Combining Incentive Schemes with Mechanisms of Counter Planning and Plan Adjustment

Vladimir N. Burkov*,
Mikhail V. Goubko*
*Trapeznikov Institute of Control Sciences of Russian Academy of Sciences, Moscow, Russian Federation (e-mail: mgoubko@mail.ru)

The research is supported by the grant 10-07-00104 of Russian Foundation for Basic Research.

Planning is an essential function of management in an organization. Plans and forecasts help organizations to meet future events and conditions. For instance, sales forecasts are used to calculate production schedules, stock reserves, and purchases. Plan failures result in substantial transaction costs due to overstocks and cash deficiency, or, in contrast, emergency work, imperfect logistics, and violation of delivery terms. The expectable medium output is often preferable to the unplanned success.

A typical planning mechanism met in business is centralized, i.e. the plan is set by a principal to her agents on the basis of historical data, current circumstances, and corporate strategy (see, for instance, Lewis & Sappington, 1997). A disadvantage of such approach is that detailed private information available to agents is missed. A counter planning mechanism where agents are asked for their plans provides an alternative.

Counter planning mechanisms for individual employees were introduced in the late 60th of the XX century in Soviet economy to motivate employees' "enhanced obligations". The responsibility for the plan quality in the process of counter planning is supported by a system of penalties. Now, fees for deviations from the planned consumption level are typical in wholesale energy and natural gas contracts, but are less common within organizations.

Counter planning mechanisms were first studied from the game-theoretic point of view by Burkov (1977). Linear penalties were shown to be enough to achieve any specific desired plan stringency (the probability of plan underfulfilment), which is determined by the ratio $\pi_O/(\pi_U + \pi_O)$, where π_U and π_O are the penalty rates for plan underfulfilment and overfulfilment respectively. Surprisingly, in the linear case the principal need not even know the probability distribution of output to implement the first best. In last decades the counter planning mechanisms were implemented in several industries and demonstrated their applicability and high effectiveness.

Unfortunately, the classic theory fails to explain the absolute values of the optimal penalty rates. In this paper we equip the model of counter planning with agent's planning costs and efforts and immerse it into the moral hazard framework. The aim of the analysis is to develop the policy recommendations on penalty strength. The policy must be simple enough to be used in management consulting projects under time pressure and lack of statistics.

Additional information arrives in the process of plan execution by an agent. When agent's output expectations change during the planning period the principal is interested in plan adjustment. To motivate timely re-planning requests the agent is faced with another system of re-planning penalties of smaller strength, as compared to the plan failure penalties (the idea of early replanning from Burkov, 1977).

From the point of view of the principal-agent theory the counter planning mechanism belongs to the class of hidden-action models. Alike adverse selection framework, agent's private information is not related to his performance. Instead, agent knows the probability distribution of output z given his productive action y, and environment $\theta \in \{\theta_L, \theta_H\}$ (the cumulative probability function is denoted by $F(z, y, \theta)$). Initially, the agent knows $p := \text{Prob}(\theta = \theta_L)$ and can resolve uncertainty about the value of θ with probability $\Delta \in [0, 1]$ at cost $cp(\Delta)$ (Dowd, McGonigle, & Djatej, 2010). Then the agent reports plan x to the principal. After that the agent chooses productive effort y and incurs cost $c(y)$. Then he gets know the exact value of θ and reports adjusted plan x'. Finally, output z is realized.

Efforts y and Δ are not observed by the principal. The principal instead builds the incentive scheme $\sigma(z, x, x')$ for the agent basing on initial plan x, adjusted plan x', and output z.

The payoff of the principal is

$$\Phi(x, x', z) = H(z) - \sigma(x, x', z) - \lambda_1(x, x') - \lambda_2(x', z),$$

where $H(\cdot)$ is the profit function, $\lambda_1(\cdot)$ are plan adjustment expenses, and $\lambda_2(\cdot)$ are losses from the plan failure. Typical incentive scheme is combined from constant payment σ_0, bonus $\sigma_1(z)$, plan adjustment penalties $-\pi_1(x' - x)$, and plan failure penalties $-\pi_1(z - x')$.

Accordingly, the agent's payoff is

$$f(\Delta, x, y, x', z) = u(\sigma(x, x', z)) - c(y) - c_p(\Delta),$$

where $u(\cdot)$ is the utility of money (strictly concave for risk-averse agent).

Analogous to the simplest moral hazard model (Harris and Raviv, 1977) no problem arises in the case of a risk neutral agent, when $u(\sigma) = \sigma$. The optimal combined mechanism replicates principal's profits and costs to an agent, while constant payment σ_0 is chosen to fulfill individual rationality. In the more realistic situation of a risk-averse agent (including the important case of guaranteed payment constraints) a number of biases arise from principal's efforts to maximally secure an agent. We perform the detailed analysis of these biases to justify the following extensively used policy recommendations:

- When $H(z)$ is monotone, the incentive function $\sigma(z, x, x')$ is also monotone in z.
- Any desired plan stringency can be implemented by the principal.
- Plan failure penalties $\pi_1(z - x')$ never exceed $\lambda_2(\cdot)$ and increase when $\lambda_2(\cdot)$ increase.
- $\pi_1(z - x')$ increase when planning costs increase.
- Productive and planning efforts are complementary.
- Plan adjustment penalties increase when plan adjustment expenses $\lambda_1(\cdot)$ increase.

1. *Burkov V. N.* Osnovy matematicheskoi teorii aktivnykh sistem (Fundamentals of the Mathematical Theory of Active Systems), Moscow: Nauka, 1977.
2. *Dowd J., McGonigle W., Djatej A.* The optimal level of budgetary goal difficulty: an experimental study. International Journal of Managerial and Financial Accounting. 2010. Vol. 2(2), P. 153 – 160.
3. *Harris M., Raviv A.* Optimal incentive contracts with imperfect information // Journal of Economic Theory. 1979. Vol. 20. No 2. P. 231 – 259.
4. *Lewis T.R., Sappington D.E.M.* Information Management in Incentive Problems // Journal of Political Economy. 1997. Vol. 105(4). P. 796 – 821.