

# Non-stationary model of public-private partnership

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An important part of problems of natural and resource complex of Russia is devoted to development of the mechanism of public-private partnership (PPP). As a rule, the investor cannot start an investment project due to a lack of the necessary infrastructure. On the other hand, the state officials are unwilling to invest in infrastructure without guarantee that it is used efficiently. Practical examples of the solution of this problem are not really successful in the Russian conditions. Thus, we are interesting in the following question: what economic and mathematical tools should be used for designing efficient PPP models in the Russian context?

To describe adequately the interaction hierarchy between the state and the private investors in the natural resources sector, we use the concept of the Stackelberg equilibrium. The relevant economic and mathematical tools are based on the Stackelberg games and the mixed integer bi-level programming models. This approach ensures long-term efficiency for the state as well as for the private investors.

Recently, a stationary PPP models were considered assuming that the start of each project is included in the input data. In this paper, we study so-called non-stationary model. A general technological description of production, infrastructure and ecological projects are input information of the bi-level model. The start of each project is a variable, and the ranges of possible mutual temporary lags of projects of various types are given. As a result, we can find a subset of the most profitable projects of all types and their schedule for the state and investors. We design stochastic local search algorithm for this bi-level model and use CPLEX software for solving the investor's sub-problem at each step of the algorithm. Computational experiments are conducted on special polygon of test instances based on the mineral resources of the Trans-Baikal territory. Our experimental results illustrate that the approach can be used as a basic tool for long range strategic planning of the mechanism of public-private partnership.

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