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Framework of Equilibrium Random Processes for Assessing Monopolisation and Demonopolisation

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Abstract. This study analyses the interrelations and behaviour of economic entities (EEs) under market and planned economy conditions in Russia. It identifies the objective regularities that lead to specific cycles of increasing and decreasing levels of monopolisation and demonopolisation. The main causes and consequences of firm proliferation and market concentration are examined. It is shown that the processes of market and planned economies can be described within the framework of the theory of equilibrium random processes (ERP), which is based on an evolutionary-simulation methodology implemented through evolutionary-simulation models (ESMs). An algorithm is proposed for firm behaviour under both planned and market conditions, enabling the simulation of production planning and management under uncertainty. Formal formulations of decision-making problems in market and planned environments are presented in terms of evolutionary-simulation models. Examples of modelling the operation of EEs in both types of economies are provided, along with an analysis of equilibrium mechanisms applied in market and planned economic systems. The results make it possible to assess the fundamental characteristics of the relationships between industries and the state. This picture becomes more comprehensive when considering the specific nature of natural monopolies and the socio-economic significance of bureaucratic structures – essential components of both monopolies and the state.

Keywords: market, plan, equilibrium random processes, evolutionary-simulation model, overestimation risk, underestimation risk, instrumental system "Decision", monopolisation and demonopolisation.

1. Introduction

The difficult economic situation caused by numerous sanctions has raised questions for both citizens and the authorities regarding methods for overcoming the resulting challenges. Many believe that the solution lies in already proven methods: a planned economy, increased state influence, and the use of other non-market instruments. In each specific case, the market and the plan appear as alternative mechanisms for the interaction of economic entities (EEs): one can act either to satisfy market demand or to fulfil a plan. The scope of application of market and planned mechanisms is closely related to ownership distribution: interactions between EEs belonging to the same legal entity (LE) are typically plan-based, while interactions between different LEs are market-based. Under these conditions, several key questions arise: Can a plan completely replace the market? Can they coexist, complement, and support each other? Can a planned economy exist under capitalism? A considerable number of studies suggest that in practice, market and plan often manage to coexist successfully. The answers to these questions have significant practical importance for making decisions about monopolisation and demonopolisation

mechanisms, mergers and acquisitions, and the division of large entities into smaller, independent legal entities. The study of these processes earned the Anglo-American economist Ronald Coase the 1991 Nobel Prize in Economics. According to Coase, even in the presence of externalities, market mechanisms can and should be used – provided that property rights, responsibilities, and appropriate legislation are properly established.

The objective of this article is to develop methods for assessing the efficiency of economic entities (EEs) operating within planned and market economies using the theory of equilibrium random processes (ERP) [1, 2]. The fundamental elements of ERP theory were laid out in the works of V.E. Lichtenstein [1, 2, 3, 6]. In our view, ERP theory can help define specific goals and provide the tools needed to assess the efficiency of market and planned economic mechanisms. ERP theory demonstrates that: The behaviour of an EE, regardless of whether it follows a plan or is guided by market demand, belongs to the class of equilibrium random processes; Behavioural models of EEs under both systems can be constructed using the evolutionary-simulation methodology (ES method); and By employing evolutionary-simulation models (ESMs), it is possible to develop methods for comparing the economic efficiency of enterprises operating under market and planned systems within specific contexts.

Examples are provided comparing the formal mathematical models of economic entities (EEs) in market and planned economies, as well as experimental studies that have revealed the following: the presence of equilibrium random processes (ERPs) in both market and planned systems; the structural identity of their mathematical formulations (the behavioural models of EEs differ only in the semantic interpretation of variables); and the possibility of mutual transformation between the two systems – the market economy evolves into a planned economy as monopolisation increases, while the planned economy evolves into a market economy as demonopolisation progresses [1, 2, 3, 4, 5, 6].

2. Background of Monopolisation and Demonopolisation

Perfect Competition is a market situation in which there exists a large number of independent suppliers offering a homogeneous product (that is, one indistinguishable in quality), as well as a large number of independent consumers of that product. Neither any individual supplier nor any consumer is large enough to influence the aggregate supply or aggregate demand. The only permissible form of interaction among market participants is exchange. The state does not intervene in these exchanges or exert any other form of influence on participants, but ensures the protection of property rights and the compliance of all actors with common rules of exchange.

Under conditions of perfect competition, the market operates in the most efficient manner. Situations approaching this ideal are found primarily in commodity exchanges. Outside such exchanges, the conditions of perfect competition are inevitably violated. In reality, the market structure of imperfect competition is a combination of natural monopolies, oligopolies, and monopolies (including state monopolies), monopsonies, and various forms of market entry restrictions.

In modern terms, a natural monopoly refers to a company that, due to the

inherent features of its technology and production organisation, achieves greater cost efficiency as production scales up. This interpretation of a natural monopoly provides the most reasonable explanation of why monopoly is not only possible but sometimes even necessary within a market economy. In addition, there exists a sphere of non-market goods and services. As noted in the description of perfect competition, the role of the state is to guarantee property rights and enforce compliance with the rules of exchange. To this, one must also add other essential state functions such as ensuring national security, maintaining domestic political stability, and others – all of which fall within the domain of non-market goods and services.

The boundaries between the spheres of monopolies and oligopolies, the “pure market,” and the state are neither stable nor immutable. There are many reasons why these boundaries continuously shift and evolve. Well-designed legislation allows the market to penetrate ever new areas of activity. A characteristic example of such expansion is the phenomenon of externalities – that is, external costs or effects of production and consumption that impact the environment: forests, air, water basins, and human health. In principle, externalities can be not only harmful but also beneficial or profitable. For example, bees raised for honey production simultaneously pollinate nearby orchards, producing a positive external effect.

It would seem quite obvious that externalities belong to the category of non-market goods or services. Even one of the founders of monetarism, Milton Friedman, acknowledged that the potential harm caused by market forces makes state intervention fundamentally necessary – for instance, through budgetary funding of relevant programmes, the establishment of permissible pollution standards, monitoring mechanisms, penalties, and taxation. Nevertheless, even this sphere is constantly penetrated by the market.

The study of these processes earned Ronald Coase the 1991 Nobel Prize in Economics. According to Coase, even in the presence of externalities, the market can – and indeed should – be employed, provided that property rights, responsibilities, and appropriate legislation are properly established [3].

Following this, Coase’s ideas gained wide recognition. Large-scale experiments began to be conducted in ecology and other fields traditionally considered beyond the reach of the market. It turned out that without the market – just as without command methods – high efficiency is unattainable anywhere. This assertion has come to be known as the Coase theorem [4].

The relationship between the state and the market, or more precisely, between administrative-command management methods and market self-regulation, has another important dimension, in which Coase also made significant contributions. He posed several fundamental questions:

- Why is a “completely” market-based system, in which all interactions are voluntary bilateral exchanges of buying and selling impossible?
- Why does part of economic activity take place within firms and rely on administrative subordination of employees?
- Why cannot the entire system of economic relations be organised as a super-giant firm based entirely on administrative-command relationships?
- Why is a planned socialist economic system impossible without the market?
- Does there exist an optimal balance between the market and administrative-command systems within the economy?

The answer to the first two questions follows from the dependence of transaction costs on the average size of a firm. The smaller the market entities become, the higher their costs for information search and property rights protection. In some cases, the growth of transaction costs can be quite steep. Therefore, the introduction of intra-firm organisational and managerial structures allows for a reduction in transaction costs and is, consequently, economically advantageous.

The answers to the next two questions stem from the dependence of management costs and managerial efficiency on firm size. As a firm grows, the costs associated with the bureaucratic apparatus increase, while inefficiencies in the management system also become more significant. This relationship was studied not only by Coase but also by other prominent economists, including Nobel laureate John Kenneth Galbraith, who focused mainly on the U.S. economy, and the Hungarian economist János Kornai [5], a recognised authority on the analysis of the socialist economic system.

These scholars convincingly demonstrated that the expansion of firms is usually accompanied by two correlated phenomena: the growth of internal and external lobbying, and the oligopolisation or even monopolisation of certain market sectors. Lobbying serves as a universal mechanism operating across all bureaucratic structures – governments, regional administrations, and corporate leadership alike. It is this mechanism that shapes goal-setting within managerial systems. Galbraith argued that an expanding bureaucracy redirects a firm's activities towards extensive expansion rather than profit generation, while Kornai identified a mechanism of rising costs with increasing bureaucratisation. The essence of this mechanism lies in the tendency of monopoly bureaucracies to secure guaranteed demand, which initially creates local, and subsequently system-wide, shortages that can ultimately paralyse the entire economy. For this reason, the final stage of a planned economic system inevitably results in total monopolisation and total deficit [5]. The main causes and consequences of firm expansion and monopolisation are illustrated in Fig. 1.

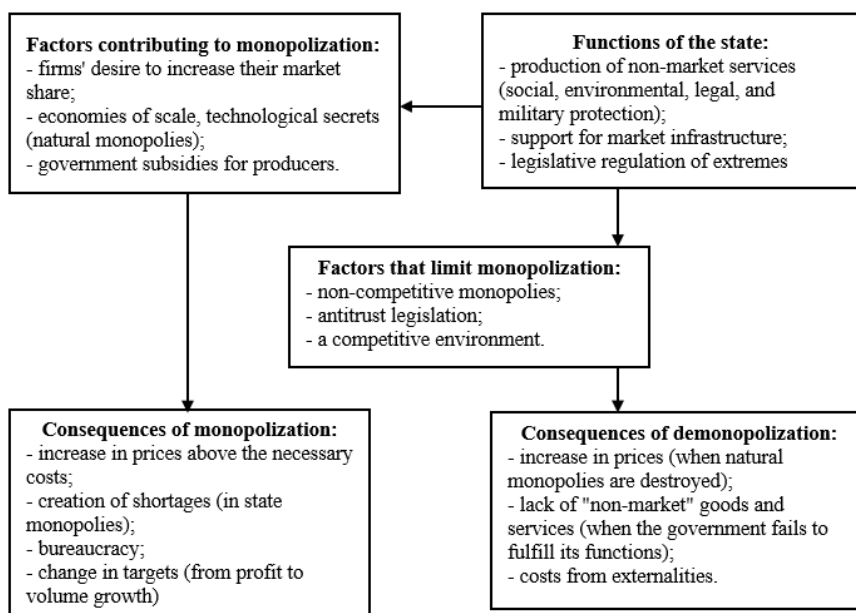


Fig. 1. Monopolisation: causes and consequences.

In summary, a decrease in the average size of firms leads to an increase in transaction costs, while an increase in firm size results in higher bureaucratic costs and inefficiency. The answer to the final question therefore follows naturally: 'Is there a regular relationship between the market and the administrative-command system in the economy? According to Ronald Coase, this equilibrium is determined by the point at which transaction costs equalise with bureaucratic costs, and it determines the average efficient size of firms.

3. Behaviour of a Firm in a Planned Economy and in Market Conditions

A firm's behaviour consists of making decisions and implementing them [7, 8, 9, 10, 11, 12]. These results are analysed and taken into account when new decisions are made. As previously noted, decision-making under conditions of uncertainty is associated with risk, which has a dual nature. On the one hand, there is the risk of making an overly optimistic decision (overestimation risk); on the other hand, there is the risk of making an overly pessimistic decision (underestimation risk).

Psychologically, overestimation risk is perceived by the decision-maker (DM) as a fear of wasting resources irrationally ('cowardice'), while underestimation risk is perceived as a desire to avoid missing potential opportunities ('greed'). Maintaining correct intuitive orientation in a complex environment requires a moderate presence of both attitudes. Thus, cowardice and greed act as opposing forces that influence the adoption of rational economic decisions. Ultimately, they determine the behaviour of the decision-maker (whether an individual or a legal entity) and consequently the behaviour of the firm itself.

Therefore, overestimation and underestimation risks serve as real motivational factors that shape firm behaviour. To study their economic significance

and quantify these intuitive notions, specialised analytical tools have been developed, specifically the 'Equilibrium' module within the 'Decision' system.

A simplified block diagram of firm management is shown in Fig. 2 [1]. The decision-maker (DM) (Block 1) prepares a sales plan (PL), which is usually expressed in physical units. Clearly, the plan must be established before the start of the planning period during which it is to be implemented.

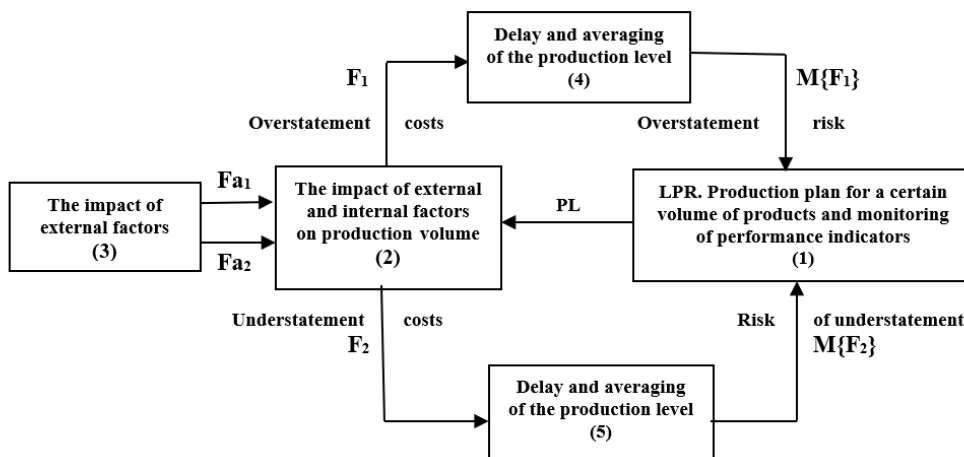


Fig. 2. Block diagram of production plan management under uncertainty.

The implementation of the plan occurs under the influence of external random factors

$\bar{f} = f_1, \dots, f_n$ such as the number of potential buyers, their incomes, preferences, the level of competition, and so forth (Block 3 of Fig.2). As a result, the actual sales volume usually differs from the planned one. At the same time, sales outside the target market sector are often observed. If Fa_1 represents the total volume of sales, including additional sales possibly made outside the considered market sector, and Fa_2 represents the aggregate volume of sales within the sector under consideration, then the difference $Fa_1 - Fa_2$ corresponds to sales outside the target sector.

The economic conditions (Block 2) in which the firm operates include tax legislation, market conditions, production technologies and organisation, methods of storage and transportation, and other factors. These conditions determine the costs arising from discrepancies between actual and planned outcomes.

In particular, if the plan is not fulfilled – i. e., if $p_L > Fa_1$ – then the goods in the volume $p_L - Fa_1$ remain unsold (stored for long periods) or even perish. This leads to overestimation losses F_1 : storage costs, quality deterioration losses during storage, and capital immobilisation in unsold goods. Conversely, if the sales plan is lower than the effective market demand – i. e., if $p_L < Fa_2$ – then underestimation losses F_2 arise, expressed in the form of missed revenue, lost profit, and diminished market share. All of this could have been achieved if a larger volume had been planned and, consequently, prepared in advance.

The decision-maker (DM) learns the size and structure of these losses not immediately – not at the moment of decision-making, but later, once the decision has

not only been made but also executed, that is, after the completion of the planning period. Moreover, there is not only a time lag, but also an averaging of overestimation and underestimation losses with those incurred from previously implemented plans (Blocks 4 and 5). The average losses are denoted as

$$M\{F_1\} \text{ and } M\{F_2\},$$

where M represents the mathematical expectation.

Thus, we obtain a feedback-based control scheme, where the DM receives the results of the decision in the form of various types of losses. What, then, is the task of the decision-maker (DM) in this situation? What decision should they make?

Under conditions of uncertainty, several behavioural strategies are possible. A particular feature of a planning task is that the plan (unlike a normative standard) is applied only once. For each new planning period, product, or market sector, a new plan must be developed. It follows that once a plan has been adopted and implemented, only one of the two risks is realised – either the overestimation risk $M\{F_1\}$ or the underestimation risk $M\{F_2\}$, but not both simultaneously. In such conditions, it is necessary to apply the so-called minimax strategy – in other words, to act in a way that minimises the greater of the two risks. Any residual risks may then be compensated through insurance mechanisms [7].

4. Evolutionary-Simulation Models for Describing Market and Planned Economic Mechanisms

To construct a mathematical model of the desired equilibrium, it is important to note that the behaviour of an economic entity (EE) operating in a planned economy – as well as in a market environment – can be represented as a system of relations (1)–(8). These relations form a mathematical model of firm behaviour in the market, also referred to as a marketing planning model.

$$\bar{f} = f_1, \dots, f_n \quad (1)$$

$$\bar{p} = p_1, \dots, p_n \quad (2)$$

$$F_{a1} = r_1(\bar{f}, \bar{p}) \quad (3)$$

$$F_{a2} = r_2(\bar{f}, \bar{p}) \quad (4)$$

$$F_1 = q_1(PL, F_{a1}, \bar{f}, \bar{p}) \quad (5)$$

$$F_2 = q_2(PL, F_{a2}, \bar{f}, \bar{p}) \quad (6)$$

$$\Phi(PL, F_{a1}, F_{a2}, F_1, F_2) = \begin{cases} F_1, PL \geq F_{a1} \\ F_2, PL < F_{a2} \end{cases} \quad (7)$$

$$\min_{PL} \{ \max_i \{ M\{\Phi(PL, F_{ai}, F_i)\} \} \quad (8)$$

In this model: Equation (1) introduces the notation for the vector of factors (random variables); Equation (2) defines the notation for the indicators (conditionally constant values).

From equations (3) and (4) it follows that F_{a1} and F_{a2} depend on the factors $\bar{f}$ and indicators $\bar{p}$, and that the forecasted realisations of F_{a1} are obtained using

the simulation model r_1 , while the forecasted realisations of F_{a2} are obtained using the simulation model r_2 .

Equations (5) and (6) show that the overestimation losses F_1 and the underestimation losses F_2 depend on the planned values, the actual results, as well as on the factors $\bar{f}$ and indicators $\bar{p}$, and that the forecasts of F_1 and F_2 are obtained using the simulation models q_1 and q_2 , respectively.

Condition (7) expresses the rule for calculating costs, while Condition (8) represents the optimality criterion, reflecting the minimax strategy of firm behaviour in the market.

In administrative-command structures, in addition to the planning system, there necessarily exists a system of incentives. In the simplest case, under a totalitarian regime, such an incentive system may be based on non-economic coercion. However, it is also possible, at certain periods of time, to organise the management of a firm's activities through a system of economic incentives, whereby specific financial sanctions are imposed for both over-fulfilment and under-fulfilment of plans. Such a system serves to encourage the establishment of ambitious plans and to stimulate their implementation.

The behavioural model of an economic entity in a planned economy differs from that in a market economy in the semantic meaning of the variables. In a planned economy:

$\bar{f} = f_1, \dots, f_n$ are factors of production (rather than factors of demand, as in a market economy);

$\bar{p} = p_1, \dots, p_n$ denote the indicators of production organisation (in particular, parameters such as the size of bonuses and potential penalties);

F_{a1} and F_{a2} are the actual production volumes (not the actual volumes of demand);

$F_{a1} = r_1(\bar{f}, \bar{p})$ and $F_{a2} = r_2(\bar{f}, \bar{p})$ represent models of organisational and technological production processes (rather than models of effective demand formation).

F_1 and F_2 denote the bonuses and penalties for over-fulfilment and under-fulfilment of the plan, respectively, in accordance with the existing system of economic incentives (rather than the losses from frozen capital or forgone income);

$F_1 = q_1(PL, F_{a1}, \bar{f}, \bar{p})$ and $F_2 = q_2(PL, F_{a2}, \bar{f}, \bar{p})$ are models of the economic incentive system, that is, the established rules for calculating bonuses and penalties (rather than models for estimating the costs of unsold goods and lost profits).

PL^{plan} is the production plan, independent of demand (as opposed to the marketing plan, denoted PL^{market}). Table 1 clearly illustrates the similarities and differences between the formulations of a firm's behavioural model under market conditions and within a planned economic system.

Table 1. Equilibrium Models of Enterprise Behaviour under Market and Planned Conditions

Market model (perfect competition)	Planned economy model (net monopoly)
$\bar{f} = f_1, \dots, f_n$ } demand factors and $\bar{p} = p_1, \dots, p_n$ } baseline indicators	$\bar{f} = f_1, \dots, f_n$ } demand factors and baseline technolo $\bar{p} = p_1, \dots, p_n$ } and production organization
PL^{market} – sales marketing plan	PL^{plan} – production plan

$\left. \begin{matrix} F_{a1} = r_1(\bar{f}, \bar{p}) \\ F_{a2} = r_2(\bar{f}, \bar{p}) \end{matrix} \right\}$ effective demand	$\left. \begin{matrix} F_{a1} = r_1(\bar{f}, \bar{p}) \\ F_{a2} = r_2(\bar{f}, \bar{p}) \end{matrix} \right\}$ production forecast
$F_1 = q_1(PL^{\text{market}}, F_{a1}, \bar{f}, \bar{p})$ – overestimation costs associated with the production of a part of the goods that could not be sold at the intended price on time	$F_2 = q_1(PL^{\text{plan}}, F_{a1}, \bar{f}, \bar{p})$ – overstatement costs associated with excess inventory and premium fund expenses
$F_2 = q_2(PL^{\text{market}}, F_{a2}, \bar{f}, \bar{p})$ – costs of understatement, i. e. lost revenue due to loss of market share or undervaluation	$F_2 = q_2(PL^{\text{plan}}, F_{a2}, \bar{f}, \bar{p})$ – understatement costs related to downtime, imbalances, fines and penalties
$\min_{PL} \{ \max_i \{ M \{ \Phi(PL^{\text{market}}, F_{ai}, F_i) \} - \text{equilibrium condition} \}$	$\min_{PL} \{ \max_i \{ M \{ \Phi(PL^{\text{plan}}, F_{ai}, F_i) \} - \text{optimality criterion} \}$

In a market system, all risks are borne by the firm itself, whereas in a planned economic system, the risks primarily fall upon the planning authority, which may operate outside the firm – for example, a state planning body such as Gosplan in the former USSR.

Since $\min_{PL} \{ \max_i \{ M \{ \Phi(PL^{\text{market}}, F_{ai}, F_i) \}$ represents the mathematical expectation of business operating costs under market conditions, and $\min_{PL} \{ \max_i \{ M \{ \Phi(PL^{\text{plan}}, F_{ai}, F_i) \}$ represents the mathematical expectation of the planning authority's costs under a planned economic system, it follows, according to Coase, that the equilibrium between market and administrative-command structures is determined by the condition:

$$\min_{PL} \{ \max_i \{ M \{ \Phi(PL^{\text{market}}, F_{ai}, F_i) \} = \min_{PL} \{ \max_i \{ M \{ \Phi(PL^{\text{plan}}, F_{ai}, F_i) \} \quad (9)$$

1) To enable practical calculations, it is necessary to have specific models of the economic entity's behaviour. As a behavioural model under market conditions, we will use Model MM1, which was discussed in detail in [7].

2) As a behavioural model of an economic entity in a planned economy, let us consider the following simple model – Model MM3. Let: f_1 – number of employees (persons); f_2 – number of working days; f_3 – average output per employee (RUB/day); PL – planned output (RUB); p_1 – bonus payments from the incentive fund for plan over-fulfilment (%); p_2 – penalties imposed for plan under-fulfilment (%).

The relationships of Model MM3 are as follows:

$$F_{a1} = F_{a2} = f_1 \times f_2 \times f_3 - \text{total output} \quad (10)$$

$$F_1 = (PL - F_{a1}) \times (p_1 / 100) - \text{total bonus payments from the incentive fund for plan over-fulfilment} \quad (11)$$

$$F_2 = (F_{a2} - PL) \times (1 - p_2 / 100) - \text{budget losses due to plan under-fulfilment} \quad (12)$$

$$\Phi(PL, F_{a1}, F_{a2}, F_1, F_2) = \begin{cases} F_1, PL \geq F_{a1} \\ F_2, PL < F_{a2} \end{cases} - \text{penalty function} \quad (13)$$

$$\min_{PL} \{ \max_i \{ M \{ \Phi(PL^{\text{plan}}, F_{ai}, F_i) \} - \text{optimality condition} \} \quad (14)$$

$$r_1 = PL \times p_3 / 100 - \text{budget allocations} \quad (15)$$

In any market economy, there exists a certain number of state-owned enterprises or enterprises with a significant share of government participation. These enterprises often operate as oligopolies or monopolies, while the remaining firms function under conditions that are, to varying degrees, close to market competition.

All enterprises operating under market conditions will be considered collectively as aggregate business. Their risks will be calculated using model (1)–(8), based on the initial data presented in Table 2.

Table 2. Initial Data for the Market Model

Parameter	Unit of Measurement	Value
Number of buyers, min	units	10,000.00
Number of buyers, max	units	12,000.00
Income, min	thousand RUB/year	150.00
Income, max	thousand RUB/year	250.00
Share of income spent on this product, min	%	17.00
Share of income spent on this product, max	%	29.00
Market share occupied by competitors, min	%	91.00
Market share occupied by competitors, max	%	100.00
Competitors' product price, min	RUB	250.00
Competitors' product price, max	RUB	300.00
Cost price	RUB	130.00
Selling price	RUB	270.00
Selling price	%	11.00
Profit tax	%	13.00

All enterprises operating on the basis of a centrally approved plan will be regarded collectively as a single state-owned enterprise. The risks of the planning authority are calculated using model (10)–(15), based on the initial data presented in Table 3.

Table 3. Initial Data for the Planned Model

Symbol	Name, Unit	Unit of Measurement	Value
f ₁	Number of employees, min	Pers.	50,000
	Number of employees, max	Pers.	70,000
f ₂	Number of working days, min	Days	250
	Number of working days, max	Days	270
p ₁	Output per employee, min	%	25
p ₂	Penalties	%	7
r ₁	Budget allocations	%	3

To analyse the economic situation – specifically, to compare business risks and planning authority risks under given economic conditions – the Equilibrium module of the Decision system was used. In this module, Models MM1 and MM3 are designed to solve equilibrium problems under conditions of uncertainty or risk [8].

“Market Sector” Model

We perform a series of interactive procedures:

Equilibrium Model Library → MM1 → load data from Table 4 → Optimisation → Direct calculation.

The results of this procedure are presented in Table 5.

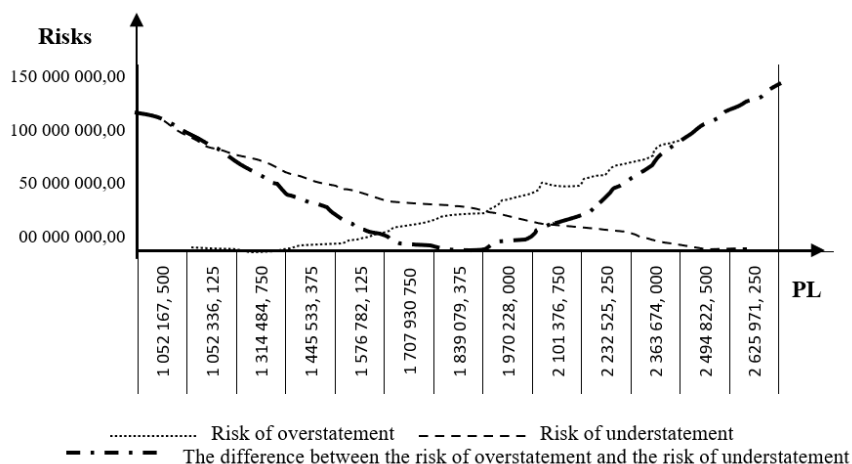
Table 4. Initial Data for Model MM1

Item No.	Parameter	Unit of Measurement	Value
1	Number of buyers, min	units	10,000.00
2	Number of buyers, max	units	12,000.00
3	Income, min	thousand/year	150.00
4	Income, max	thousand/year	250.00
5	Share of income spent on this product, min	%	17.00
6	Share of income spent on this product, max	%	29.00
7	Market share occupied by competitors, min	%	0.00
8	Market share occupied by competitors, max	%	1.00
9	Competitors' product price, min	RUB	250.00
10	Competitors' product price, max	RUB	300.00
11	Cost price	RUB	130.00
12	Selling price	RUB	270.00
13	Selling price	%	11.00
14	Profit tax	%	13.00

Table 5. Result of the Optimisation Calculation

Plan	Unit of Measurement	Value
Optimum	Units	1,839,079.38
Overestimation/Underestimation	fraction of a unit	1.22
Reliability for overestimation	fraction of a unit	0.52
Reliability for overestimation	fraction of a unit	0.52
Total costs	thousand RUB	265,379.15
Profit	thousand RUB	201,119.88
Tax payments	thousand RUB	56,351.23

The calculation results presented in Table 5 reflect the situation in the "market sector" of the economy, which in this context refers to the aggregate activity of all firms not directly controlled by the state. Fig. 3 presents the graph of overall business risks. At the bottom of the figure, the bolded line highlights the point where the "overestimation risk" most closely approaches the "underestimation risk."



Plan (PL)	Risk of overstatement	Risk of nderstatement	Risk difference
1 052 187,500	15 042,063	93 098 408,000	93 083 368,000
1 183 336,125	240 249,969	78 906 728,000	78 666 480,000
1 314 484,750	1 082 014,625	65 165 552,000	64 083 536,000
1 445 633,375	3 072 163,000	52 304 464,000	49 232 300,000
1 576 782,125	6 734 960,000	40 694 980,000	33 960 020,000
1 707 930,750	12 436 005,000	30 643 730,000	18 207 724,000
1 839 079,375	20 405 270,000	22 341 934,000	1 936 664,000
1 970 228,000	30 689 458,000	15 745 693,000	14 943 765,000
2 101 376,750	43 032 432,000	10 605 027,000	32 427 404,000
2 232 525,250	57 089 020,000	6 781 728,000	50 307 292,000
2 363 674,000	72 580 520,000	4 073 513,000	68 507 008,000
2 494 822,500	89 246 072,000	2 243 858,500	87 002 216,000
2 625 971,250	106 754 168,000	1 136 665,125	105 617 504,000
2 757 119,750	124 910 224,000	532 724,688	124 377 496,000
2 888 268,500	143 431 808,000	240 261,922	143 191 552,000
3 019 417,000	162 169 184,000	94 991,078	162 074 192,000
3 150 565,750	181 011 488,000	29 936,023	180 981 552,000
3 281 714,500	199 918 448,000	6 081,825	199 912 368,000

Fig. 3. Risks of the Market Sector

"Planned Sector" Model

Equilibrium Model Library → MM3 → load data from Table 6 → Optimisation → Direct calculation

Table 7 shows the calculation results of the initial data from Table 6, reflecting the situation in the "planned sector" of the economy, which in this context refers to the aggregate activity of all enterprises directly controlled by the state.

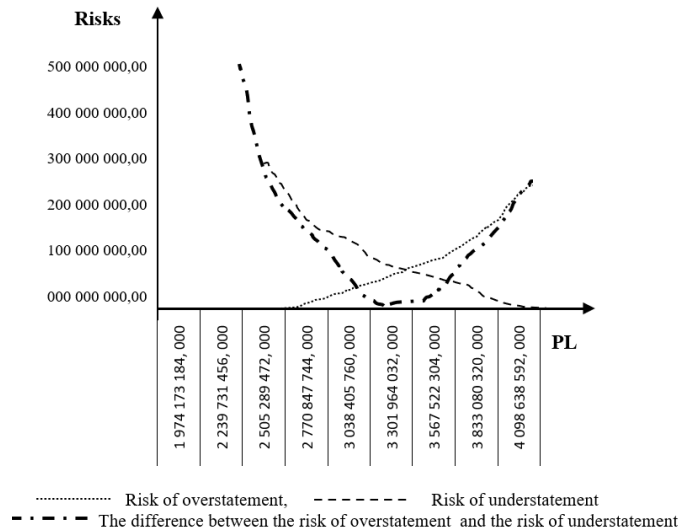
Table 6. Initial Data for the Model

Symbol	Name, Unit	Unit of Measurement	Value
f ₁	Number of employees, min	Pers.	50,000
	Number of employees, max	Pers.	70,000
f ₂	Number of working days, min	Days	250

	Number of working days, max	Days	270
f ₃	Output per employee, min	Units	150
	Output per employee, max	Units	230
p ₁	Output per employee, min	%	25
p ₂	Penalties	%	7
r ₁	Budget allocations	Units	3

Table 7. Result of the Optimisation Calculation

Plan	Unit of Measurement	Value
Optimum	million RUB	3,235,574,528.00
Overestimation/Underestimation	fraction of a unit	0.64
Reliability for overestimation	fraction of a unit	0.29
Reliability for overestimation	fraction of a unit	0.28
Budget allocations	million RUB	9,706,723.58



Plan (PL)	Risk of overstatement	Risk of understatement	Risk difference
1 974 173 184,000	9 171,936	918 084 416,000	918 075 264,000
2 106 952 320,000	238 355,188	795 657 152,000	795 418 816,000
2 239 731 456,000	1 327 696,625	676 277 248,000	674 949 568,000
2 372 510 464,000	3 832 737,750	562 493 952,000	558 661 184,000
2 505 289 472,000	8 432 898,000	456 703 456,000	448 270 560,000
2 638 068 736,000	15 769 022,000	361 016 032,000	345 247 008,000
2 770 847 744,000	26 340 484,000	276 521 696,000	250 181 216,000
2 903 626 752,000	40 247 820,000	205 043 120,000	164 795 296,000
3 036 405 760,000	57 739 552,000	146 167 248,000	88 427 696,000
3 169 185 024,000	78 436 400,000	100 071 640,000	21 635 240,000
3 301 964 032,000	102 047 288,000	65 500 108,000	36 547 180,000
3 434 743 040,000	128 191 560,000	40 276 408,000	87 915 152,000
3 567 522 304,000	156 525 552,000	22 760 136,000	133 765 416,000
3 700 301 312,000	186 523 952,000	11 288 602,000	175 235 344,000
3 833 080 320,000	217 764 544,000	4 653 167,500	213 111 376,000
3 965 859 328,000	249 983 952,000	1 451 603,125	248 532 352,000
4 098 638 592,000	282 850 208,000	297 163,844	282 553 056,000
4 231 417 600,000	315 979 328,000	22 104,672	315 957 216,000

Fig. 4. Risks of the Planned Sector

Fig. 4 shows the risk curves of state-owned enterprises as a whole. At the bottom of the figure, the bolded line highlights the point where the “overestimation risk” most closely approaches the “underestimation risk.”

From Fig. 3, the aggregate business risk is 22,341,934 units, and from Fig. 4, it is 100,071,640 units (in the highlighted rows, the greater of “overestimation risk” and “underestimation risk” is taken). Comparing these risks provides important information for economic analysis. In the example considered, the risk borne by state-owned enterprises is substantially higher than the aggregate business risk. This may have various explanations: a larger share of state participation in social and environmental programmes, higher defence spending, or an inefficient system of economic incentives. To improve economic efficiency—and in the absence of special reasons – it is generally desirable to reduce the share of state participation in the economy. However, concrete conclusions require cross-country analysis and comparisons across different time periods.

A comparison of market and planned economic models is also useful in that it indicates:

- First, the existence of an equilibrium mechanism not only in market systems but also in planned economies;
- Second, a deep structural similarity between these mechanisms (the mathematical formulations are identical);
- Third, the possibility of mutual transformation from one system to the other: a market economy transitions into a planned economy as monopolisation increases (where limited consumer demand becomes unlimited, and sufficient resource availability becomes scarce), while a planned economy transitions into a market economy as demonopolisation progresses (with money becoming the sole universal scarce resource).

These considerations also reveal the principal elements of the relationship between industry and the state. The picture becomes more complete when one considers the specific features of natural monopolies and the socio-economic role of bureaucratic structures – integral components of both monopolies and the state.

5. Conclusion

The central issue that the plan economy must address is the relationship between the state and the market. The market is essential for revealing real prices, demand and supply, the intentions of producers and consumers, and for allocating resources efficiently. The state, in turn, must intervene to correct disproportions, deflate speculative bubbles, and address social and strategic objectives. The state can intervene in the operation of any market sector by introducing a planning mechanism based on the principle that the sales volume, price, or both are established as control figures, while the system of economic incentives provides for penalties and rewards depending on the magnitude and direction of deviations of actual values from the established control figures. The state may implement such a planning mechanism for a limited period, replacing the market mechanism in which sales volumes and prices are determined spontaneously by the interplay of supply and demand. Through this mechanism, the state can also regulate capital flows and control the coverage of

various categories of clients within specific market sectors.

A comparison of the above mathematical models of the market and planned economies is valuable in that it reveals:

- the existence of an equilibrium mechanism not only within the market system but also within the planned system of management;
- a deep structural similarity between these mechanisms (their mathematical formulations are identical);
- the possibility of mutual transformation of one system into the other: the market economy evolves into a planned economy as monopolisation increases (where limited consumer demand becomes unlimited and resource sufficiency turns into scarcity), whereas the planned economy evolves into a market economy as demonopolisation progresses (with money becoming the sole universal scarce resource).

The presented models also make it possible to identify the main elements of the relationship between industry and the state. This picture becomes more comprehensive when considering the specific nature of natural monopolies and the socio-economic significance of bureaucratic structures – essential components of both monopolies.

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