# Evolutionary-Simulative Methodology in the Management of Social and Economic Systems

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**Abstract.** The article outlines the main provisions of the evolutionary-simulative methodology (ESM) which is a methodology of mathematical modeling of equilibrium random processes (CPR), widely used in the economy. It discusses the basic directions of use of ESM solutions for social problems and economic management systems.

## 1 Introduction

Evolutionary-simulative methodology (ESM) is a methodology of mathematical modeling of equilibrium random processes (CPR). The discovery of CPR, the development of ESM, the creation Decision, the system providing instrumental optimal decision making in risk conditions and uncertainties, enable to implement programmatically the mathematical models CPR, designed by V.E. Liechtenstein and G.V. Ross [1, 2], the authors.

Based on ESM they have been developed the models of various objects and processes in economics, physics, biology and robotics [2–5]. It has been created CPR, the theory [1, 2], which managed to build on the axiomatic principle. The main scientific results are protected by the following patents: "A method for optimizing the characteristics of equilibrium stochastic process" [6]; "Method of optimal control equilibrium stochastic process" [7]; "The method for selecting the external environment parameters agreed with the optimal management of equilibrium stochastic process" [8].

Reporting about Decision computer system is placed on the site of high technologies in Russia [9]. To date, as part of this research area they were defended more than 30 doctoral and master's theses.

## 2 Evolutionarily – simulative methodology

ESM includes generalized (structural) formulation of evolutionary-simulative model represented by correlations presented below in (1) - (9) and universal search optimization algorithms realized in Decision. Let us consider the evolutionary-simulation models, following 1.3 in [3].

$$Fa_1 = \rho_1(f_1, \ldots, f_n) \quad (1)$$

$$Fa_2 = \rho_2(f_1, \ldots, f_n) \quad (2)$$

$$F_1 = \rho_3(PL, Fa_1, f_1, \ldots, f_n), \text{ if } PL > Fa_1 \quad (3)$$

$$F_2 = \rho_4(PL, Fa_2, f_1, \ldots, f_n), \text{ if } PL < Fa_2 \quad (4)$$

$$\Phi(PL, Fa_1, Fa_2) = \{F_1, \text{ if } PL > Fa_1 \text{ and } F_2, \text{ if } PL < Fa_2\} \quad (5)$$

$$\min_{PL}\{max\{M\{F_j\}\}\}, j \in \{1;2\} \quad (6)$$

$$\min_{PL}\{M\{\Phi(PL, Fa_1, Fa_2)\}\} \quad (7)$$

$$P(PL > Fa_1) = P^0 \text{ or } P(PL > Fa_2) = P^0 \quad (8)$$

$$r = \rho_5(PL) \quad (9)$$

Symbols and meaningful sense of correlations (ratio - ?) is convenient to consider as an example marketing planning tasks. A block diagram of planning is shown in Fig. 1.

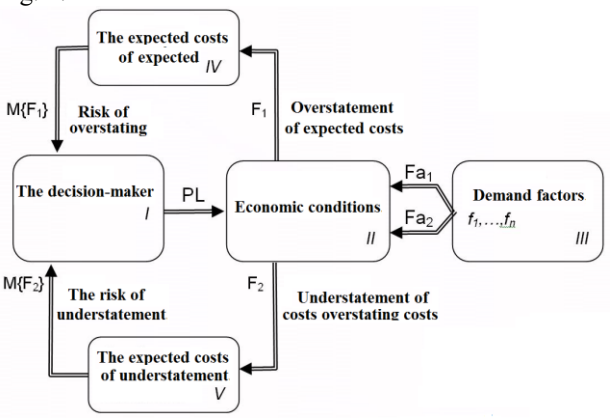


**Fig. 1.** Block diagram of the control based on the planning.

The decision-maker (DM) (block I), at the beginning of the plan period sets the sales plan (marked as *PL*), and by the end of the planning period it appears the actual volume of sales ($Fa_1$ – excluding sales outside the market, such as pre-signed contracts; $Fa_2$ - with their account). $Fa_1$ and $Fa_2$ depend on random factors (Block III), such as for example: the number of buyers ($f_1$),

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income buyers ($f_2$), customer preferences ($f_3$), rivalry ($f_4$), the comparative quality of goods ($f_5$), and others.

Sales Plan *PL* deterministic, and the actual volume of sales and $Fa_1$, $Fa_2$ — random variables. It is possible one of two situations: $PL > Fa_1$, or $PL < Fa_2$. If the plan proved to be more than demand, i.e., if $PL > Fa_1$, the economic environment (Block II) determine the costs of overvaluation (marked as $F_1$) and the risk of overstatement (marked as $M\{F_1\}$, where $M$ — a sign of the expectation). Costs of overstatement — it is the costs of queue time or waiting time and loss of quality of the goods in the amount of $PL - Fa_1$, as well as the freezing of funds invested in its production. If the plan was less demand ($PL < Fa_2$), then there are the costs of understating (marked as $F_2$) in the form of lost profits from the pent-up demand in volume $Fa_2 - PL$ and the loss of market share. In developing the plan a decision maker is trying to anticipate the expected costs of overstatement (unit IV) and understating costs (block V), and to compare risks.

Psychologically, the risk of overstatement $M\{F_1\}$ – this irrational fear of a decision maker to spend funds ("cowardice"), and the risk of understating $M\{F_2\}$ – fear of missed profit ("greed"). Moderate presence of these sensations is necessary for proper intuitive orientation in the environment. Charts of risk depending on the plan are shown on Fig. 2.

The risk of overstatement is presented by nondecreasing dotted line, and understating risk – not increasing dotted line with a dot. The solid line represents a risk difference module of overstatement and understatement. PL Plan, in which the difference between the risk of overstatement and understatement turns to zero, is the optimum by the criterion (6). It is proved (see chap. 3 in [2] or [16]) that the risk of balance concept of overstatement and understatement is a generalization of the concept of balance of demand and offers, that is, that the PL plan which is optimum by the criterion (6), is the optimal by correlation on demand and offers. The fine dashed line is a graph of the amount of risk lines. PL plan of the minimal amount of the risk, is optimal by the criterion (7).

The meaning of the model correlations (1)–(9) is that:

– ratio (1) and (2), they indicate that the dependence of demand of $Fa_1$ and $Fa_2$ and factors $f_1$, ..., $f_n$ is represented in the form of simulation models $\rho_1$ and $\rho_2$;

– ratio (3) and (4), they indicate that the dependence of overstatement costs of $F_1$ and understating costs $F_2$ respectively the *PL*, the fact $Fa_1$ (or $Fa_2$) and factors $f_1$, ..., $f_n$ are represented in the form of simulation models and $\rho_3$ $\rho_4$;

– ratio (5), it introduces a penalty function $F$;

– ratio (6), it expresses the minimax principle of optimality, which is used in the planning of (at least the solid line in Fig. 2);

– ratio (8) shows the probability $P^0$ of meeting or even exceeding (reliability) of PL plan;

– ratio (9) indicates the existence of a vector calculation indices $r$, dependent on the optimum sales plan *PL*.

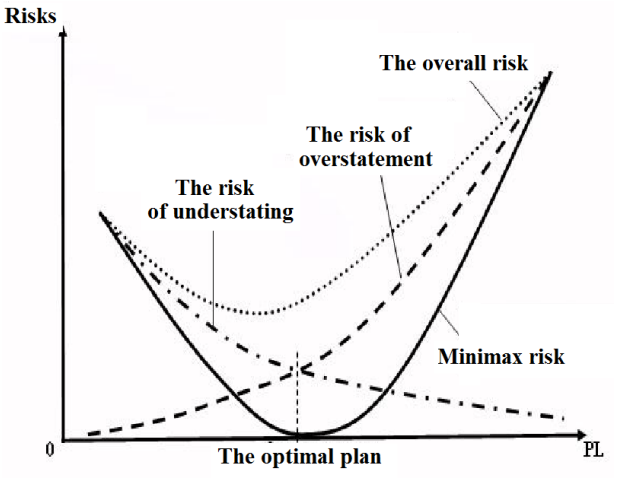


**Fig. 2.** Market risks and minimax strategy of the company in the market.

Evolutionary-simulative model has three modifications, each of which provides a mathematically correct definition of the PL optimal plan:

1) comprises of (1)–(6) and (9);
2) comprises of (1)–(4), (7), (9);
3) relation comprises of (1), (8), (9) or (2), (8), (9) (it is applicable if known beforehand reliability $P^0$).

## 3 Conclusion

There are several areas of application of ESM in the management of social and economic systems. Some of these areas can be called traditional in the sense that the ESM opens the possibility of developing new, more effective and versatile tool to solve traditional business tasks, such as marketing planning (ch. 3 [3]), forecasting and planning of various processes and trends in microeconomics (inflation, taxation, etc., 4.2 in [3]) and macroeconomics (the budget, employment and others., 5.2 in [3]), the valuation of stocks (ch. 1 in [3]) and al.

In addition, ESM provides new direction for the economy. Based on the ESM was able to formulate and prove a number of theorems (see chap. 3 in [2] or [16]), which reveal the mechanisms of negative tendencies and processes, such as randomization (Chapter 4 in [5]), economic measurement distortion (Chapter 3 [5]), lack of control of financial flows (chapter 3 in [2]).

It follows from the theory that the primary source of all problems is the formation of total and global criterion of maximizing the average unit profitability with taking into account the risks (denote the *D*) (see. [17]). Every economic agent is increasingly forced to rely on the criterion $D \rightarrow \max$. The state, not in opposition to the market, is intended to rid the economy of the criterion $D \rightarrow \max$.

This criterion should be replaced by a requirement of economic justice, for which it is necessary to maintain approximate equality *D* for the economic agents and activities. And we are not talking about how to withstand this equation perfectly. In this case, they will stop all movement of capital and lost the incentive to rivalry and

economic competition. ESM allows the creation of tools for management of these processes.

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