now $\hat{y}$ and, by formula (1), $\hat{B}$ are selected by the enterprise according to the multistage procedure just outlined.

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[4] The description is based primarily on the supplement to *Ekonomicheskaya Gazeta,* No. 22 (1971), and an article in the same journal, No. 23 (1972, pp. 15–16). While the Soviet authorities are obviously serious about this reform (it is mandatory for every enterprise, and in no sense voluntary or recommended), there is difficulty in assessing the actual economic impact. Sporadic reports indicate that some enterprises may be having trouble understanding or implementing the procedure. There is also journalistic evidence that Soviet planners, themselves, are sometimes uncertain about how strictly the new bonus payment structure should actually be applied *ex post* when unforeseen contingencies arise. My overall impression is that the formulation expressed here is a fair abstraction or idealization of what is essentially a real life procedure. It will be interesting to look at the forthcoming Tenth Five-Year Plan document for clues on the current administrative status of this incentive model.

[5] The *fond material'nogo pooshchreniia,* which can be used for a variety of purposes, including paying out bonuses to managers and workers. See Berliner (1975) for more details.

[6] In principle, the numbers for each year are all set at the beginning of the five-year plan and are intended not to be altered later. This is the situation analyzed in the present paper. It remains an open question what will actually happen, e.g., if the planners see that the economic environment has changed. The instructions contain vague provisions about the possibility of reassigning targets in extraordinary situations. Although all coefficients are clearly intended to be fixed beforehand and unaltered over the five-year plan, we do not yet have enough information to know for sure that this is, in fact, what is generally happening. In the past, authorities have sometimes tinkered with incentive schemes to reduce disparities in bonus funds among enterprises. If this is done in a systematic way, it of course changes the nature of the incentives themselves and thwarts their original purpose.

For the new system to have the proper incentive effects, α, β, and γ must be set so that

$$0 < \alpha < \beta < \gamma. \tag{3}$$

This conclusion has not escaped the attention of Soviet planners[7] and the standards in *Ekonomicheskaya Gazeta* specify that γ shall be at least 30 percent greater and α at least 30 percent less than β.

Notice that the dynamic incentive problem is not altogether eliminated by the new model. There is still a multiperiod gaming problem associated with the tendency of planners to use recent performance as a partial basis for setting future indicators. As under the old scheme, an enterprise suspects that if it performs conspicuously well, its burden will probably be greater later on. The dynamic incentive problem, however, is made considerably less acute in the new system, since the lag between present performance and future target or coefficient setting has been greatly lengthened. In the formal analysis all such multiperiod gaming considerations are suppressed for the sake of analytic simplicity (the dynamic problem is very messy). An enterprise is assumed to act as if it were concerned only about the present period (or as if future targets and coefficients are set independently of present achievements). This allows us to concentrate more directly on the ability of the new model to induce correct revelations in the short run, which is the essence of the static incentive problem.

Now a very basic question which the enterprise must answer is this.[8] What is the optimal self-selected target $\hat{y}$? In their turn, the planners would like to know the answer to the following question. What relation does the optimal self-selected target $\hat{y}$ bear to the actual output y?

First note that if the enterprise knows for sure how much y can be produced, it will always get the maximum bonus by setting $\hat{y}$ equal to that value. This follows directly from examining the consequences of over or underreporting the target when (3) holds. Thus, there is an incentive to be truthful in the case of perfect certainty.

Now suppose a small amount of uncertainty in y, small enough to permit us to use the expected value hypothesis. The probability density function of y is $f(y)$. By hypothesis, the enterprise will choose $\hat{y}$ to maximize the expected bonus:

$$\int_{-\infty}^{\hat{y}} [\bar{B} + \beta(\hat{y}-\bar{y}) + \gamma(y-y)]\, f(y)dy + \int_{\hat{y}}^{\infty} [\bar{B} + \beta(\hat{y}-\bar{y}) + \alpha(y-\hat{y})]f(y)dy. \tag{4}$$

Differentiating (4) with respect to $\hat{y}$ and setting the result equal to zero yields (after cancelling out terms)

$$\int_{-\infty}^{\hat{y}} (\gamma-\beta)\, f(y)dy = \int_{\hat{y}}^{\infty} (\beta-\alpha)\, f(y)dy. \tag{5}$$

Using the fact that $\int_{-\infty}^{\infty} f(y)dy = 1$, the above expression becomes

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[7] Veselkov (1973), for example, lays great stress on it.

[8] There have been other studies of the new Soviet incentive system (for example: Ellman (1973), Fan (1975), Leeman (1970), Sokolovsky (1974)). I think it is fair to say that they have not been so explicit as this one in modeling the analytic side.

$$P(y \geq \hat{y}) = \frac{\gamma-\beta}{\gamma-\alpha}, \tag{6}$$

where

$$P(y \geq \hat{y}) = \int_{\hat{y}}^{\infty} f(y)dy.$$

Thus, the optimal self-selected target is such that the probability of *ex post* plan fulfillment is the ratio of the difference in the coefficients $(\gamma-\beta)/(\gamma-\alpha)$. Note that it is only the relative (to each other) magnitudes of the coefficients which count in determining y.

Out of what looked like a complicated problem comes a simple solution. An optimal plan target lies somewhere between the minimum and maximum possible output levels, at a point where the incentive coefficients determine the percentile level for the probability that it can be met. With α less than β by the same percentage which γ is greater than β, $\hat{y}$ would be chosen as the median value of y. By raising α, lowering β, or raising γ, the planners can induce more conservative (lower) plan targets, $\hat{y}$, which are more likely to be fulfilled. By doing the opposite they can stimulate more ambitious targets.

3. Extensions and conclusions

■ If we introduce risk aversion in the form of a concave utility function, we get an analogous set of results; only now the first-order condition (5) would contain marginal utility (of the bonus) under the integral sign. If the center does not know the enterprise's utility function, in place of strict equality (6) it could only conclude that

$$P(y \geq \hat{y}) \geq \frac{\gamma - \beta}{\gamma - \alpha}, \tag{7}$$

due to the concavity of utility. The more pronounced the decrease in marginal utility, the more conservative the proposed plan target. Otherwise the qualitative properties of a solution are more or less the same as for the expected value hypothesis.

Thus far, output has been treated as if it were a random variable entirely beyond the control of the enterprise. This is a simple case which most easily reveals the analytical essence of the basic incentive problems. But in reality *effort* can also influence output.[9] With extra effort, an enterprise may be able to increase its production possibilities. The effect is to stabilize realized output closer to the announced target level. This helps make the output quota a more meaningful concept to the planners because they can count on it more.

To see this effect most clearly, consider the following simplified scenario. Assume once again a degree of uncertainty sufficiently small to justify linear approximations and the expected value hypothesis. If the enterprise expends no extra effort, or the "usual" effort, the density function of output will be $f(y)$ (as before). But now suppose output can be increased from any level by expending *extra* effort. Let the expenditure of extra effort required to increase output by a unit give disutility equivalent to a loss of γ' from the bonus. If $\gamma' \geqq \gamma$, it does not pay the enterprise to exert the extra effort needed to bring below-target output up to the target level, and we are back in the

[9] For more on this point see Keren (1972).

world of last section's model. If $\gamma' < \gamma$, the enterprise will want to raise what would otherwise be below-target output up to $\hat{y}$ by expending extra effort because the benefit of so doing outweighs the cost. In this case $\hat{y}$ is chosen by the enterprise exactly as before, except that γ' replaces γ in all the formulae. With the new interpretation $\gamma'(\hat{y}-y)$ represents the psychic cost of raising output from y to $\hat{y}$, whereas before $\gamma(\hat{y}-y)$ stood for the penalty cost of falling below the target by amount $\hat{y}-y$. Although the interpretation of the model is somewhat different (since realized output will always be at least $\hat{y}$), the mathematics is identical.

What are the best levels of α, β, and γ from the center's point of view? They should be proportional[10] to: the real social value of having an extra unit which has been prepromised (for β); the real social value of having an extra unit unexpectedly delivered (for α); the real social cost of being unexpectedly caught short by one unit (for γ). Setting the incentive coefficients this way guarantees the enterprise will choose that target level which is socially optimal (in the sense of maximizing the enterprise's contribution to expected national product when the center treats the target *ex ante* as if it stands for the actual output which will be forthcoming). Note that the various social costs and values will differ according to the situation. For example, γ will probably be relatively high for basic intermediate goods and raw materials far back in the production process due to multiplier loss effects.[11] As of the moment, there seems to be no evidence that Soviet planners have seriously analyzed how the incentive coefficients ought to be set.

This seems to be about as far as one can go with a simple model. My own tentative conclusion is that the new Soviet incentive scheme looks like a clever innovation. And it seems to have some nice theoretical properties. But we shall have to wait to see how it works in practice before passing final judgment.[12]

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[10] The proportionality factor should be the *same* for all of the parameters. When effort is irrelevant, the magnitude is arbitrary because of the linearity of the enterprise's objective function under the expected value hypothesis. But when effort matters, the proportionality factor ought to be unity to elicit the socially optimal target.

[11] See Manove (1973) for a full discussion of this sort of thing.

[12] An interesting application of this analysis in our own economy is to the contracting of projects on what is basically a cost-plus formula. In many cases the contractor would like very much to know beforehand what the realized cost of a project will turn out to be. For example, the U.S. government may engage a firm to build and operate a pilot breeder reactor primarily to determine cost and feasibility. Some important policy issues might depend on the magnitude of construction and operating costs, which the government does not really know beforehand nearly so well as the firm. Naturally, the government would like to have the relevant information as soon as possible. Unfortunately, the static incentive problem encourages a misrepresentation of initial cost estimates by the firm so long as it assumes some fraction of cost overruns while sharing a (smaller) fraction of cost savings. But let a three-stage incentive scheme like the model of this paper be used (where y now stands for the (negative of) costs). Then the firm is induced to reveal at the very beginning its own best estimate of future costs.

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