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Assessing the Outcomes of Digital Transformation Smartization Projects in Industrial Enterprises: A Model for Enabling Sustainability

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Abstract: Digital transformation and smartization projects in industrial enterprises have become increasingly prevalent in recent years, aiming to enhance operational efficiency, productivity, and sustainability. Assessing the outcomes of such projects is crucial to determine their effectiveness in enabling sustainability. In this context, a model for evaluating digital transformation smartization projects (DTSP) outcomes can be developed to provide a comprehensive assessment framework. This study aims to develop and test a model for diagnosing the results of implementing digital transformation smartization projects for industrial enterprises. The methodology presented in this article involves using statistical tests to detect multicollinearity and heteroskedasticity in regression models. It also proposes an economic–mathematical model with three objective functions to optimize the implementation of smartization projects, considering cost minimization, deviations from planned business indicators, and production rhythm disruptions. The most important results of the survey are (1) a proposed matrix for the selection of indicators for diagnosing the results of the implementation of digital transformation smartization projects for industrial enterprises, (2) a two-level model for the economic evaluation of diagnosed digital transformation smartization projects, which can be used at any stage of the digital transformation smartization project and based on it, conclusions can be drawn regarding the effectiveness of the implementation of both the entire project and its individual stages, objects, or elements. The advantage of the model is the possibility of its decomposition, that is, a division into separate parts with the possibility of introducing additional restrictions or, conversely, reducing the level of requirements for some of them. The results were tested at industrial enterprises in Ukraine and proved their practical significance.

Keywords: digital transformation smartization projects (DTSP); industrial enterprises; smartization; sustainability

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1. Introduction

In an era defined by rapid technological advancements, the concept of digital transformation has emerged as a pivotal force reshaping industries worldwide. As industrial enterprises grapple with the challenges posed by an ever-evolving business landscape, they are increasingly turning to smartization projects to survive and thrive in this digital age. These projects, characterized by the infusion of intelligent technologies such as IoT, AI, and data analytics into industrial processes, promise to enhance operational efficiency, reduce costs, and unlock new avenues for innovation.

While the potential benefits of digital transformation smartization projects are widely recognized, their outcomes still need to be guaranteed. The road to successful smartization is fraught with complexities, ranging from technical hurdles to organizational resistance. Moreover, as the world faces escalating concerns over environmental sustainability, it has become imperative to assess the impact of these projects not only in terms of profitability but also in their contributions to a greener and more sustainable future.

This article delves into the multifaceted realm of digital transformation smartization in industrial enterprises and aims to provide a comprehensive framework for evaluating their outcomes with a particular emphasis on sustainability. It is well-established that sustainability considerations are no longer peripheral concerns but integral to modern organizations' strategic decisions. As such, any assessment of digital transformation projects must incorporate sustainability as a key performance indicator.

The journey toward digital transformation is not a one-size-fits-all endeavor. Each industrial enterprise faces unique challenges, opportunities, and environmental contexts, necessitating a nuanced approach to assessing the outcomes of smartization initiatives. This article seeks to address this need by proposing a model that considers the diverse facets of digital transformation and sustainability.

By integrating these components, the model for assessing the outcomes of digital transformation DTSP in industrial enterprises can provide a comprehensive framework to evaluate the projects' effectiveness in enabling sustainability. The model's results can guide decision-making processes, identify areas for improvement, and support the development of future projects that prioritize sustainability goals.

To achieve the set goal, the following tasks must be performed consistently:

– To study the essence of the concept of smartization and digital transformation smartization projects;
– To explore the relationship between smartization and sustainable development;
– To develop a system of indicators for evaluating the results of the implementation of DTSP;
– To develop a model for diagnosing the results of implementing DTSP for industrial enterprise;
– To test the proposed model on a sample of industrial enterprises.

2. Theoretical Framework

2.1. The Concept of Smartization and Digital Transformation Smartization Projects

After the World Economic Forum in 2016, the current state of society began to be called the era of the Fourth Industrial Revolution, the scale and complexity of transformations of which will be fundamentally new and unfamiliar to humanity. The response to this challenge must be integrated and comprehensive, involving all actors, from the public and private sectors to academia and civil society. Under such conditions, the questions of the essence and form of the integration of enterprises in the new era, the use of opportunities, and the prevention of risks caused by the Fourth Industrial Revolution are brought into focus. On the one hand, industrial enterprises can take advantage of the opportunities of the new system, eliminate the existing shortcomings of management, and become leaders of the world market—smart (intelligent) factories. On the other hand, the turbulence and riskiness of the new system require new management of this process.

A smart factory is a modern production of a new generation for the production of globally competitive and customized products, as well as for solving the urgent tasks of the development of high-tech export of products based on the application of advanced production technologies with the effective application of the concept of open innovation and the transfer of advanced science-intensive technologies.

Thus, a smart factory is the desired result of the enterprise, but it is necessary to invest in this concept of not only automation but also the characteristic features of smartization;

the process of achieving this result is smartization. The achievement of this result is expressed in the management of smartization projects of the enterprise.

Smartization is the targeted introduction of the optimum latest global achievements into the sphere of innovations of the enterprise for the efficient use of resources, increasing the synergetic efficiency of all business processes at the enterprise for the effective achievement of the set goals in the short and long term in the conditions of the constant change in the environment [1].

So, to better understand the author's vision, the term "smartization" can have the following synonyms: smart factory; smart production; smart industrialization; smart industry, etc., but smartization has a broader interpretation. Smartization is not only the use of information technologies; it is a new approach to the organization of all activities in an industrial enterprise.

The conceptual foundations of various aspects of smartization were considered by the authors in previous works [2–4], but the issue of evaluating the results of smartization projects remained unsolved, so the purpose of this study is to develop and test a model for diagnosing the results of the implementation of smartization projects for industrial enterprises.

Digital transformation smartization projects in industrial enterprises can be defined as strategic initiatives that aim to utilize advanced digital technologies and innovative approaches to enhance the efficiency, competitiveness, and adaptability of industrial organizations within the context of the Fourth Industrial Revolution. These projects involve integrating cutting-edge technologies, data-driven decision-making, and comprehensive organizational changes to optimize resource utilization, foster innovation, and achieve sustainable business goals in an ever-evolving industrial landscape.

Thus, we define the digital transformation smartization projects as their targeted rethinking and redesigning using information and innovation technologies through the intelligent use of resources; then, it is considered a tool by which industrial enterprises can use the "window of opportunity" (Figure 1) and, saving resources (time, costs) will accelerate the approach to industry leaders.

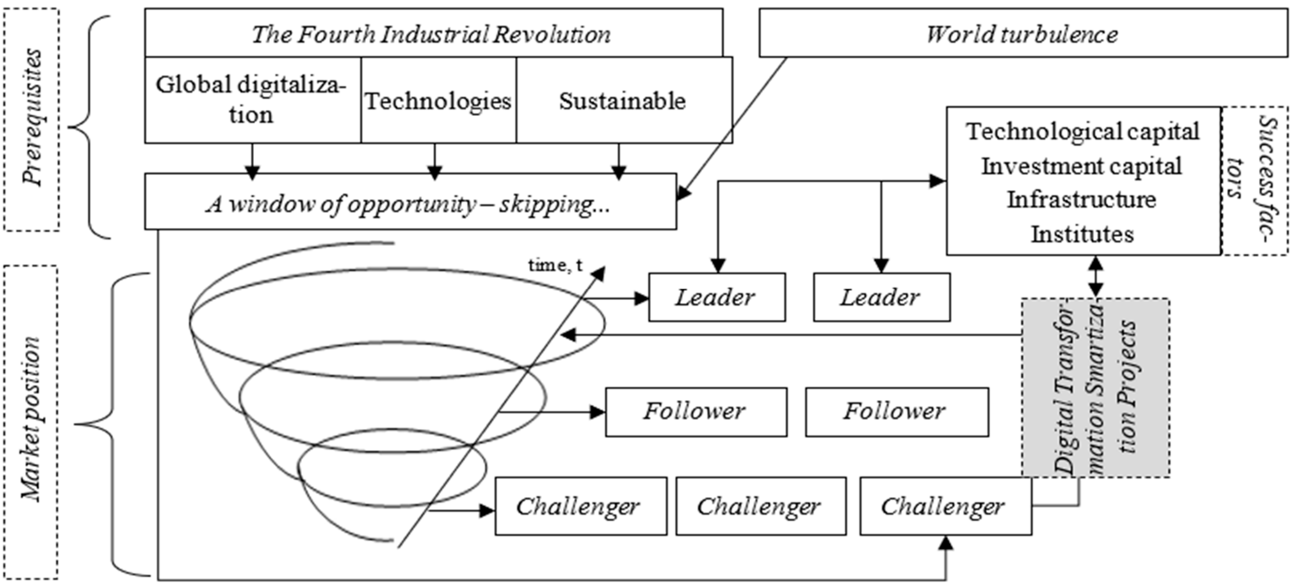

Figure 1. Digital transformation smartization projects for using the "window of opportunity" [5].

Thus, these projects will allow the enterprise to quickly and efficiently (due to the depreciation of financial investments) approach the leading position, that is, take the role of a follower. However, the important fact that such enterprises will never be able to become industry leaders (unless the leader leaves the market) should be noted; this requires more breakthrough innovative technologies. Smartization is aimed precisely at effectively optimizing resources (all their kinds), focusing on sustainable development. At the same time, it is pretty challenging to keep leadership positions; leaders usually consist of two or three enterprises, while sustainable, smartized development will allow the enterprise to prosper for many years.

2.2. Linking Smartization and Sustainable Development

Pursuing sustainable development has become an imperative for industrial enterprises in the 21st century [6,7]. Beyond traditional profit-centric models, these enterprises now recognize that their actions have far-reaching consequences for the environment, society, and their long-term viability. In this context, digital transformation smartization projects emerge as a potent catalyst for aligning industrial operations with sustainability principles.

Digital transformation smartization projects entail the strategic integration of cutting-edge technologies, data-driven processes, and intelligent systems into the fabric of an industrial enterprise [8]. When thoughtfully designed and executed, this transformative journey can produce many synergies that reinforce sustainable development goals. Here's how:

1. Resource Optimization: At the core of smartization lies the ability to optimize resource utilization [9]. Through real-time data analytics and process automation, industrial enterprises can reduce energy consumption, minimize waste, and enhance resource efficiency. This not only lowers operational costs but also reduces the enterprise's ecological footprint;
2. Emissions Reduction: Smartization empowers industrial enterprises to monitor and control emissions more effectively. Whether through predictive maintenance to reduce emissions from machinery or by optimizing logistics to minimize transportation-related emissions, digital technologies play a pivotal role in advancing sustainability [10,11];
3. Circular Economy Integration: Smartization projects enable the transition to a circular economy model, where products and materials are reused, refurbished, or recycled. By tracking product lifecycles, managing returns efficiently, and promoting sustainable product design, enterprises can contribute to a more circular and environmentally responsible economy [12,13];
4. Environmental Compliance: Meeting and exceeding regulatory environmental standards is crucial for sustainability. Smart systems provide real-time monitoring and compliance reporting tools, helping enterprises avoid costly penalties and reduce their environmental impact [14,15];
5. Supply Chain Transparency: Digital transformation enhances transparency within the supply chain. This transparency is essential for identifying and mitigating social and environmental risks in the supply network, ensuring suppliers adhere to sustainable practices [16];
6. Social Responsibility: Sustainable development extends beyond environmental concerns to encompass social responsibility [17]. Smartization projects can include initiatives to improve workplace safety, labor conditions, and employee well-being, contributing to the social pillar of sustainability;
7. Innovation and Competitiveness: Sustainability often drives innovation. Digital transformation can spark creativity and new business models, creating opportunities for enterprises to differentiate themselves in the market and tap into sustainable product lines or services [18,19];
8. Stakeholder Engagement: Smartization facilitates better engagement with stakeholders, including customers, investors, and the community. Demonstrating a commitment to sustainability through digital transparency and reporting can enhance an enterprise's reputation and build trust;

9. Long-Term Resilience: By optimizing operations and reducing environmental risks, smartization projects enhance an enterprise's long-term resilience in the face of climate change, resource scarcity, and other sustainability-related challenges;
10. Data-Driven Decision-Making: Smartization leverages data analytics to inform decision-making. This data-driven approach allows enterprises to make informed choices that align with their sustainability objectives, from supply chain optimization to energy management.

So, Digital transformation smartization projects hold immense potential for industrial enterprises seeking to advance their sustainability agenda. In an era where sustainability is not only a choice but a necessity, smartization emerges as a strategic imperative for industrial enterprises committed to the long-term viability and responsible global citizenship. By harnessing the power of technology and data, these projects can lead to resource efficiency, emissions reduction, circular economy practices, improved supply chain sustainability, and enhanced stakeholder engagement. These synergies highlight the importance of integrating sustainability considerations into digital transformation strategies and further reinforce the idea that smartization and sustainable development are not mutually exclusive but rather mutually reinforcing pathways to a better future.

2.3. Development of Indicators for Diagnosing the Results of the Implementation of DTSP for Industrial Enterprises

The problem in diagnosing the results of the implementation of DTSP is the impossibility of evenly distributing the efforts of the control subsystem between different objects at different stages of project implementation. Thus, the intensification of the intellectual activity of the staff has its limits, which cannot be crossed due to the threat of "burnout" of employees and the subsequent sharp drop in their productivity. However, such intensification is essential at the beginning of project implementation; without it, it is impossible to evaluate the response of the managed subsystem to management actions, which are the essence of the diagnosed project.

The smartization project, which is ready for implementation, is aimed at changing the given objects of the management system. These changes must be diagnosed dynamically; that is, the result of the project implementation is not only fixed indicators or compliance with the specified criteria but also a study of the stability of the impact over time. The consequence of most implemented DTSP is an impact not only on the target objects but also an indirect impact on other management subsystems of the enterprise. Sometimes, the strength and stability of such influence exceed the corresponding parameters of the target objects of smartization. This means that indirect effects must also be diagnosed and include relevant business indicators in alternative sets of indicators. The diversity of objects of influence, their different importance, complexity, and incomplete hierarchy determine the need to codify the elements of the management system to organize the relevant indicators with their subsequent combination within the limits of the proposed sets. Summarizing the scientific research [20–25], we present the groups of elements of the industrial enterprise management system (Table 1).

Using such a system of designations, it is possible to form different sets of indicators, to highlight among them the indicators of the impact of the smartization project on various objects of the management system, taking into account whether these objects were the goals of the project or whether the impact on them was a side effect of the project implementation. It is most convenient for further data processing to have the same dimension of the indicator matrix for different objects.

If this cannot be achieved, then the maximum dimensionality of the matrix is taken, and in smaller sets of indicators, a unit is placed on the empty places. The final goal is the formation of two–three sets of indicators that can be considered the indicators of the success of project implementation and contain elements of the initial combinations of indicators for the primary and additional objects of influence:

$$\begin{vmatrix} a_{11}^{S_1} & \dots & a_{n1}^{S_1} \\ \dots & \dots & \dots \\ a_{1m}^{S_1} & \dots & a_{nm}^{S_1} \end{vmatrix} \cap \begin{vmatrix} a_{11}^{S_2} & \dots & a_{n1}^{S_2} \\ \dots & \dots & \dots \\ a_{1m}^{S_2} & \dots & a_{nm}^{S_2} \end{vmatrix} \cap \dots \cap \begin{vmatrix} a_{11}^{S_k} & \dots & a_{n1}^{S_k} \\ \dots & \dots & \dots \\ a_{1m}^{S_k} & \dots & a_{nm}^{S_k} \end{vmatrix} = \begin{vmatrix} a_{11}^{S} & \dots & a_{n1}^{S} \\ \dots & \dots & \dots \\ a_{1m}^{S} & \dots & a_{nm}^{S} \end{vmatrix} \tag{1}$$

$$\begin{vmatrix} a_{11}^{S} & \dots & a_{n1}^{S} \\ \dots & \dots & \dots \\ a_{1m}^{S} & \dots & a_{nm}^{S} \end{vmatrix} \times \begin{vmatrix} w_{i1}^{S} \\ \dots \\ w_{in}^{S} \end{vmatrix} = \begin{vmatrix} A_1^S \\ \dots \\ A_n^S \end{vmatrix} \tag{2}$$

$$\begin{vmatrix} b_{11}^{C_1} & \dots & b_{n1}^{C_1} \\ \dots & \dots & \dots \\ b_{1m}^{C_1} & \dots & b_{nm}^{C_1} \end{vmatrix} \cap \begin{vmatrix} b_{11}^{C_2} & \dots & b_{n1}^{C_2} \\ \dots & \dots & \dots \\ b_{1m}^{C_2} & \dots & b_{nm}^{C_2} \end{vmatrix} \cap \dots \cap \begin{vmatrix} b_{11}^{C_k} & \dots & b_{n1}^{C_k} \\ \dots & \dots & \dots \\ b_{1m}^{C_k} & \dots & b_{nm}^{C_k} \end{vmatrix} = \begin{vmatrix} b_{11}^{C} & \dots & b_{n1}^{C} \\ \dots & \dots & \dots \\ b_{1m}^{C} & \dots & b_{nm}^{C} \end{vmatrix} \tag{3}$$

$$\begin{vmatrix} b_{11}^{C} & \dots & b_{n1}^{C} \\ \dots & \dots & \dots \\ b_{1m}^{C} & \dots & b_{nm}^{C} \end{vmatrix} \times \begin{vmatrix} v_{i1}^{C} \\ \dots \\ v_{in}^{C} \end{vmatrix} = \begin{vmatrix} B_1^C \\ \dots \\ B_n^C \end{vmatrix} \tag{4}$$

$$\begin{vmatrix} A_1^S \\ \dots \\ A_n^S \end{vmatrix} \cup \begin{vmatrix} B_1^C \\ \dots \\ B_n^C \end{vmatrix} = \begin{vmatrix} C_1^{SC} \\ \dots \\ C_n^{SC} \end{vmatrix} \tag{5}$$

where $a_{ij}^{S_k}$—indicators of diagnosing the impact on individual elements of the target object of the smartization project (in this case, S—strategy);

$i \in [1; n]$; n—the number of sets of indicators;

$j \in [1; m]$; m—the number of indicators in the set;

$k \in [1; l]$; l—the number of control object elements;

a_{ij}^{S}—indicators of diagnosing the impact on the target object of the project;

w_{ij}^{S}—weights of individual indicators in sets for target objects (the same for all sets within the target object);

A_i^S—aggregated indicators according to the i-th set of indicators for the target object;

$b_{ij}^{C_k}$—indicators of diagnosing the impact on individual elements of the object of the smartization project, which was not targeted (in this case, C—sales);

b_{ij}^{C}—indicators of diagnosing the impact on a non-target object of the project;

v_{ij}^{C}—weights of the individual indicators in sets for non-target objects (the same for all sets within a non-target object);

B_i^C—aggregated indicators according to the i-th set of indicators for a non-target object;

C_i^{SC}—indicators that simultaneously characterize the impact on target and non-target objects of the smartization project.

As a result of reviewing all possible combinations of indicators, we obtain two sets of indicators that characterize individual elements of target and non-target objects of the smartization project. Next, the project's impact on these individual elements is diagnosed according to various combinations of indicators, and the convergence of the obtained results is determined. You can use aggregated indicators that reflect changes in individual indicators within the influence objects or their elements. And finally, a combination of target and non-target impact indicators can be used as indicators if, as a result of the implementation of the consulting project, it turns out that the latter have become predominant. Automating the seemingly complicated procedure of forming alternative sets of indicators is easy.

The fragment of the management system, represented by three objects, is described by four groups of indicators, which, according to the BSC technology, characterize the financial condition, work with consumers, personnel, and internal business processes (Table 2). However, although the indicators are not repeated, some simultaneously characterize either two objects or two directions according to the BSC system. Therefore, after the initial identification of the indicators (basic with the base "a" and mediated with the base "b"), one of the two paired indicators for each identified pair is discarded, as well as those that are less informative, if there is a limit on the size of the matrix of input parameters to the simulation modeling. It is advisable to impose restrictions on the structure of the data array because of the number of options for solving the combinatorial problem; i = 2, j = 5 will be optimal as two alternative sets of five indicators for each target object.

Table 1. Codification of the elements of the management system of an industrial enterprise (source: supplemented by the authors based on [2–4,20–25].

Management Objects and Their Elements	Object Markers	Indicator Designation	Management Objects and Their Elements	Object Markers	Indicator Designation
personnel	P	$a_{ij}^{P}, b_{ij}^{P}, A_i^{P}, B_i^{P}$	strategy	S	$a_{ij}^{S}, b_{ij}^{S}, A_i^{S}, B_i^{S}$
recruitment	P1	$a_{ij}^{P1}, b_{ij}^{P1}, A_i^{P1}, B_i^{P1}$	mission and goals	S1	$a_{ij}^{S1}, b_{ij}^{S1}, A_i^{S1}, B_i^{S1}$
attestation	P2	$a_{ij}^{P2}, b_{ij}^{P2}, A_i^{P2}, B_i^{P2}$	planning technology	S2	$a_{ij}^{S2}, b_{ij}^{S2}, A_i^{S2}, B_i^{S2}$
certification training	P3	$a_{ij}^{P3}, b_{ij}^{P3}, A_i^{P3}, B_i^{P3}$	prognostication	S3	$a_{ij}^{S3}, b_{ij}^{S3}, A_i^{S3}, B_i^{S3}$
retraining	P4	$a_{ij}^{P4}, b_{ij}^{P4}, A_i^{P4}, B_i^{P4}$	work with counterparties	S4	$a_{ij}^{S4}, b_{ij}^{S4}, A_i^{S4}, B_i^{S4}$
rotations and development	P5	$a_{ij}^{P5}, b_{ij}^{P5}, A_i^{P5}, B_i^{P5}$	R&D	N	$a_{ij}^{N}, b_{ij}^{N}, A_i^{N}, B_i^{N}$
human capital	P6	$a_{ij}^{P6}, b_{ij}^{P6}, A_i^{P6}, B_i^{P6}$	innovations	N1	$a_{ij}^{N1}, b_{ij}^{N1}, A_i^{N1}, B_i^{N1}$
communications	K	$a_{ij}^{K}, b_{ij}^{K}, A_i^{K}, B_i^{K}$	objects of intellectual property	N2	$a_{ij}^{N2}, b_{ij}^{N2}, A_i^{N2}, B_i^{N2}$
communication networks	K1	$a_{ij}^{K1}, b_{ij}^{K1}, A_i^{K1}, B_i^{K1}$	patent and licensing work	N3	$a_{ij}^{N3}, b_{ij}^{N3}, A_i^{N3}, B_i^{N3}$
computers	K2	$a_{ij}^{K2}, b_{ij}^{K2}, A_i^{K2}, B_i^{K2}$	resource	R	$a_{ij}^{R}, b_{ij}^{R}, A_i^{R}, B_i^{R}$
software	K3	$a_{ij}^{K3}, b_{ij}^{K3}, A_i^{K3}, B_i^{K3}$	material	R1	$a_{ij}^{R1}, b_{ij}^{R1}, A_i^{R1}, B_i^{R1}$
information support	K4	$a_{ij}^{K4}, b_{ij}^{K4}, A_i^{K4}, B_i^{K4}$	energy	R2	$a_{ij}^{R2}, b_{ij}^{R2}, A_i^{R2}, B_i^{R2}$
document flow	K5	$a_{ij}^{K5}, b_{ij}^{K5}, A_i^{K5}, B_i^{K5}$	financial	R3	$a_{ij}^{R3}, b_{ij}^{R3}, A_i^{R3}, B_i^{R3}$
marketing	C	$a_{ij}^{C}, b_{ij}^{C}, A_i^{C}, B_i^{C}$	business processes	B	$a_{ij}^{B}, b_{ij}^{B}, A_i^{B}, B_i^{B}$
foreign economic activity	C1	$a_{ij}^{C1}, b_{ij}^{C1}, A_i^{C1}, B_i^{C1}$	smartization	B1	$a_{ij}^{B1}, b_{ij}^{B1}, A_i^{B1}, B_i^{B1}$
marketing	C2	$a_{ij}^{C2}, b_{ij}^{C2}, A_i^{C2}, B_i^{C2}$	legal support	B2	$a_{ij}^{B2}, b_{ij}^{B2}, A_i^{B2}, B_i^{B2}$
advertising	C3	$a_{ij}^{C3}, b_{ij}^{C3}, A_i^{C3}, B_i^{C3}$	security and safety	B3	$a_{ij}^{B3}, b_{ij}^{B3}, A_i^{B3}, B_i^{B3}$
after-sales support	C4	$a_{ij}^{C4}, b_{ij}^{C4}, A_i^{C4}, B_i^{C4}$	social infrastructure	B4	$a_{ij}^{B4}, b_{ij}^{B4}, A_i^{B4}, B_i^{B4}$
customer capital	C5	$a_{ij}^{C5}, b_{ij}^{C5}, A_i^{C5}, B_i^{C5}$	technologies	T	$a_{ij}^{T}, b_{ij}^{T}, A_i^{T}, B_i^{T}$
vintage capital	C6	$a_{ij}^{C6}, b_{ij}^{C6}, A_i^{C6}, B_i^{C6}$	own developments	T1	$a_{ij}^{T1}, b_{ij}^{T1}, A_i^{T1}, B_i^{T1}$
production	V	$a_{ij}^{V}, b_{ij}^{V}, A_i^{V}, B_i^{V}$	shared use	T2	$a_{ij}^{T2}, b_{ij}^{T2}, A_i^{T2}, B_i^{T2}$
the main thing	V1	$a_{ij}^{V1}, b_{ij}^{V1}, A_i^{V1}, B_i^{V1}$	purchase of licenses	T3	$a_{ij}^{T3}, b_{ij}^{T3}, A_i^{T3}, B_i^{T3}$
auxiliary	V2	$a_{ij}^{V2}, b_{ij}^{V2}, A_i^{V2}, B_i^{V2}$	engineering	T4	$a_{ij}^{T4}, b_{ij}^{T4}, A_i^{T4}, B_i^{T4}$
ensuring production	Z	$a_{ij}^{Z}, b_{ij}^{Z}, A_i^{Z}, B_i^{Z}$	supply	L	$a_{ij}^{L}, b_{ij}^{L}, A_i^{L}, B_i^{L}$
technical training	Z1	$a_{ij}^{Z1}, b_{ij}^{Z1}, A_i^{Z1}, B_i^{Z1}$	transport economy	L1	$a_{ij}^{L1}, b_{ij}^{L1}, A_i^{L1}, B_i^{L1}$
design work	Z2	$a_{ij}^{Z2}, b_{ij}^{Z2}, A_i^{Z2}, B_i^{Z2}$	warehousing	L2	$a_{ij}^{L2}, b_{ij}^{L2}, A_i^{L2}, B_i^{L2}$
technological support	Z3	$a_{ij}^{Z3}, b_{ij}^{Z3}, A_i^{Z3}, B_i^{Z3}$	logistics	L3	$a_{ij}^{L3}, b_{ij}^{L3}, A_i^{L3}, B_i^{L3}$
engineering support	Z4	$a_{ij}^{Z4}, b_{ij}^{Z4}, A_i^{Z4}, B_i^{Z4}$	economic support	E	$a_{ij}^{E}, b_{ij}^{E}, A_i^{E}, B_i^{E}$
safety equipment and labor protection	Z5	$a_{ij}^{Z5}, b_{ij}^{Z5}, A_i^{Z5}, B_i^{Z5}$	operative planning	E1	$a_{ij}^{E1}, b_{ij}^{E1}, A_i^{E1}, B_i^{E1}$
quality control	Z6	$a_{ij}^{Z6}, b_{ij}^{Z6}, A_i^{Z6}, B_i^{Z6}$	accounting and analysis	E2	$a_{ij}^{E2}, b_{ij}^{E2}, A_i^{E2}, B_i^{E2}$
instrumental support	Z7	$a_{ij}^{Z7}, b_{ij}^{Z7}, A_i^{Z7}, B_i^{Z7}$	commercial activity	E3	$a_{ij}^{E3}, b_{ij}^{E3}, A_i^{E3}, B_i^{E3}$
repair support	Z8	$a_{ij}^{Z8}, b_{ij}^{Z8}, A_i^{Z8}, B_i^{Z8}$	investment activity	E4	$a_{ij}^{E4}, b_{ij}^{E4}, A_i^{E4}, B_i^{E4}$

Table 2. Matrix for the selection of indicators for diagnosing the results of the implementation of DTSP for industrial enterprises (source: proposed by the authors based on [2,4,9,10,26–30]).

Project Objects	Groups of Indicators According to BSC Technology			
	Financial Indicators	**Indicators of Work with Consumers**	**Indicators of Personnel Development**	**Indicators of Internal Processes**
Strategy	The effectiveness of the control subsystem in terms of labor productivity, b_{11}^{E2}	Capital return on client capital, a_{11}^{C5}	Correspondence of the actual number of managers to the normative, a_{12}^{S2}	Coefficient of realization of long − term goals, a_{11}^{S1}
	The number of administrative costs, b_{12}^{E2}	The share of regular consumers, a_{12}^{C5}	Task completion time, a_{12}^{S1}	Current task completion ratio, a_{12}^{S1}
	Norms of resource consumption, a_{11}^{S2}	Market value, a_{13}^{C5}	Turnover of managers, a_{13}^{S2}	Accuracy of forecasts, a_{11}^{S2}
	Number and structure of activities, a_{11}^{S4}	The average growth rate of the client base, a_{14}^{C5}	Effectiveness of manager rotations, a_{14}^{S2}	Number of patents, a_{13}^{S4}
	Return on capital of projects, b_{13}^{E2}	The growth index of the quality of consumer capital, a_{15}^{C5}	Increase in the competencies of managers, a_{24}^{S2}	Number of commercialized IPOs, a_{14}^{S4}
	The volume and profitability of R&D, b_{14}^{E2}	Customer base reliability index, a_{21}^{C3}	Return on improving the qualifications of managers, a_{11}^{B1}	Technological equipment, a_{11}^{T1}
	The volume and profitability of NMA, b_{11}^{E2}	Sales volume and profitability, a_{12}^{S4}	Return from combining positions, a_{15}^{S2}	Production rhythm, a_{11}^{V1}
	Volume and structure of assets, b_{15}^{E2}	Price change index, a_{11}^{C4}	The level of quality of solutions, a_{23}^{S2}	Inventory level, a_{11}^{L2}
	The scope and structure of obligations, b_{15}^{E2}	Sales expenses, b_{14}^{E1}	The degree of decision − making risk, a_{22}^{S2}	The level of losses due to organizational reasons, a_{21}^{S2}
	and other			
Personnel	Labor compensation fund, b_{22}^{E2}	Ahead of competitors, a_{11}^{P5}	An increase in the level of intellectual activity, a_{15}^{P2}	Productivity, a_{11}^{P4}
	The volume of social expenditures, a_{12}^{P4}	The number of complaints and advertisements, a_{11}^{P4}	An increase in the share of operational time, a_{14}^{P2}	Staff utilization ratio, a_{11}^{P2}
	Salary intensity of products, b_{23}^{E2}	Complaint response time, a_{22}^{C3}	Coefficient of intellectual activity, a_{12}^{P2}	Staff turnover rate, a_{11}^{P1}
	The structure of premiums, surcharges, and allowances, b_{24}^{E2}	The number of lost and attracted consumers, a_{23}^{C3}	The level of use of artificial intelligence, a_{13}^{P2}	The level of conflict, a_{12}^{P2}
	Corporate costs related to personnel, a_{13}^{P4}	Working time with consumers, a_{12}^{P2}	Return on professional development, a_{11}^{P2}	Loyalty level, a_{13}^{P2}
	and other			
Communications	Costs for maintaining the communications system, b_{25}^{E2}	Market share, a_{11}^{C2}	Coefficient of information loading, a_{11}^{K4}	The coefficient of automation of business processes, a_{11}^{K2}
	Information protection costs, b_{11}^{B2}	Average time of communication with the client, a_{24}^{C2}	Number of errors, a_{12}^{K4}	The coefficient of document flow automation, a_{12}^{K2}
	Document processing costs, b_{11}^{E1}	Effectiveness of marketing communications, a_{12}^{C2}	The number of unauthorized accesses, a_{11}^{K1}	Information processing automation coefficient, a_{13}^{K2}
	Profitability of communication costs, b_{12}^{E1}	Volume of advertising services, a_{11}^{C3}	Error correction time, a_{13}^{K4}	Information security factor, a_{11}^{K2}
	The expected increase in the value of information, b_{13}^{E1}	Direct communications with consumers, a_{25}^{C2}	Speed of reaction to information problems, b_{12}^{B2}	The number of IT functions, the level of their use, a_{14}^{K4}
	and other			

2.4. Economic Evaluation of the Implementation of Diagnosed DTSP for Enterprises

Developing and implementing DTSP for industrial enterprises is quite complex due to technical and economic reasons. The industry needs technical and technological support, and the level of product innovation determines the competitive position of enterprises in the domestic and foreign markets [31,32]. At the same time, most of Ukraine's large industrial enterprises are burdened with worn-out fixed assets; their assets are characterized by low liquidity, and their infrastructure is mainly unprofitable. All this complicates the implementation of the smartization of enterprises because, on the one hand, they must improve the elements of the enterprise management system. Still, on the other hand, they cannot recommend drastic measures to reorganize the business because, in the conditions of the deterioration of the economic situation, the loss of a significant part of sales markets and the disruption of relations with counterparties from CIS countries, industrial enterprises need external financing and a long period to adapt to current business conditions based on market competition [33,34].

Conducted preliminary studies [1,5,35,36] clearly proved that projects of smartization of business processes of enterprises have a positive effect not only on the target objects of smartization but also raise other elements of the management system to a higher level due to the activation of the intellectual activity of employees, increasing the responsibility of managers and intensifying control over carrying out separate technological operations and implementing typical business processes. From a managerial point of view, the results of the implementation of DTSP are apparent; they can be measured and controlled. However, deviations inevitably occur, some of which require further participation of the entities that developed and implemented the relevant projects. In this connection, the issue of evaluating the effectiveness of DTSP at the stage of their support after implementation and obtaining the planned result arises again.

To unify tools for the economic assessment of the implementation of DTSP, it is proposed to establish conditional permanent procedures for identifying the connections of business indicators for diagnosing the performance of DTSP with the general financial results of enterprises. These procedures will be permanent because of the stability of the evaluation objects; however, in the case of business restructuring or diversification of activities, they will still have to be changed.

The economic evaluation of the implementation of smartization projects is variable from the point of view of the objects of smartization influence but can be unified in terms of the procedures for calculating indicators and interpreting the obtained results. A two-level approach is proposed for the economic evaluation of diagnosed DTSP (Figure 2).

At the first level, sustainable relationships between the performance parameters of DTSP and the enterprise's financial results are identified and described. Stable relationships exist for at least six months after the smartization project was implemented, and the relationship density between parameters is not less than 0.667. Of course, from the point of view of statistics, correlation coefficients should be in the range of 0.75–0.95, but this is hardly achievable in the conditions of the Ukrainian industry. In addition, within six months, the requirements of the internal and external business environment will change, most of which cannot be predicted, and even more so, this impact cannot be separated from the results of the diagnosed smartization project, which also reduces the density of communication between the studied parameters.

At the second stage of the economic evaluation of the implementation of diagnosed DTSP, alternative models of the relationship of the key parameters of the financial state of enterprises with sets of results of DTSP are formed either by objects of influence or by the key business indicators with a universal purpose. The conducted research and calculations show that in most cases, the communication density between parameters is not high; therefore, it is advisable to form an economic–mathematical model for optimizing the implementation of diagnosed DTSP.

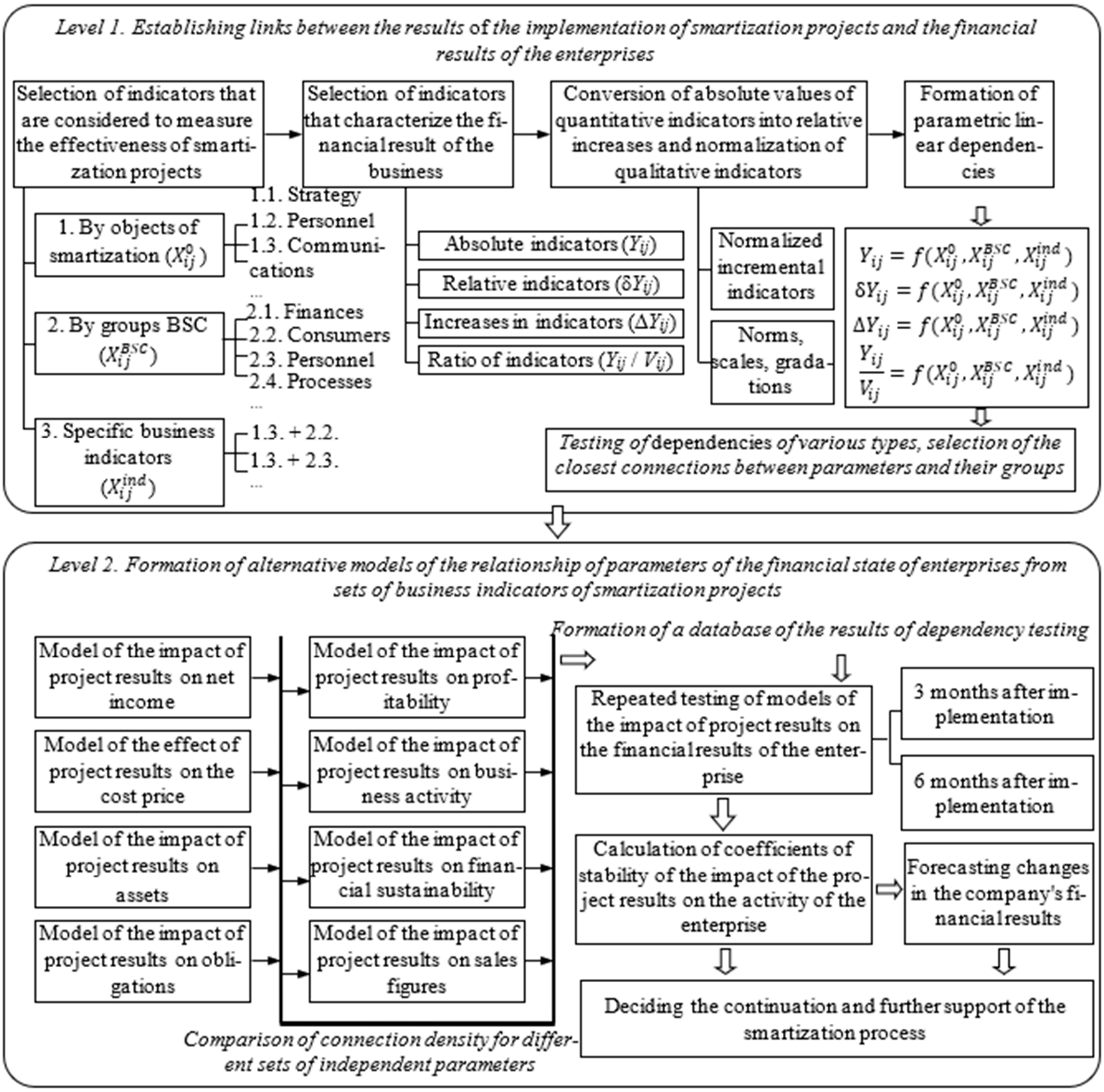

Figure 2. Graphical model of the economic evaluation of the implementation of DTSP (source: developed by the authors).

The distribution of the indicators, which are measures of the proven effectiveness of DTSP by smartization objects or BCS groups, is conditional; often, we operate with integrated specific business indicators that characterize several objects and/or groups of indicators of a balanced system simultaneously. For example, the indicator “effectiveness of the management system in terms of labor productivity” links the increase in labor productivity and the costs of maintaining the management apparatus; therefore, it simultaneously characterizes the budgetary component of the business and measures to intensify the intellectual activity of the staff along with the improvement in interpersonal communications. The main task is to establish dependencies between the results of the implementation of DTSP (independent variables) and the financial results of enterprises (dependent variables). It is not known in advance which possible dependencies will be characterized by sufficient connection density; therefore, all possible models are formed, their parameters are calculated, and those with the highest correlation coefficients are selected for further research. These models should be used for six months after the end of the implementation of DTSP, and only then can it be asserted that the dependencies exist and are stable enough to conclude the economic efficiency of smartization at the level of the entire enterprise and not its subsystems.

One of the constant technical problems when working with regression models is the partial dependence on individual factor variables. Multicollinearity leads to the fact that the estimates of the model parameters are shifted, the covariances of the estimates increase, and the deterioration of the t-statistics is observed. Multicollinearity cannot be completely avoided, so its influence on model estimates should be minimized. To a lesser extent, heteroskedasticity is still a problem (working with dynamic series). The assumption of the least squares method regarding the invariance of the variance of the residual term is not always fulfilled; one of the reasons is a purely psychological factor: with constant control of the same parameters at different time intervals, staff expectations unknowingly cause disturbances in the interpretation of qualitative parameter estimates.

Suppose the presence of multicollinearity is visible almost immediately (a considerable value of the coefficient of determination against the background of insignificant coefficients of the model and/or significant coefficients of pairwise correlation of factor variables), then detect heteroskedasticity. In that case, it is necessary to additionally test the models using the methods of Breusch–Pagan, Goldfeld–Quandt, Schleser, or Aitken [36–38]. The toolkit for detecting and eliminating the effects of multicollinearity and heteroscedasticity is well developed; therefore, standard approaches to testing the specified models were used, based on which a decision was made regarding their suitability for the economic evaluation of the implementation of diagnosed DTSP.

However, despite all attempts to reduce the input data to a normalized incremental form and select regression models with the best relationship density indicators and minimal influence of multicollinearity and heteroscedasticity, decisions have to be made in some cases based on expert judgments. These experts were recruited from among the teaching staff and leading specialists of industrial enterprises. Their decisions were collected and elaborated based on well-known methods and techniques of expert evaluation [39–42], and based on the obtained results, alternative models of relationships were chosen in those cases when, from a formal point of view, they were either wholly equivalent or had separate reservations for use.

The distribution of the variables of the selected alternative models of the relationship of the parameters of the financial state of enterprises from the sets of business indicators of DTSP (Table 3) was based on the following criteria: the number of factor variables four–six; pairwise correlation of the dependent variable and each of the factors—not less than 0.85, the minimum probability of multicollinearity and the conditional constancy of the variance of the residuals of the free terms. The input data for the modeling was obtained as a result of direct observation of the work of PrJSC "Iskra" and PrJSC "LLRZ" after the implementation of DTSP on them and thanks to computer modeling of the impact of similar projects on five more industrial enterprises from different regions (see Table 4 and Appendix A).

The regression of probable dependencies was studied in two stages: first, "clean" data from seven enterprises were used, and later, those values that were significantly outside the limits of the explained variance of the dependent and factor variables were cut off.

Table 3. Distribution of factor variable models of the relationship of indicators of the financial condition of enterprises from sets of business indicators of DTSP (source: developed by the authors).

Dependent Variables (% Increase)	Factor Variables (Relative Improvement in Normalized Values), %					
Net income from product sales, Y_1	Return on capital of client capital, $a_{11}^{C5} \to x_{11}$	Price level, $a_{11}^{C4} \to x_{12}$	Effectiveness of marketing communications, $a_{12}^{C2} \to x_{13}$	The level of competencies of managers, $a_{24}^{S2} \to x_{14}$	Level of intellectual activity, $a_{15}^{P3} \to x_{15}$	Share of operational time, $a_{14}^{P3} \to x_{16}$
Cost of goods sold, Y_2	The number of administrative costs, $b_{12}^{E2} \to x_{21}$	Norms of resource consumption, $a_{11}^{S2} \to x_{22}$	Sales expenses, $b_{14}^{E1} \to x_{23}$	Salary capacity of production, $b_{23}^{E2} \to x_{24}$	Costs for the communications system, $b_{25}^{E2} \to x_{25}$	Losses due to organizational reasons, $a_{21}^{S2} \to x_{26}$
Operating profit, Y_3	The coefficient of automation of business processes, $a_{11}^{K5} \to x_{31}$	Staff load factor, $a_{11}^{P2} \to x_{32}$	Production rhythm, $a_{11}^{V1} \to x_{33}$	Accuracy of forecasts, $a_{11}^{S3} \to x_{34}$	Coefficient of realization of long-term goals, $a_{11}^{S1} \to x_{35}$	The share of regular consumers, $a_{12}^{C5} \to x_{36}$
Volume of liquid assets, Y_4	The effectiveness of the control subsystem in terms of labor productivity, $b_{11}^{E2} \to x_{41}$	Return on capital of projects, $b_{13}^{E2} \to x_{42}$	The share of R&D, $b_{14}^{E2} \to x_{43}$	Share of NMA, $b_{11}^{E3} \to x_{44}$	Correspondence of the number of managers to the standard, $a_{12}^{S2} \to x_{45}$	The coefficient of automation of document circulation, $a_{12}^{K5} \to x_{46}$
Market value, Y_5	The effectiveness of the control subsystem in terms of labor productivity, $b_{11}^{E2} \to x_{51}$	Return on capital of projects, $b_{13}^{E2} \to x_{52}$	Profitability of communication costs, $b_{12}^{E1} \to x_{53}$	Labor compensation fund, $b_{22}^{E2} \to x_{54}$	The level of reliability of the client base, $a_{21}^{C5} \to x_{55}$	Effectiveness of marketing communications, $a_{12}^{C2} \to x_{56}$
Profitability of sold products, Y_6	Labor compensation fund, $b_{22}^{E2} \to x_{61}$	Corporate costs related to personnel, $a_{13}^{P6} \to x_{62}$	Information protection costs, $b_{11}^{B3} \to x_{63}$	The level of quality of consumer capital, $a_{15}^{C5} \to x_{64}$	Market share, $a_{11}^{C2} \to x_{65}$	The level of intellectual activity, $a_{15}^{P3} \to x_{66}$
Coefficient of autonomy, Y_7	Return on capital of projects, $b_{13}^{E2} \to x_{71}$	The volume of social expenditures, $a_{12}^{P6} \to x_{72}$	Costs for the communications system, $b_{25}^{E2} \to x_{73}$	Effectiveness of manager rotations, $a_{14}^{S2} \to x_{74}$	The degree of decision-making risk, $a_{22}^{S2} \to x_{75}$	The level of intellectual activity, $a_{15}^{P3} \to x_{76}$
Total liquidity ratio, Y_8	The effectiveness of the control subsystem in terms of labor productivity, $b_{11}^{E2} \to x_{81}$	Correspondence of the number of managers to the standard, $a_{12}^{S2} \to x_{82}$	The level of competence of managers, $a_{24}^{S2} \to x_{83}$	Coefficient of realization of long-term goals, $a_{11}^{S1} \to x_{84}$	Production rhythm, $a_{11}^{V1} \to x_{85}$	Labor productivity, $a_{11}^{P6} \to x_{86}$
Capital House, Y_9	Return on capital of projects, $b_{13}^{E2} \to x_{91}$	Salary intensity of products, $b_{23}^{E2} \to x_{92}$	Costs for the communications system, $b_{25}^{E2} \to x_{93}$	Return on capital of client capital, $a_{11}^{C5} \to x_{94}$	Effectiveness of marketing communications, $a_{12}^{C2} \to x_{95}$	Share of operational time, $a_{14}^{P3} \to x_{96}$

Table 4. Results of computer modeling of the impact of implemented DTSP on the activities of other industrial enterprises (source: calculated by the authors).

Enterprises	**Relative Improvements in the Normalized Values of the Indicators as a Result of the Implementation of the Smartization Project (for 2021), %**														
	A Set of Indicators α														
	$b_{11}^{E_2}$	$b_{23}^{E_2}$	$b_{25}^{E_2}$	$a_{11}^{C_5}$	$a_{12}^{P_5}$	$a_{12}^{C_2}$	$a_{24}^{S_2}$	$a_{12}^{P_3}$	$a_{11}^{K_4}$	$a_{11}^{S_1}$	$a_{11}^{P_6}$	$a_{11}^{K_5}$	$a_{11}^{S_3}$	$a_{11}^{P_1}$	$a_{11}^{K_3}$
PJSC «LLRP»	0.3	−0.5	8.6	3.4	5.9	9.7	8.3	7.2	3.7	7.2	2.5	16.0	2.5	8.9	21.2
PJSC «Odeskabel»	4.8	0.9	1.0	2.6	3.6	6.7	4.7	3.4	2.6	5.4	1.4	3.0	4.6	6.9	6.6
PJSC «Iskra»	2.8	−1.2	1.6	4.5	2.5	7.9	5.9	9.8	6.3	10.8	4.0	14.4	3.8	6.2	18.6
PJSC «Azot»	0.8	−0.8	2.3	1.4	8.4	7.2	7.7	5.8	4.8	4.0	3.1	8.2	5.0	7.5	4.7
PJSC «Radar»	1.2	−0.8	2.9	1.2	7.9	7.2	7.7	7.2	4.8	4.7	3.3	8.2	5.4	6.6	5.3
JSC «Ekvator»	0.7	−1.0	3.1	4.5	2.5	7.9	5.9	9.8	6.3	10.8	4.0	4.4	3.8	6.2	9.8
PJSC «KBVP»	−0.5	0.6	0.4	4.8	2.7	2.5	4.3	6.4	7.0	4.1	1.3	6.2	4.2	4.5	11.2
Enterprises	A set of indicators β														
	$b_{13}^{E_2}$	$b_{22}^{E_2}$	$b_{11}^{E_1}$	$a_{14}^{C_5}$	$a_{22}^{C_5}$	$a_{24}^{C_5}$	$a_{12}^{S_2}$	$a_{15}^{P_3}$	$b_{12}^{B_3}$	$a_{12}^{S_1}$	$a_{14}^{P_3}$	$a_{12}^{K_5}$	$a_{11}^{T_1}$	$a_{11}^{P_2}$	$a_{13}^{K_5}$
PJSC «LLRP»	8.6	6.7	3.0	9.6	14.9	4.1	9.4	4.9	13.8	4.8	2.5	14.5	2.5	7.4	13.9
PJSC «Odeskabel»	7.1	5.8	2.3	3.4	5.8	4.4	5.8	3.2	6.5	6.6	4.1	7.3	2.2	3.1	11.1
PJSC «Iskra»	6.2	5.9	1.8	3.8	10.4	3.3	4.4	3.8	6.9	6.9	1.5	12.1	4.4	8.1	15.4
PJSC «Azot»	5.4	2.6	0.8	1.1	2.7	0.6	1.5	0.6	7.4	2.6	0.6	4.1	1.2	4.8	3.1
PJSC «Radar»	11.3	5.3	1.5	7.1	8.9	4.4	6.7	5.7	9.7	6.3	3.2	7.8	3.0	6.0	7.6
JSC «Ekvator»	4.2	5.6	1.4	4.3	11.1	3.3	4.6	3.1	4.9	5.8	1.4	12.1	4.2	9.1	4.7
PJSC «KBVP»	12.1	6.3	1.3	6.7	7.6	2.8	7.2	4.0	7.1	4.8	2.1	14.4	1.8	7.6	5.7

Here and further: PJSC «LLRP»—PJSC "Lviv Locomotive Repair Plant"; PJSC «Iskra»—PJSC "Lvivskyy elektrolampovyy zavod ISKRA"; PJSC Radar—Public Joint Stock Company "Kiev" "Radar" Plant; PJSC "KBVP"—Public Joint Stock Company Industrial And Manufacturing Enterprise "Kryvbasvibuhprom".

Since the financial indicators according to the BSC system should have been present but were not targeted for the smartization project, they all ended up with the base "b" according to our codification. The same applies to indicator $b_{12}^{B_3}$, which characterizes business processes that were not the target object but better reflected the indicators of personnel development in terms of communication skills. At the output, two matrices of indicators are formed, which are indicators of the smartization project and based on which it is possible to diagnose the results of its implementation:

$$\alpha = \begin{vmatrix} b_{11}^{E_2} & b_{23}^{E_2} & b_{25}^{E_2} \\ a_{11}^{C_5} & a_{12}^{P_5} & a_{12}^{C_2} \\ a_{24}^{S_2} & a_{12}^{P_3} & a_{11}^{K_4} \\ a_{11}^{S_1} & a_{11}^{P_6} & a_{11}^{K_5} \\ a_{11}^{S_3} & a_{11}^{P_1} & a_{11}^{K_3} \end{vmatrix}; \ \beta = \begin{vmatrix} b_{13}^{E_2} & b_{22}^{E_2} & b_{11}^{E_1} \\ a_{14}^{C_5} & a_{22}^{C_5} & a_{24}^{C_5} \\ a_{12}^{S_2} & a_{15}^{P_3} & b_{12}^{B_3} \\ a_{12}^{S_1} & a_{14}^{P_3} & a_{12}^{K_5} \\ a_{11}^{T_1} & a_{11}^{P_2} & a_{13}^{K_5} \end{vmatrix} \quad (6)$$

Although only three target objects (strategy, personnel, communications) are considered, due to their connections with other elements of the management system, such objects as business processes, sales, technologies, and economic support will be diagnosed. To simplify perception, it is possible to change the index designations of indicators, introduce aggregated metrics by objects or their groups, and combine elements of smartization objects in different ways. This means that the proposed method of choosing business indicators is universal but does not require further detail within the scope of this study.

3. Research Method

Regression analysis is a convenient tool for researching relationships between variables [43,44], but more is needed to provide an answer to the question of resource allocation in the process of developing and implementing DTSP. In addition, at most enterprises that implemented DTSP, significant violations of the rhythm of production were observed, associated with the need to simultaneously carry out organizational changes and increase the level of staff involvement in management decision-making. These changes provide an impetus for business development in the future. Still, their implementation process is complex, often causes staff resistance, and provokes conflicts between individual employees, structural units, stakeholder interests, etc.

To take into account these aspects of the smartization practice, an economic–mathematical model is proposed for calculating the efficiency and optimizing the process of implementing DTSP, which will be able to reconcile the costs of implementing project solutions with the requirements of minimizing the deviations of the fundamental values of business indicators from the planned ones and at the same time ensure the slightest possible disturbances to the rhythm of production. The named conditions are reflected in three corresponding objective functions, which are transformed into a general model using the method of uniform linear optimization:

1. Minimization of uncovered costs for the design, implementation, and maintenance of the smartization project. Uncovered are the costs incurred at all stages of the implementation of the smartization project but not compensated by future savings on administrative costs or increased productivity of managerial labor.

$$F_1(x) = \sum_{i=1}^{n} \sum_{j=1}^{m} x_{ij} \to min \tag{7}$$

where x_{ij}—uncovered costs for creating and implementing the smartization project under the i-th article at the j-th stage of implementation, thousand UAH.

$$x_{ij} = v_{ij} - \omega_{ij} t_j \tag{8}$$

where v_{ij}—the costs incurred directly for the smartization project under the i-th article at the j-th stage of implementation, thousand UAH;

ω_{ij}—savings under the i-th article at the j-th stage of the implementation of the smartization project, which will occur in the following periods as a result of the implementation of smartization, thousand UAH;

t_j—coefficient that takes into account the depreciation of money at the jth stage (depends on the interest rate on the borrowing market);

$i \epsilon \overline{1, n}$; n—the number of expenditure items that change;

$j \epsilon \overline{1, m}$; m—the number of stages of the smartization project.

The implementation of the first function of the goal is subject to budgetary restrictions, namely,

$$\sum_{i=1}^{n} \sum_{j=1}^{m} v_{ij} \leq s_j V_j \tag{9}$$

where s_j—the coefficient of unplanned costs, admissible due to compensation at the later stages of the implementation of the smartization project;

V_j—the budget of the smartization project at the j-th stage, thousand UAH.

$$\sum_{j=1}^{m} s_j \leq \overline{K} \tag{10}$$

where $\overline{K}$—the average annual interest rate on loans available to the enterprise; at the time of this study, $\overline{K} \approx 0.215$; i.e., the considered enterprises were, on average, lent at 21.5% in UAH.

$$\sum_{i=1}^{n} \sum_{j=1}^{m} \omega_{ij} \leq dW_j \tag{11}$$

where d—the marginal level of admissible savings in administrative costs; in this case, d = 0.25, limiting the maximum level of projected savings in administrative costs to 25%, because attempts at further savings will lead to abuses and attempts to distort actual data, i;

W_j—the fund for the maintenance of administrative personnel and general corporate expenses, operating at the jth stage of the smartization project.

$$t_j \leq \frac{K_{max}/100}{12}\tau_j \quad (12)$$

where K_{max}—the maximum lending rate that was effective for the enterprise last year, %;

τ_j—the time during which the j-th stage of the smartization project lasts, months;

2. Minimization of negative deviations of the actual values of business indicators from the planned ones:

$$F_2(y) = \sum_{i=1}^{n}\sum_{j=1}^{m}\left(y_{ij}\Theta_{ij}\right) \rightarrow min \quad (13)$$

$$y_{ij} = \left|\frac{y_{ij}^1 - y_{ij}^0}{y_{ij}^0} \times 100\%\right| \quad (14)$$

$$\begin{cases} y_{ij} \geq 0 \Rightarrow \Theta_{ij} = 0 \\ y_{ij} < 0 \Rightarrow \Theta_{ij} = 1 \end{cases} \quad (15)$$

where y_{ij}^0, y_{ij}^1—the planned and actual values of the i-th business indicator, which characterizes the impact of the smartization project on the j-th object;

Θ_{ij}—a Boolean variable that takes a single value only in case of negative deviation of the i-th business indicator from the plan; if the deviation is positive, then the Boolean variable takes a zero value, thereby excluding such a deviation from consideration;

$i\epsilon\overline{1,n}$; n—the number of business indicators that characterize the object;

$j\epsilon\overline{1,m}$; m—the number of objects of the smartization project;

3. Minimization of production rhythm violations during the implementation of the smartization project:

$$F_3(z) = \sum_{i=1}^{n}\sum_{j=1}^{m} z_{ij} \rightarrow min \quad (16)$$

$$z_{ij} = \left|\frac{z_{ij}^1 - z_{ij}^0}{z_{ij}^0}\right| \quad (17)$$

where z_{ij}^0, z_{ij}^1—he planned and actual values of the rhythmicity coefficients of production of the i-th type of the j-th object (subdivision);

$i\epsilon\overline{1,n}$; n—the number of types of rhythmicity coefficients that characterize the object;

$j\epsilon\overline{1,m}$; m—the number of objects (subdivisions) that are subject to changes as a result of the implementation of the smartization project.

In contrast to the second function of the goal, positive deviations of the coefficients of rhythmicity are not cut off because their excess from the planned indicators also negatively affects the work of the enterprise: if the underestimation of the indicators of rhythmicity leads to losses due to the underloading of part of the production capacities, then the overestimation of these indicators, on the contrary, overloads individual subsystems management, which later begins to deteriorate their effectiveness. We are talking not only about production units, the rhythmic execution of all technological and control operations but also the maintenance of all business processes and communications.

The formed economic–mathematical model contains three equivalent objective functions $F_1(x)$, $F_2(y)$, $F_3(z)$, which, in the general formulation of the problem, have the same significance. Hence, it is possible to use the scheme of uniform optimization. In practice, it may turn out that budget constraints are not critical, and most control subsystems are not loaded to design capacity, so the priority will be the function $F_2(y)$—minimization of deviations of business indicators. If the enterprise has financing problems, we focus on function $F_1(x)$—minimizing the uncovered costs associated with implementing the smartization project. The rarest case is when the control system is really overloaded; then the $F_3(z)$ function will become critical, minimizing disruptions to the rhythm of business processes.

So, according to the scheme of uniform optimization, an additional problem is constructed, the objective functions are translated into constraints, and the basic economic–mathematical model is obtained:

$$\begin{cases} \varphi \to min \\ F_1(x) + F_1^* \varphi \geq F_1^*; \\ F_2(x) + F_2^* \varphi \geq F_2^*; \\ F_3(x) + F_3^* \varphi \geq F_3^*; \\ \sum_{i=1}^{n} \sum_{j=1}^{m} v_{ij} \leq s_j V_j; \\ \sum_{j=1}^{m} s_j \leq \overline{K}; \\ \sum_{i=1}^{n} \sum_{j=1}^{m} \omega_{ij} \leq dW_j; \\ t_j \leq \frac{\frac{K_{max}}{100}}{12} \tau_j; \\ \varphi, v_{ij}, s_j, V_j, \overline{K}, \omega_{ij} \geq 0; \\ d, W_j, t_j, K_{max}, \tau_j \geq 0. \end{cases} \tag{18}$$

where φ is the relative deterioration of the best value of each objective function, which is obtained during the partial solution for each function (assuming that the weights of all three functions $F_1(x)$, $F_2(y)$, $F_3(z)$ are the same);

F_1^*, F_2^*, F_3^*—the optimal values of the target functions $F_1(x)$, $F_2(y)$, $F_3(z)$, which are obtained by solving three partial cases (one by one for each function separately, that is, the value of F_1^*, F_2^*, F_3^* are exemplary, obtained under conditions where the other two functions do not exist, as well as their inherent limitations).

In expanded form, the economic–mathematical model will look like this:

$$\begin{cases} \varphi \to min \\ \sum_{i=1}^{n} \sum_{j=1}^{m} \left(v_{ij} - \omega_{ij} t_j \right) + F_1^* \varphi \geq F_1^*; \\ \sum_{i=1}^{n} \sum_{j=1}^{m} \left(\left| \frac{y_{ij}^1 - y_{ij}^0}{y_{ij}^0} \times 100\% \right| \times \Theta_{ij} \right) + F_2^* \varphi \geq F_2^*; \\ \sum_{i=1}^{n} \sum_{j=1}^{m} \left| \frac{z_{ij}^1 - z_{ij}^0}{z_{ij}^0} \right| + F_3^* \varphi \geq F_3^*; \\ \sum_{i=1}^{n} \sum_{j=1}^{m} v_{ij} \leq s_j V_j; \\ \sum_{j=1}^{m} s_j \leq \overline{K}; \\ \sum_{i=1}^{n} \sum_{j=1}^{m} \omega_{ij} \leq dW_j; \\ t_j \leq \frac{\frac{K_{max}}{100}}{12} \tau_j; \\ \varphi, v_{ij}, \omega_{ij}, t_j, y_{ij}^0, y_{ij}^1, z_{ij}^0, z_{ij}^1 \geq 0; \\ s_j, V_j, \overline{K}, d, W_j, K_{max}, \tau_j \geq 0; \\ \Theta_{ij} = 0 \vee 1. \end{cases} \tag{19}$$

This model can be used at any stage of the smartization project. Based on it, conclusions can be drawn regarding the effectiveness of the implementation of the entire project and its individual stages, objects, or elements. The advantage of this model is the possibility of its decomposition, that is, a division into separate parts with the possibility of introducing additional restrictions or, conversely, reducing the level of requirements for some of them. For example, when budget conditions change, adjusting the variable V_j (budget of the smartization project at the j-th stage) and/or the coefficient of unplanned expenses sj is enough. Often, there is a need to consider changes in credit conditions; then, we adjust the coefficients $\overline{K}$ (average annual interest rate on loans available to the enterprise) and K_{max}—the maximum lending rate of the previous year).

It is most difficult to change the conditions related to calculating the optimal value of the second objective function $F_2(y)$, which reflects the minimization of negative deviations of the actual values of business indicators from the planned ones. The fact is that the planned values of business indicators are mostly set at the level of the implemented smartization project after it has been created, but the customer often wants to see the forecast results for the objects vital to him, even at the project development stage. In this case, it is proposed to carry out a computer simulation of the reaction of the production and management subsystems of the enterprise to the "intervention" of smartization in its business processes. For such simulation results to be significant, it is possible to calculate the Model (19) in partial forms several times, setting the planned values of business indicators at the minimum permissible and desired levels. At the output, we obtain not unit values of deviations, but their ranges, which becomes a criterion for the ineffectiveness of the smartization project.

4. Results

The proposed scheme for selecting indicators for diagnosing the results of DTSP was tested at PJSC "Odeskabel" and PJSC "Lviv Locomotive Repair Plant" (hereinafter PJSC "LLRP") since these enterprises had practice in similar directions, namely, smartization of business processes related to the improvement in strategic planning, personnel work, or the communication system. Simulation modeling of the impact of a similar smartization project on the results of operations was carried out at five more enterprises (based on the hypothesis that these enterprises will develop stably even without smartization within the limits of the increases in indicators that they demonstrated in previous periods). The influence of external environmental factors is excluded, and the deviations in demand, prices, exchange rates, and the consequences of state regulation are neglected. In such conditions, a computer simulation was carried out, which involved reproducing the impact of real DTSP of PJSC "Odeskabel" and PJSC "LLRP" on the input data of the other five enterprises in the same time intervals.

Technologically, the hypothetical impact of the standardized project of smartization on the work of enterprises was diagnosed according to the following mechanism:

(1) For each indicator from the selected sets, the structure and dynamics of changes during the calendar year 2021 are monitored, and attention is paid to the smoothness of changes in indicators and the connections between them;
(2) As far as possible, the influence of price indexation, exchange rate fluctuations, and the influence of state regulation is eliminated;
(3) A dynamic model of indicator increments is formed, i.e., the trends of changes in each indicator are monitored in the absence of additional influences;
(4) The hypothetical impacts of the smartization project are superimposed on each indicator (in proportion to those that actually occurred at PJSC "Odeskabel" and PJSC "LLRP");
(5) Parameter differences are monitored, and the "net" impact of the diagnosed smartization project is calculated.

We calculate the parameters of the models of the relationship of indicators of the financial condition of enterprises and the resulting business indicators on the primary data obtained from the implemented DTSP of PJSC "Odeskabel" and PJSC "LLRP" and simulated for five more industrial enterprises (Table 4). In some cases, the list of indicators can be expanded due to those not included in the basic sets of business indicators (see Table 2 and Appendix B) but are informative in the context of individual DTSP.

The results of such simulation (Table 4) indicate a high level of convergence of diagnostic indicators, which proves the effectiveness of the proposed indicator selection scheme. The input data of the computer simulation are given in Appendix A.

For presenting the results of DTSP to the management of customer enterprises, graphic constructions that reflect the comparative dynamics of changes in indicators are well-suited. Such graphs are built automatically; they can be grouped by objects of influence, the composition of indicators, the structure of changes, etc. For example, a visualization of the impacts of the smartization project averaged according to the data of those enterprises that were the objects of this study, is given. Since most DTSPs are implemented annually, four quarterly periods are taken as a basis (Figure 3).

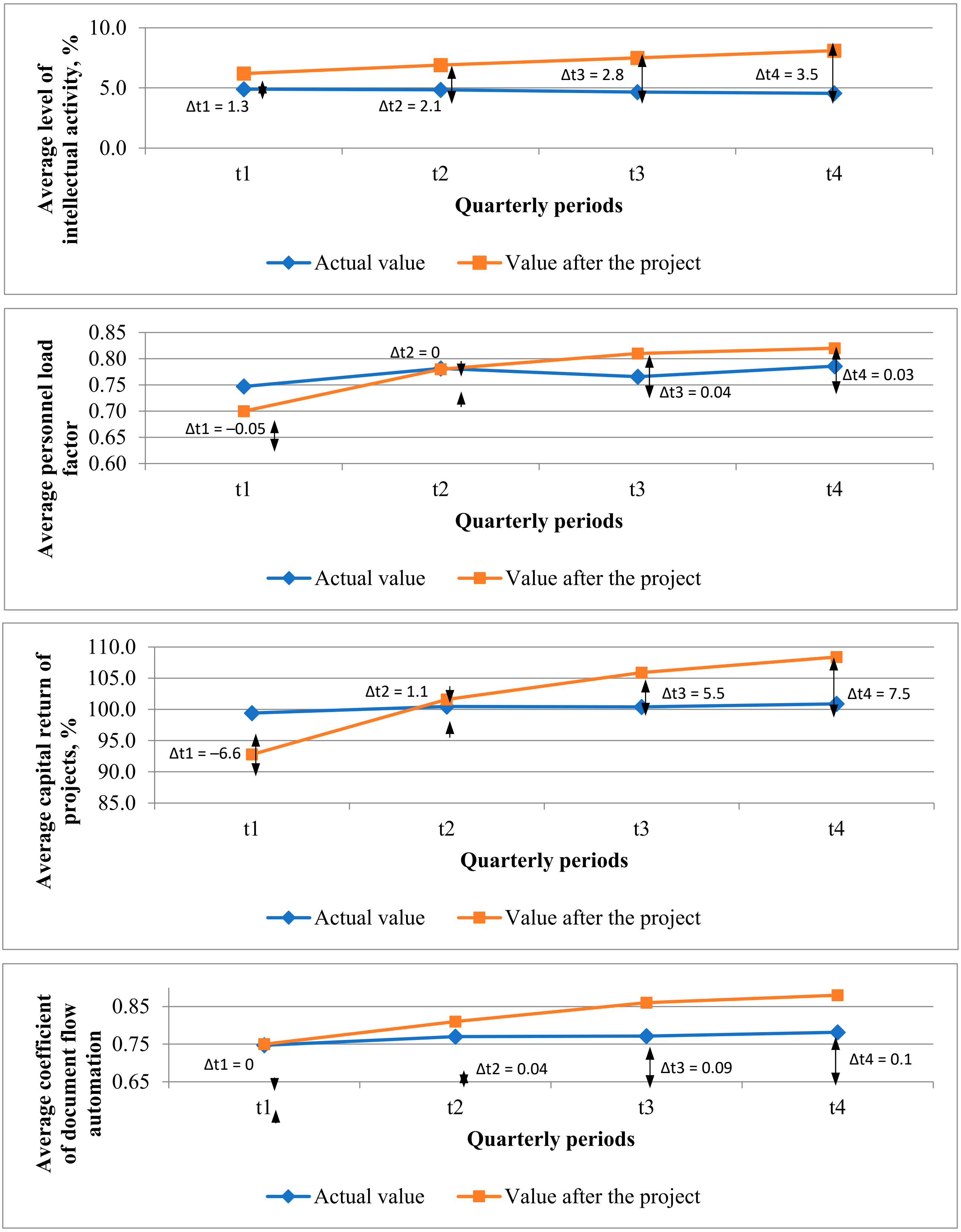

Figure 3. Graphical interpretation of individual results of the implementation of the smartization project diagnosed at the investigated enterprises (source: calculated by the authors).

The obtained results, among other things, demonstrate the deterioration of individual indicators and highlight the need for situational relaxation of requirements for individual results of the smartization project. For example, in the first quarter, the average staff utilization ratio is reduced because, due to innovations, part of the employees cannot perform some types of work on time (software is changed, technical means are updated, part of the functional duties undergo changes, rotations occur, etc.). Also, in the beginning, the average return on capital of projects of a strategic nature, which were started before the implementation of smartization proposals, is sharply reduced because financial and human resources are diverted to other works. However, later, the values of these indicators level off and reach levels that would be attainable with the implementation of the smartization project.

Separate results of modeling the impact of implemented DTSP on the activities of some industrial enterprises also demonstrate a relative deterioration (for example, $b_{23}^{E_2}$—wage intensity of products or $b_{25}^{E_2}$—costs of maintaining the communications system). This is quite natural since the wage fund increases to stimulate the intellectual activity of employees and communication costs increase, without which it will not be possible to increase the automation of business processes. At individual enterprises, the situation is significantly different from the average trend; in particular, PJSC "Iskra" has a much higher initial level of development of information and technological work support; therefore, the growth of its indicators is much more modest. On the other hand, due to the economic and political circumstances of the region, JSC "Ekvator" is losing its production capacity, which cannot be eliminated in the modeling (see Table 2).

In the first stage, nine multivariate regression equations were obtained, five of which were characterized by an insignificant coefficient of determination ($R^2 < 0.33$). The regression analysis results (Appendix B, Tables A25–A33) show that the weak connection between the indicators is short-term peak changes in parameters caused mainly by force majeure circumstances at individual enterprises. Indeed, PJSC "LLRP", PJSC "Odeskabel", PJSC "Iskra", PJSC "Azot" Sich", and PJSC "KZR" demonstrated a sharp increase in net income (over 100%); then, this indicated the receipt of advance payments for large contracts at the beginning of the year, and not about the general trend of income growth. In subsequent quarters, the increase in net income did not exceed 40% due to its cumulative reflection in the financial statements of enterprises. This gives reason to exclude from consideration or additionally normalize extreme changes in individual parameters at the second stage of the regression analysis, provided that their sharp differences are compensated for in the following quarters (on average, linear deviations in the sum are insignificant). The same applies to the modeling of changes in the cost of production: in specific periods, enterprises purchased large batches of material resources or energy carriers, so in some quarters, there was a sharp increase in direct costs, and in others—their proportional reduction to the average annual value.

The operating profit of enterprises was also characterized by peak fluctuations associated with non-production activities (purchase and sale of financial assets, investments, currency transactions, etc.). On the one hand, enterprises in the east of Ukraine had significant violations of the rhythm of activity, but on the other hand, there was a situational increase in orders related to the production and repair of military equipment. Much more minor fluctuations characterized the market value of enterprises and the number of liquid assets; however, some sharp fluctuations of the parameters were also observed here. As for the relative indicators of the financial condition of enterprises (profitability of sold products, autonomy coefficient, total liquidity coefficient, return on capital), they are derived values that characterize several parameters at the same time; therefore, the requirements for the density of communication for them are lower by default.

After eliminating the influence of extreme changes in parameters, a repeated regression study was conducted, which demonstrated a significantly higher degree of density of the connection between the features (Appendix B, Tables A34–A42). However, several regression equations still revealed the insufficient density of connections to conclude the impact of specific business indicators on indicators of the financial condition of enterprises.

As a result of the comparison of regression equations at two stages, answers to the feasibility of further analysis were obtained (Table 5).

Table 5. The results of the regression analysis of the relationship between indicators of the financial condition of enterprises from sets of business indicators of DTSP.

Indicators of the Financial Condition of Enterprises (All Values)	**Values of Parameters of Regression Equations at the First Stage of Analysis**								
	a_0	a_1	a_2	a_3	a_4	a_5	a_6	R^2	δ
Net income from product sales, Y_1	−0.64	0	32	0	0	0	0	0.9999	0.001
Cost of goods sold, Y_2	258.5104	−1.0239	0	−0.7196	0.9996	−0.1223	−2 01.278	0.526	34.8937
Operating profit, Y_3	−5	0	0.0000	100	0	0	0	0.875	0.0001
Volume of liquid assets, Y_4	58.9658	−1.8806	−1.6785	4.2202	– 0.4001	2.7485	−10.3290	0.3221	104.894
Market value, Y_5	0.02788	−0.2568	2.4207	0	−0.258	0	−0.258	0.875	0.0001
Profitability of sold products, Y_6	22.6012	−0.444	0	0	0	0	– 2.1145	0.063	130.95
Coefficient of autonomy, Y_7	−0.8574	0.1637	0.0956	−0.0222	0	0	0.0582	0.2069	3.649
Total liquidity ratio, Y_8	0.3246	0.1429	1.4342	−1.1639	−2.4851	−0.0677	0.07860	0.2475	22.1488
Capital return, Y_9	52.2708	1.5262	−1.4153	−0.2606	2.0184	0.0521	1.1664	0.3607	34.1633
Indicators of the financial condition of enterprises (without extreme changes)	Values of parameters of regression equations at the second stage of analysis								
	a′0	a′1	a′2	a′3	a′4	a′5	a′6	R 2	δ
Net income from the sale of products, Y'_1	−1.9393	0.0469	32.2121	−0.1063	0.0761	−0.0362	−0.0598	0.9984	0.985
Cost of goods sold, Y'_2	207.280	−13.5345	109.4440	−3.0303	−0.2361	−0.7493	−161.7350	0.3650	23.2338
Operating profit, Y'_3	−2.4900	0.1924	−0.0971	77.3293	23.7265	−0.0123	0.9860	0.9999	1.5829
Volume of liquid assets, Y'_4	3.5238	0.1836	0.1524	−0.0176	−0.1179	0.6446	−0.3273	0.3646	4.0823
Market value, Y'_5	0.0000	−0.2568	2.2300	0.2980	−0.2580	0.5480	−0.2580	0.9999	0.0000
Profitability of sold products, Y'_6	−2.2434	−0.0443	10.266	0	0.5382	0	−0.0234	0.9145	8.4389
Coefficient of autonomy, Y'_7	−3.0772	0.0688	0.0032	0.0407	9.1069	2.059	−0.0185	0.7186	2.3233
Total liquidity ratio, Y'_8	−2.4760	0.3173	−0.3432	−0.5369	0.8752	0.4006	0.0249	0.7048	2.5850
Capital return, Y'_9	50.8056	−1.0782	−1.3685	−0.4618	1.1777	1.4227	−1.0325	0.4087	17.560

At the first stage of regression analysis, the highest degree of relationship density (R^2 = 0.9999) was observed for indicators of net income (Y_1), operating profit (Y_3), and market value (Y_5). A more or less significant degree of connection density is based on the cost of goods sold (Y_2) with an indicator of R^2 = 0.5260. According to the rest of the indicators, the coefficient of determination is $R^2 < 0.5$, so the models based on the parameters of the volume of liquid assets (Y_4), the profitability of sales (Y_6), autonomy coefficients (Y_7), total liquidity (Y_8), and return on capital (Y_9) are unsuitable for further work. As a result, increases in all relative indicators of financial stability in a "pure" form do not depend on gains in business indicators of DTSP. Relative indicators are significantly more affected by extreme but short-term changes in input parameters, which have different directions of change according to various factor characteristics.

After excluding from consideration all extreme values of the input data, related either to force majeure circumstances at the enterprises or to disproportionate changes in performance indicators in individual quarters, a much better result of the regression analysis was obtained. In particular, in addition to net income (Y'_1), operating profit (Y'_3), and market value (Y'_5), the coefficients of determination for which remained at the level of R^2 = [0.9988 ÷ 0.9999], the dependencies became significant: profitability of sold products (Y'_6) with R^2 = 0.9145; coefficient of autonomy (Y'_7) with R^2 = 0.7186; coefficient of total liquidity (Y'_4) with R^2 = 0.7048. Three indicators of financial condition did not reach a level of connection density sufficient for further analysis—the cost of goods sold, Y'_2 with R^2 = 0.365, volume of liquid assets, Y'_4 with R^2 = 0.3646, and return on capital (Y'_9) with R^2 = 0.4087.

If we are guided by the limiting criteria of $a_{ij} \geq 0.001$ and $R^2 \geq 0.667$, then the regression models will remain significant for the economic evaluation of the implementation of diagnosed DTSP:

$$Y_1' = -1.9393 + 0.0469X_{11} + 32.2121X_{12} - 0.1063X_{13} + 0.0761X_{14} - 0.0362X_{15} - 0.0598X_{16} \quad (20)$$

$$Y_3' = -2.49 + 0.1924X_{31} - 0.0971X_{32} + 77.3293X_{33} + 23.7265X_{34} - 0.0123X_{35} + 0.986X_{36} \quad (21)$$

$$Y_5' = -0.2568X_{51} + 2.23X_{52} + 0.298X_{53} - 0.258X_{54} + 0.548X_{55} + 0.258X_{56} \quad (22)$$

$$Y_6' = -2.2434 - 0.0443X_{61} + 10.266X_{62} + 0.582X_{64} - 0.0234X_{66} \quad (23)$$

$$Y_7' = -3.0772 + 0.0688X_{71} + 0.032X_{72} + 0.0407X_{73} + 9.1069X_{74} + 2.059X_{75} + 0.0185X_{76} \quad (24)$$

$$Y_8' = -2.476 + 0.3173X_{81} - 0.3432X_{82} - 0.5369X_{83} + 0.8752X_{84} + 0.4006X_{85} + 0.0249X_{86} \quad (25)$$

Based on the decoding of the variables (see Table 4), it is evident that the business indicators of consumer capital had the most significant impact on the financial results of enterprises—customers of DTSP (return on capital of client capital X_{11}; effectiveness of marketing communications X_{13}, X_{56}; share of regular consumers X_{36}; level of reliability of the customer base X_{55}; level of quality of consumer capital X_{64}); business indicators of management quality (staff load ratio X_{32}; level of managers' competencies X_{14}, X_{83}; share of operational time X_{16}; long-term goal realization ratio X_{35}, X_{84}; effectiveness of the management subsystem in terms of labor productivity X_{51}, X_{81}; level of intellectual activity X_{15}, X_{66}, X_{76}; correspondence of the number of managers to the normative X_{82}), business indicators of the effectiveness of expenses for the development of intellectual capital (profitability of communication expenses X_{53}; labor remuneration fund X_{54}, X_{61}; volume of social costs X_{72}; costs for the communication system X_{73}), and indicators of internal processes (coefficient of business automation of processes X_{31}; capital return on projects x_{71}; production rhythm X_{85}; labor productivity X_{86}).

It is worth noting that the input data were very heterogeneous because of the specifics of industrial enterprises, their territorial location, economic problems of recent years, military operations in Donbas, etc. Suppose a group of enterprises is selected more precisely, or it is about one enterprise. In that case, the mentioned models of Relationships (20)–(25) will have an even greater density of connections, and the coefficient of determination of regression models excluded from consideration will increase significantly. Thus, we argue the practical significance of the developed methodology of cross-selection of business indicators for the study of relationships between the results of implemented DTSP and the current financial results of enterprises. Similar multifactor regression models can be built to diagnose the impact of smartization at the stages of development and implementation of project solutions. The results of comparing the forecast regression values of indicators with their actual changes may well become the basis for adjusting the process and tools of DTSP.

5. Discussion and Conclusions

We consider the following developments as the most important results of this study:

– A two-level graphical and analytical model for diagnosing the results of the implementation of DTSP (Figure 2), which allows for taking into account the interests of the project participants regarding the choice of diagnosis methods and techniques for identifying alternative sets of business indicators for each object of influence of the smartization project, to establish economic and non-economic criteria for evaluating the effectiveness of consulting, as well as perform monitoring of indicators and automated processing of diagnostic results to regulate deviations from the optimal values of project results. At the first level, sustainable relationships between the project effectiveness parameters of DTSP and the financial results of the customer enterprise are identified and described. At the second stage of the economic evaluation of the implementation of diagnosed DTSP, alternative models of the relationship of key parameters of enterprises' financial state with sets of DTSP results are formed either by objects of influence or by crucial business indicators with a universal purpose. Conducted research and calculations show that in most cases, the density of communication between parameters is not high; therefore, it is advisable to form an economic–mathematical model for optimizing the implementation of diagnosed DTSP, which will be able to reconcile the costs of implementing the project solutions with the requirements for minimizing deviations of the actual values of business indicators from the planned and at the same time ensure the slightest possible disturbances in the rhythm of production. The formed economic–mathematical model contains three equivalent functions of the goal: $F_1(x)$—minimization of uncovered costs for the design, implementation and maintenance of the smartization project; $F_2(y)$—minimization of negative deviations of the actual values of business indicators from the planned ones; $F_3(z)$—depreciation of violations production rhythms in the process of implementing the smartization project, which in the general formulation of the problem have the same significance; therefore we can use the scheme of uniform optimization. This model can be used at any stage of the smartization project. Based on it, conclusions can be drawn regarding the effectiveness of the implementation of the entire project and its individual stages, objects, or elements. The advantage of this model is the possibility of its decomposition, that is, a division into separate parts with the possibility of introducing additional restrictions or, conversely, reducing the level of requirements for some of them;
– A matrix for selecting indicators for diagnosing the results of the implementation of DTSP for industrial enterprises (Table 2), which showed its effectiveness when tested at industrial enterprises;
– Simulation modeling of the impact of a smartization project on the performance of industrial enterprises was carried out (based on the hypothesis that these enterprises will develop stably even without smartization within the limits of the increases in indicators that they demonstrated in previous periods). The influence of external environmental factors is excluded, and the deviations in demand, prices, exchange rates, and the consequences of state regulation are neglected. In such conditions, a computer simulation was carried out, which involved reproducing the impact of real DTSP of PJSC "Odeskabel" and PJSC "LLRP" on the input data of the other five enterprises in the same time intervals.

6. Limitations of this Study

For clarity of presentation of the results and ease of approbation of this study, the authors set certain limitations:

– Definition of smartization as a process in its essence;
– Management of the smartization process is defined as a project management process, that is, one that has a clear time frame, resources, executors, etc.;
– The smartization project is carried out by a third-party organization (not by the enterprise itself) for an industrial enterprise.

Therefore, if there are other conditions (considering smartization as a phenomenon or the company carrying out smartization on its own), then it will be necessary to make corrections both in the methodology and assessment indicators and to conduct an approbation once again.

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Data Availability Statement: This study analyzed publicly available datasets. The data can be found here: https://databank.worldbank.org (accessed on 15 March 2022), http://www.ukrstat.gov.ua (accessed on 15 March 2022), https://saee.gov.ua (accessed on 15 March 2022). Other data were collected by the authors. The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Input data for computer modeling of the impact of implemented consulting projects on the activities of other machine-building enterprises.

Table A1. Balance indicators regarding the structure of enterprise assets, thousand UAH.

Enterprises	The Value of Indicators															
	Balance Sheet Assets				Non-Current Assets				Intangible Assets				Current Asset			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC “LLRP”	245,002	247,574	247,968	268,576	131,864	131,500	130,340	134,035	4312	4357	4488	4740	113,138	116,074	117,628	134,541
PJSC “Odeskabel”	1,093,358	1,109,748	1,108,564	1,117,976	139,584	141,252	144,281	144,885	13,978	14,520	15,218	15,332	953,774	968,496	964,283	973,091
PJSC “Iskra”	21,444,785	23,528,546	25,235,330	25,245,657	6,066,133	6,142,107	6,288,825	6,852,489	1800	1782	5705	5266	15,378,652	17,386,439	18,946,505	18,393,168
PJSC “Azot”	419,589	422,159	431,580	434,835	79,859	78,443	80,564	80,229	785	748	756	762	339,730	343,716	351,016	354,606
PJSC “Radar”	518,966	497,832	528,238	530,632	312,197	311,966	311,813	333,823	215,829	215,843	215,894	240,025	206,769	185,866	216,425	196,809
JSC “Ekvator”	337,973	336,390	332,448	329,975	300,954	300,745	300,912	309,999	1392	1392	1253	1253	37,019	35,645	31,536	19,976
PJSC “KBVP”	1,068,497	1,066,798	1,069,577	1,069,979	924,458	924,980	925,948	927,017	1200	1236	1249	1199	144,039	141,818	143,629	142,962

Table A2. Balance indicators regarding the structure of enterprises’ liabilities, thousand UAH.

Enterprises	The Value of Indicators															
	Balance Sheet liabilities				Own Capital				Long-Term Liabilities				Current Liabilities			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC “LLRP”	245,002	247,574	247,968	268,576	153,283	141,103	132,795	131,230	826	670	662	393	90,893	105,801	114,511	136,953
PJSC “Odeskabel”	1,093,358	1,109,748	1,108,564	1,117,976	−294,938	−297,955	−285,970	−273,887	111,068	113,189	113,189	116,781	1,277,228	1,294,514	1,281,345	1,275,082
PJSC “Iskra”	21,444,785	23,528,546	25,235,330	25,245,657	14,128,146	15,517,954	16,500,510	16,342,312	1,257,610	4,199,314	4,176,924	3,376,012	6,059,029	3,811,278	4,557,896	5,527,333
PJSC “Azot”	419,589	422,159	431,580	434,835	324,205	324,205	324,205	324,205	786	759	795	771	94,598	97,195	106,580	109,859
PJSC “Radar”	518,966	497,832	528,238	530,632	414,570	405,708	428,102	452,871	681	692	692	637	103,715	91,432	99,444	77,124
JSC “Ekvator”	337,973	336,390	332,448	329,975	304,453	293,214	290,549	290,090	415	1605	1800	1992	33,105	41,571	40,099	37,893
PJSC “KBVP”	1,068,497	1,066,798	1,069,577	1,069,979	−415,928	−428,458	−436,190	−447,158	205,259	204,869	206,171	207,377	1,279,166	1,290,387	1,299,596	1,309,760

Table A3. Indicators of financial results of enterprises, thousand UAH.

Enterprises	The Value of Indicators															
	Net Income from Product Sales				Cost of Goods Sold				Gross Profit				Net Profit			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	27,356	59,413	82,628	116,924	26,425	59,522	83,638	178,490	931	−109	−1010	−61,566	−11,158	−22,979	−33,083	−35,944
PJSC "Odeskabel"	115,984	235,959	408,887	526,259	107,998	203,187	355,287	428,836	7986	32,772	53,600	97,423	−3195	−10,958	−16,352	−20,931
PJSC "Iskra"	2,111,134	5,058,087	7,541,346	10,496,206	747,833	1,809,703	2,915,451	4,220,240	1,363,301	3,248,384	4,625,895	6,275,966	310,665	1,279,660	1,860,610	1,955,441
PJSC "Azot"	113,085	197,750	312,287	514,113	98,580	166,095	253,811	407,132	14,505	31,655	58,476	106,981	6618	23,098	42,610	51,504
PJSC "Radar"	28,690	73,445	146,267	205,106	22,450	60,493	121,056	168,047	6240	12,952	25,211	37,059	896	1456	18,988	21,652
JSC "Ekvator"	7811	14,803	21,636	29,421	5738	11,847	28,774	28,394	2073	2956	−7138	1027	−3081	−10,610	−12,375	−13,234
PJSC "KBVP"	59,852	105,787	155,190	223,545	60,198	108,284	163,457	235,873	−346	−2497	−8267	−12,328	−599,124	−613,248	−694,941	−666,757

Table A4. Indicators of the structure of functional costs of enterprises, thousand UAH.

Enterprises	The Value of Indicators															
	Administrative Expenses				Sales Expenses				Labor Costs				Deductions for Social Events			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	8878	16,885	24,424	33,745	226	434	552	833	16,669	31,765	45,332	64,402	3667	6988	9973	14,168
PJSC "Odeskabel"	7668	15,861	23,681	30,216	5237	9668	14,580	21,236	17,945	37,985	54,510	71,688	3948	8357	11,992	15,771
PJSC "Iskra"	248,238	508,166	752,166	1,052,515	58,858	98,352	245,153	378,887	444,220	879,171	1,362,583	1,835,975	97,728	193,418	299,768	403,915
PJSC "Azot"	10,259	21,689	30,457	41,975	3038	6648	8970	12,535	33,158	65,884	95,702	132,289	7295	14,494	21,054	29,104
PJSC "Radar"	3457	7160	11,307	15,241	724	1536	2370	3283	9119	20,322	32,680	46,326	2006	4471	7190	10,192
JSC "Ekvator"	1188	2493	3077	3781	223	499	732	926	1198	2579	3238	3816	264	567	712	840
PJSC "KBVP"	14,491	29,212	43,578	60,246	1068	2267	3522	4686	17,442	33,689	52,247	70,291	3837	7412	11,494	15,464

Table A5. Indicators of the structure of management costs of enterprises, thousand UAH.

Enterprises	The Value of Indicators															
	Expenditures on R&D				Expenses for Professional Development				Expenses for Communication Needs				Expenditures on Strategic Projects			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC “LLRP”	1412	2698	3187	7345	223	468	621	942	661	1618	2610	3031	164	201	222	231
PJSC “Odeskabel”	6308	12,607	18,932	28,901	2309	4608	7801	8506	6204	10,608	16,007	23,290	2004	2208	3197	4398
PJSC “Iskra”	42,308	99,702	163,923	240,955	23,051	52,087	84,707	122,922	46,601	92,608	166,038	217,084	3600	5207	9796	11,614
PJSC “Azot”	4191	7498	9880	11,591	2795	4292	7590	11,602	3308	4209	5000	6607	664	1000	1314	1500
PJSC “Radar”	850	2208	3609	5500	520	1705	2207	2500	1000	1607	2707	3124	138	200	220	230
JSC “Ekvator”	293	520	1404	1492	50	320	720	1000	160	550	670	790	60	90	99	111
PJSC “KBVP”	3795	6607	10,607	16,701	1895	2208	3000	4095	1198	2000	2100	4501	160	674	998	1307

Table A6. Indicators of the number of personnel, persons.

Enterprises	The Value of Indicators															
	Average Number of Employees				The Average Number of Managers				The Average Number of Engineering and Technical Personnel				The Average Number of Active Employees			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC “LLRP”	1297	1319	1293	1249	320	320	309	310	350	340	342	333	109	110	111	109
PJSC “Odeskabel”	1598	1595	1693	1695	400	400	400	400	420	419	430	431	200	172	190	200
PJSC “Iskra”	27,080	27,089	27,206	26,920	4609	4602	4608	4612	6298	6345	6391	6408	1309	1408	1504	1303
PJSC “Azot”	2012	2045	2087	2056	320	321	330	331	420	430	440	432	120	130	140	150
PJSC “Radar”	1100	1102	1109	1110	207	199	200	201	270	260	262	264	100	101	103	99
JSC “Ekvator”	89	92	91	89	20	19	19	17	20	19	20	18	10	7	12	13
PJSC “KBVP”	2900	2902	2905	2911	499	499	489	500	699	699	702	711	300	288	295	299

Table A7. The total cost price of shares of functional costs of enterprises, %.

Enterprises	The Value of Indicators															
	Share of Administrative Costs				The Share of Sales Costs				Share of Labor Costs				Share of Social Deductions			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	33.60	28.37	29.20	18.91	0.86	0.73	0.66	0.47	63.08	53.37	54.20	36.08	13.88	11.74	11.92	7.94
PJSC "Odeskabel"	7.10	7.81	6.67	7.05	4.85	4.76	4.10	4.95	16.62	18.69	15.34	16.72	3.66	4.11	3.38	3.68
PJSC "Iskra"	33.19	28.08	25.80	24.94	7.87	5.43	8.41	8.98	59.40	48.58	46.74	43.50	13.07	10.69	10.28	9.57
PJSC "Azot"	10.41	13.06	12.00	10.31	3.08	4.00	3.53	3.08	33.64	39.67	37.71	32.49	7.40	8.73	8.30	7.15
PJSC "Radar"	15.40	11.84	9.34	9.07	3.22	2.54	1.96	1.95	40.62	33.59	27.00	27.57	8.94	7.39	5.94	6.06
JSC "Ekvator"	20.70	21.04	10.69	13.32	3.89	4.21	2.54	3.26	20.88	21.77	11.25	13.44	4.59	4.79	2.48	2.96
PJSC "KBVP"	24.07	26.98	26.66	25.54	1.77	2.09	2.15	1.99	28.97	31.11	31.96	29.80	6.37	6.84	7.03	6.56

Table A8. The full cost price of shares of management costs of enterprises, %.

Enterprises	The Value of Indicators															
	The Share of R&D Expenditures				The Share of Qualification Costs				Share of Communication Costs				The share of Costs for Strategic Projects			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	5.34	4.53	3.81	4.12	0.84	0.79	0.74	0.53	2.50	2.72	3.12	1.70	0.62	0.34	0.27	0.13
PJSC "Odeskabel"	5.84	6.20	5.33	6.74	2.14	2.27	2.20	1.98	5.74	5.22	4.51	5.43	1.86	1.09	0.90	1.03
PJSC "Iskra"	5.66	5.51	5.62	5.71	3.08	2.88	2.91	2.91	6.23	5.12	5.70	5.14	0.48	0.29	0.34	0.28
PJSC "Azot"	4.25	4.51	3.89	2.85	2.84	2.58	2.99	2.85	3.36	2.53	1.97	1.62	0.67	0.60	0.52	0.37
PJSC "Radar"	3.79	3.65	2.98	3.27	2.32	2.82	1.82	1.49	4.45	2.66	2.24	1.86	0.61	0.33	0.18	0.14
JSC "Ekvator"	5.11	4.39	4.88	5.25	0.87	2.70	2.50	3.52	2.79	4.64	2.33	2.78	1.05	0.76	0.34	0.39
PJSC "KBVP"	6.30	6.10	6.49	7.08	3.15	2.04	1.84	1.74	1.99	1.85	1.28	1.91	0.27	0.62	0.61	0.55

Table A9. The total number of shares of employees of different groups of enterprises, %.

Enterprises	The Value of Indicators															
	The Share of Workers in the Total Number of Workers				The Share of Managers in the Total Number of Employees				The Share of Engineering and Technical Personnel in the Total Number of Employees				The Share of Active Workers in Their Total Number			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	48.34	49.96	49.65	48.52	24.67	24.26	23.90	24.82	26.99	25.78	26.45	26.66	8.40	8.34	8.58	8.73
PJSC "Odeskabel"	48.69	48.65	50.97	50.97	25.03	25.08	23.63	23.60	26.28	26.27	25.40	25.43	12.52	10.78	11.22	11.80
PJSC "Iskra"	59.72	59.59	59.57	59.06	17.02	16.99	16.94	17.13	23.26	23.42	23.49	23.80	4.83	5.20	5.53	4.84
PJSC "Azot"	63.22	63.28	63.10	62.89	15.90	15.70	15.81	16.10	20.87	21.03	21.08	21.01	5.96	6.36	6.71	7.30
PJSC "Radar"	56.64	58.35	58.34	58.11	18.82	18.06	18.03	18.11	24.55	23.59	23.62	23.78	9.09	9.17	9.29	8.92
JSC "Ekvator"	55.06	58.70	57.14	60.67	22.47	20.65	20.88	19.10	22.47	20.65	21.98	20.22	11.24	7.61	13.19	14.61
PJSC "KBVP"	58.69	58.72	59.00	58.40	17.21	17.20	16.83	17.18	24.10	24.09	24.17	24.42	10.34	9.92	10.15	10.27

Table A10. Indicators of the use of labor resources.

Enterprises	The Value of Indicators															
	Salary Intensity of Production				Labor Productivity, Thousand Hryvnias/Individual				Coefficient of Intellectual Activity				Staff Turnover Rate			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	0.61	0.53	0.55	0.55	21.09	24.30	17.95	27.46	0.041	0.039	0.036	0.041	0.0118	0.0085	0.0099	0.0170
PJSC "Odeskabel"	0.15	0.16	0.13	0.14	72.58	75.22	102.14	69.25	0.039	0.05	0.04	0.037	0.0108	0.0009	0.0307	0.0006
PJSC "Iskra"	0.21	0.17	0.18	0.17	77.96	108.79	91.28	109.76	0.059	0.07	0.073	0.062	0.0025	0.0002	0.0022	0.0053
PJSC "Azot"	0.29	0.33	0.31	0.26	56.21	41.40	54.88	98.16	0.07	0.05	0.048	0.042	0.0086	0.0082	0.0103	0.0074
PJSC "Radar"	0.32	0.28	0.22	0.23	26.08	40.61	65.66	53.01	0.039	0.05	0.042	0.045	0.0015	0.0009	0.0032	0.0005
JSC "Ekvator"	0.15	0.17	0.15	0.13	87.76	76.00	75.09	87.47	0.046	0.04	0.045	0.047	0.0111	0.0169	0.0054	0.0110
PJSC "KBVP"	0.29	0.32	0.34	0.31	20.64	15.83	17.01	23.48	0.049	0.04	0.042	0.045	0.0006	0.0003	0.0005	0.0010

Table A11. Indicators of intensity of use of working time.

Enterprises	The Value of Indicators															
	Share of Operative Time of Managers				Staff Utilization Ratio				Coefficient of Information Loading				Qualification Ratio of Managers			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	0.73	0.80	0.74	0.75	0.82	0.90	0.82	0.90	0.18	0.22	0.25	0.23	0.94	0.96	0.90	0.93
PJSC "Odeskabel"	0.76	0.76	0.70	0.72	0.76	0.81	0.80	0.80	0.21	0.27	0.28	0.29	0.88	0.90	0.91	0.92
PJSC "Iskra"	0.81	0.77	0.81	0.79	0.71	0.73	0.75	0.71	0.19	0.25	0.23	0.21	0.87	0.86	0.90	0.88
PJSC "Azot"	0.89	0.81	0.72	0.74	0.72	0.74	0.81	0.73	0.21	0.16	0.24	0.20	0.88	0.90	0.91	0.90
PJSC "Radar"	0.69	0.76	0.78	0.83	0.72	0.80	0.73	0.83	0.19	0.25	0.23	0.24	0.84	0.89	0.86	0.85
JSC "Ekvator"	0.79	0.75	0.76	0.79	0.76	0.71	0.72	0.73	0.22	0.24	0.25	0.23	0.91	0.93	0.94	0.91
PJSC "KBVP"	0.80	0.83	0.83	0.80	0.74	0.78	0.73	0.80	0.20	0.27	0.25	0.25	0.93	0.93	0.93	0.94

Table A12. Time spent on working with consumers, person-hours.

Enterprises	The Value of Indicators															
	Time to Work with Consumers				Average Time of Communication with the Client				Response Time to Information Requests				Complaint Response Time			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	2179	1885	1754	1942	45.5	43.8	49.2	47.5	7.9	8.3	9.7	9.2	25.8	25.3	27.2	29.8
PJSC "Odeskabel"	4177	4258	4048	4335	19.3	20.8	24.2	22.3	14.2	15.3	14.3	15.2	16.8	15.2	15.3	16.8
PJSC "Iskra"	32,618	31,490	30,628	31,482	185.2	193.8	180.6	199.1	33.6	35.4	42.8	41.2	71.3	75.5	76.3	76.3
PJSC "Azot"	1835	1664	1794	1875	23.8	33.9	29.5	30.5	16.2	16.8	15.2	15.8	20.2	22.6	24.5	23.6
PJSC "Radar"	1068	1028	1164	1189	20.3	23.9	20.3	24.8	10.2	12.5	14.5	13.1	15.8	16.2	17.5	17.9
JSC "Ekvator"	665	528	655	694	43.3	36.8	39.4	40.1	15.2	18.8	16.3	17.7	26.6	28.5	30.1	29.3
PJSC "KBVP"	6268	6097	6387	6560	65.2	70.8	73.2	75.5	20.2	22.5	20.4	21.6	22.8	25.2	23.2	24.7

Table A13. Performance indicators of consumer capital, %.

Enterprises	The Value of Indicators															
	Effectiveness of Marketing Communications				Capital Return on Client Capital				The Growth Rate of the Client Base				Capital Return on Projects			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	44.3	43.8	43.3	44.0	68.8	70.5	71.3	73.8	85.3	83.4	80.3	82.5	64.8	66.9	65.1	61.3
PJSC "Odeskabel"	84.3	87.9	84.5	86.1	112.8	120.2	115.3	117.2	108.2	112.8	109.6	108.2	98.2	94.8	102.3	101.3
PJSC "Iskra"	72.5	71.5	73.8	72.4	166.8	156.2	158.9	188.8	105.2	106.8	105.2	106.2	106.2	114.5	105.3	108.2
PJSC "Azot"	62.9	74.5	70.4	74.3	123.8	134.4	122.8	126.7	102.8	103.6	104.8	100.2	101.5	109.5	108.9	110.1
PJSC "Radar"	68.2	65.4	70.8	75.1	118.8	128.6	131.8	129.8	99.8	102.5	1046.2	103.8	103.5	107.5	101.2	106.2
JSC "Ekvator"	74.9	80.3	80.2	76.4	111.2	156.3	142.3	131.1	105.2	104.4	108.8	111.4	112.5	106.8	115.8	113.6
PJSC "KBVP"	82.3	85.9	80.4	82.2	113.5	122.8	120.3	125.2	102.2	103.8	105.3	103.8	109.2	103.2	104.2	105.6

Table A14. Indicators of the level of process automation.

Enterprises	The Value of Indicators															
	Factor of Automation of Business Processes				The Coefficient of Document Flow Automation				Coefficient of Automation of Information Processing				Information Security Factor			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	0.32	0.38	0.34	0.36	0.44	0.48	0.49	0.50	0.51	0.56	0.59	0.60	0.18	0.22	0.25	0.23
PJSC "Odeskabel"	0.72	0.75	0.76	0.79	0.88	0.89	0.85	0.85	0.86	0.87	0.88	0.88	0.42	0.48	0.51	0.50
PJSC "Iskra"	0.82	0.84	0.83	0.84	0.85	0.88	0.87	0.87	0.92	0.92	0.91	0.91	0.78	0.72	0.78	0.77
PJSC "Azot"	0.76	0.74	0.75	0.75	0.80	0.82	0.83	0.82	0.78	0.80	0.81	0.81	0.38	0.42	0.45	0.43
PJSC "Radar"	0.68	0.71	0.70	0.72	0.72	0.73	0.72	0.74	0.75	0.76	0.79	0.77	0.41	0.45	0.45	0.46
JSC "Ekvator"	0.65	0.68	0.67	0.66	0.73	0.75	0.78	0.83	0.81	0.84	0.83	0.85	0.55	0.58	0.60	0.61
PJSC "KBVP"	0.78	0.81	0.80	0.80	0.81	0.84	0.86	0.86	0.92	0.90	0.90	0.78	0.81	0.84	0.80	0.85

Table A15. Performance indicators of the management apparatus.

Enterprises	The Value of Indicators															
	The Effectiveness of the Management Subsystem in Terms of Labor Productivity				Correspondence of the Actual Number of Managers to the Normative One				Coefficient of Realization of Long-Term Goals				Current Task Completion Ratio			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	0.85	0.82	0.80	0.79	1.23	1.21	1.19	1.24	0.75	0.78	0.73	0.72	0.84	0.82	0.80	0.80
PJSC "Odeskabel"	0.92	0.94	0.96	0.95	1.25	1.25	1.18	1.18	0.84	0.85	0.84	0.88	0.92	0.94	0.95	0.95
PJSC "Iskra"	1.02	1.03	1.03	1.02	0.85	0.85	0.85	0.86	0.92	0.95	0.94	0.95	0.96	0.96	0.95	0.95
PJSC "Azot"	0.95	0.94	0.92	0.95	0.80	0.78	0.79	0.80	0.88	0.89	0.82	0.84	0.89	0.84	0.82	0.82
PJSC "Radar"	0.84	0.82	0.86	0.82	0.94	0.90	0.90	0.91	0.82	0.84	0.85	0.87	0.78	0.78	0.80	0.79
JSC "Ekvator"	1.02	1.04	1.05	1.04	1.12	1.03	1.04	0.96	0.82	0.80	0.78	0.75	0.78	0.82	0.82	0.84
PJSC "KBVP"	1.05	1.03	1.04	1.05	0.86	0.86	0.84	0.86	0.91	0.92	0.92	0.93	0.85	0.88	0.89	0.91

Table A16. Indicators of the structure of the main production assets, thousand hryvnias.

Enterprises	The Value of Indicators															
	Residual Value				Initial Cost				Discharged during the Period				Arrived during the Period			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	114,971	1,177,025	126,077	115,998	449,094	452,963	453,930	456,004	−1108	1,058,463	−1,060,538	−12,278	2598	3591	9590	2199
PJSC "Odeskabel"	125,687	126,995	127,254	127,087	312,489	315,698	316,089	316,653	−980	−990	−1340	−1465	599	2298	1599	1298
PJSC "Iskra"	5,833,607	5,927,802	6,056,069	6,443,786	8,954,125	9,223,838	9,543,283	10,314,752	−12,597	−18,792	−10,675	−25,271	12,910	112,987	138,942	412,988
PJSC "Azot"	67,541	67,598	68,218	68,500	178,954	179,658	179,544	179,507	−259	−62	−269	−3316	369	119	889	3598
PJSC "Radar"	95,898	94,962	95,049	94,216	502,361	500,247	501,110	500,023	−960	−1045	−152	−932	829	109	239	99
JSC "Ekvator"	1112	987	1058	1024	3728	3309	2791	2304	−220	−374	−148	−234	529	249	219	200
PJSC "KBVP"	780,269	780,987	781,106	781,250	865,987	864,058	866,009	867,944	−229	−391	−240	−1060	359	1109	359	1204

Table A17. Indicators of the intensity of use of the main production assets.

Enterprises	The Value of Indicators															
	Dropout Rate				Refresh Rate				Fund Return				Attrition Rate			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	−0.0096	0.8993	−8.4118	−0.1058	0.0226	0.0031	0.0761	0.0190	0.2379	0.0505	0.6554	1.0080	0.7440	−1.5985	0.7223	0.7456
PJSC "Odeskabel"	−0.0078	−0.0078	−0.0105	−0.0115	0.0048	0.0181	0.0126	0.0102	0.9228	1.8580	3.2132	4.1409	0.5978	0.5977	0.5974	0.5987
PJSC "Iskra"	−0.0022	−0.0032	−0.0018	−0.0039	0.0022	0.0191	0.0229	0.0641	0.3619	0.8533	1.2453	1.6289	0.3485	0.3573	0.3654	0.3753
PJSC "Azot"	−0.0038	−0.0009	−0.0039	−0.0484	0.0055	0.0018	0.0130	0.0525	1.6743	2.9254	4.5778	7.5053	0.6226	0.6237	0.6200	0.6184
PJSC "Radar"	−0.0100	−0.0110	−0.0016	−0.0099	0.0086	0.0011	0.0025	0.0011	0.2992	0.7734	1.5389	2.1770	0.8091	0.8102	0.8103	0.8116
JSC "Ekvator"	−0.1978	−0.3789	−0.1399	−0.2285	0.4757	0.2523	0.2070	0.1953	7.0243	14.9980	20.4499	28.7314	0.7017	0.7017	0.6209	0.5556
PJSC "KBVP"	−0.0003	−0.0005	−0.0003	−0.0014	0.0005	0.0014	0.0005	0.0015	0.0767	0.1355	0.1987	0.2861	0.0990	0.0961	0.0980	0.0999

Table A18. Indicators of the liquid part of assets, thousand UAH.

Enterprises	The Value of Indicators															
	Reserves				Cash in Cash				Money and Its Equivalents				Accounts Receivable for Products, Goods, Works, Services			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRP"	89,828.2	88,730.4	106,441.5	84,267.7	2.2	4.3	1.9	1.1	11,501	1642	6177	6750	7994	25,016	7908	32,088
PJSC "Odeskabel"	101,923.8	104,005	105,182	106,515.2	1.3	2.4	1.8	0.9	685	358	557	483	150	1700	2300	515,616
PJSC "Iskra"	12,767,055.4	12,371,620	12,951,015	13,207,781	302.2	640.3	941.2	1681.8	582,111	2,613,644	2,464,918	2,352,855	1,059,942	1,320,024	1,390,083	1,130,028
PJSC "Azot"	165,360.8	152,526	160,169.9	167,974.4	14.5	14.8	9.5	18.7	75,842	78,992	84,306	82,092	102	312	5684	76,236
PJSC "Radar"	169,652	177,753.4	185,199.3	17,4768	50.2	26.0	41.0	78.1	13,900	4956	27,720	16,322	681	974	950	612
JSC "Ekvator"	6627.5	8453.5	8782.4	9402.8	11.1	8.1	5.7	8.3	24	57	15	16	12,043	1694	11,004	570
PJSC "KBVP"	82,047.9	80,245	83,468	85,984.8	17.2	18.2	14.9	23.3	8496	8106	9068	9414	31,597	34,889	29,818	33,598

Table A19. Indicators of the structure of receivables, thousand UAH.

Enterprises	The Value of Indicators															
	Accounts Receivable for Issued Advances				Accounts Receivable for Settlements with the Budget				Accounts Receivable from Income Tax				Other Current Receivables			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRZ"	678	589	906	1022	7261	4415	3392	3431	3150	3086	2986	2936	407	327	383	1709
Iskra PJSC	5687	5948	7054	7336	1258	489	2487	3930	2	3	2	5	26,847	35,620	45,089	67,247
Motor Sich PJSC	755,517	707,311	732,568	581,123	207,532	210,380	136,661	49,041	3157	962	962	47	189,848	214,633	346,462	322,801
PJSC "KZDM"	25,810	13,587	32,587	27,708	2687	1098	2587	3730	0	0	0	0	125	138	89	236
PJSC "KZR"	0	0	0	0	4743	3988	3827	6815	911	1031	0	1298	15,550	14,340	14,490	9541
PJSC "Azovmash"	17,073	17,074	17,072	17,071	3449	3279	3138	3061	0	2480	2480	0	3087	3022	2982	2976
PJSC "HTZ"	5489	19,587	24,506	21,136	1587	658	1958	1446	12	16	17	31	1268	1593	2158	3436

Table A20. Indicators of the structure of payables (part 1), thousand UAH.

Enterprises	The Value of Indicators															
	Current Payables: For Long-Term Liabilities				Current Accounts Payable: For Goods, Works, Services				Current Accounts Payable According to Settlements with the Budget				Accounts Payable for Income Tax Calculations			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRZ"	0	0	0	0	80,387	91,089	81,002	99,094	988	950	2607	4107	0	0	0	0
Iskra PJSC	243,092	242,089	241,097	239,012	519,087	603,077	615,080	658,115	1318	3624	5194	6204	0	0	0	0
Motor Sich PJSC	32,807	18,819	19,827	19,403	766,968	760,930	617,966	631,968	458,950	205,041	154,969	185,935	433,076	181,155	127,981	158,978
PJSC "KZDM"	0	0	0	0	13,040	20,000	13,607	14,795	2099	3120	3980	4116	0	0	0	0
PJSC "KZR"	0	0	0	0	2095	2600	2679	3011	3192	2532	5030	2254	0	0	2567	0
PJSC "Azovmash"	0	0	0	0	21,597	14,601	24,405	15,402	270	570	600	745	0	0	0	0
PJSC "HTZ"	226,987	214,580	202,358	199,291	263,958	299,050	235,005	253,024	16,687	19,587	21,159	25,110	0	0	0	0

Table A21. Indicators of the structure of payables (part 2), thousand UAH.

Enterprises	The Value of Indicators															
	Current Accounts Payable for Insurance Settlements				Current Accounts Payable for Payroll				Current Accounts Payable for Advances Received				Other Current Liabilities			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRZ"	817	800	799	1019	2900	2912	2812	3561	9	2801	27,950	20,101	178	462	152	312
Iskra PJSC	949	998	999	1022	4295	4118	4909	4845	961	598	1075	1078	13,198	19,628	31,197	25,304
Motor Sich PJSC	29,627	23,900	35,058	32,917	95,804	81,064	87,045	93,404	3,330,031	2,950,062	3,330,089	2,760,156	32,006	41,031	37,500	20,608
PJSC "KZDM"	1904	1970	1600	1650	4590	5030	5700	6520	66,004	67,952	67,119	70,447	9	7	9	12
PJSC "KZR"	0	660	251	650	2800	2845	2456	2201	0	0	0	0	82,103	64,004	89,003	66,082
PJSC "Azovmash"	193	470	471	678	1503	2901	2974	3302	6154	6154	6154	6154	1330	1390	1421	1431
PJSC "HTZ"	23,959	26,000	26,408	27,202	2201	2904	3598	3619	2600	2500	3102	3187	717,087	749,168	753,935	754,198

Table A22. Indicators of business activity.

Enterprises	The Value of Indicators															
	Accounts Receivable Turnover Ratio				Accounts Payable Turnover Ratio				Inventory Turnover Ratio				Asset Turnover Ratio			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRZ"	1.404	1.777	5.305	2.839	0.288	0.559	0.726	1.300	0.294	0.671	0.786	2.118	0.112	0.240	0.333	0.435
Iskra PJSC	3.417	5.392	7.182	0.886	0.078	0.144	0.255	0.308	1.060	1.954	3.378	4.026	0.106	0.213	0.369	0.471
Motor Sich PJSC	0.953	2.062	2.893	5.039	0.102	0.226	0.334	0.474	0.059	0.146	0.225	0.320	0.098	0.215	0.299	0.416
PJSC "KZDM"	3.937	13.066	7.627	4.764	1.034	1.696	2.364	3.680	0.596	1.089	1.585	2.424	0.270	0.468	0.724	1.182
PJSC "KZR"	1.311	3.612	7.592	11.229	0.215	0.657	1.209	2.161	0.132	0.340	0.654	0.962	0.055	0.148	0.277	0.387
PJSC "Azovmash"	0.219	0.537	0.590	1.243	0.171	0.274	0.687	0.712	0.866	1.401	3.276	3.020	0.023	0.044	0.065	0.089
PJSC "HTZ"	1.498	1.864	2.655	3.748	0.041	0.072	0.109	0.155	0.734	1.349	1.958	2.743	0.056	0.099	0.145	0.209

Table A23. Indicators of financial stability.

Enterprises	The Value of Indicators															
	Coefficient of Autonomy				Equity Maneuverability Coefficient				Total Liquidity Ratio				Absolute Liquidity Ratio			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRZ"	0.626	0.570	0.536	0.489	0.140	0.068	0.018	−0.021	1.245	1.097	1.027	0.982	0.127	0.016	0.054	0.049
Iskra PJSC	−0.270	−0.268	−0.258	−0.245	1.473	1.474	1.505	1.529	0.747	0.748	0.753	0.763	0.001	0.000	0.000	0.000
Motor Sich PJSC	0.659	0.660	0.654	0.647	0.571	0.604	0.619	0.581	2.538	4.562	4.157	3.328	0.096	0.686	0.541	0.426
PJSC "KZDM"	0.773	0.768	0.751	0.746	0.754	0.758	0.752	0.753	3.591	3.536	3.293	3.228	0.802	0.813	0.791	0.747
PJSC "KZR"	0.799	0.815	0.810	0.853	0.247	0.231	0.272	0.263	1.994	2.033	2.176	2.552	0.135	0.054	0.279	0.213
PJSC "Azovmash"	0.901	0.872	0.874	0.879	0.011	−0.026	−0.036	−0.069	1.118	0.857	0.786	0.527	0.001	0.002	0.001	0.001
PJSC "HTZ"	−0.389	−0.402	−0.408	−0.418	3.223	3.159	3.123	3.073	0.113	0.110	0.111	0.109	0.007	0.006	0.007	0.007

Table A24. Profitability indicators, %.

Enterprises	The Value of Indicators															
	Profitability of Sold Products				Return on Equity				Return on Assets				Profitability of Production			
	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4	t_1	t_2	t_3	t_4
PJSC "LLRZ"	−42.23	−38.61	−39.55	−20.14	−0.07	−0.16	−0.25	−0.27	−0.05	−0.09	−0.13	−0.13	0.04	0.00	−0.01	−0.34
Iskra PJSC	−2.96	−5.39	−4.60	−4.88	0.01	0.04	0.06	0.08	0.00	−0.01	−0.01	−0.02	0.07	0.16	0.15	0.23
Motor Sich PJSC	41.54	70.71	63.82	46.33	0.02	0.08	0.11	0.12	0.01	0.05	0.07	0.08	1.82	1.79	1.59	1.49
PJSC "KZDM"	6.71	13.91	16.79	12.65	0.02	0.07	0.13	0.16	0.02	0.05	0.10	0.12	0.15	0.19	0.23	0.26
PJSC "KZR"	3.99	2.41	15.69	12.88	0.00	0.00	0.04	0.05	0.00	0.00	0.04	0.04	0.28	0.21	0.21	0.22
PJSC "Azovmash"	−53.69	−89.56	−43.01	−46.61	−0.01	−0.04	−0.04	−0.05	−0.01	−0.03	−0.04	−0.04	0.36	0.25	−0.25	0.04
PJSC "HTZ"	−995.26	−566.33	−425.15	−282.68	1.44	1.43	1.59	1.49	−0.56	−0.57	−0.65	−0.62	−0.01	−0.02	−0.05	−0.05

Appendix B

The results of multivariate regression analysis of dependences of the financial state of enterprises on sets of business indicators of consulting projects (calculated by the author).

Table A25. Regression analysis of net income from product sales (iteration 1).

Regression Statistics				**Analysis of Variance**				
Multiple R		1	Parameters	df	SS	MS	F	Significance of F
R-squared		1	Regression	6	25,754.72706	4292.454509	1.41176×10^{31}	1.2129×10^{-214}
Normalized R-squared		1	Remainder	14	4.25669×10^{-27}	3.0405×10^{-28}		
Standard error		1.7437×10^{-14}	In total	20	25,754.72706			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y_1-intersection	−0.64	9.01493×10^{-15}	-7.09934×10^{13}	2.6729×10^{-187}	−0.64	−0.64	−0.64	−0.64
Variable X11	0	4.16812×10^{-16}	0	1	-8.93972×10^{-16}	8.93972×10^{-16}	-8.93972×10^{-16}	8.93972×10^{-16}
Variable X12	32	3.83559×10^{-15}	8.34291×10^{15}	2.7898×10^{-216}	32	32	32	32

Table A26. Regression analysis of cost of goods sold (iteration 1).

Regression Statistics				**Analysis of Variance**				
Multiple R		0.725223693	Parameters	df	SS	MS	F	Significance of F
R-squared		0.525949405	Regression	6	18,912.11905	3152.019841	3.10654253	0.040987246
Normalized R-squared		0.28521705	Remainder	14	17,045.93864	1217.567045		
Standard error		34.89365337	In total	20	35,958.05768			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y_2-intersection	258.5104415	242.2038662	1.067325826	0.303884731	−260.9651866	777.9860696	−260.9651866	777.9860696
Variable X_{21}	−1.023890556	0.704505353	−1.453346737	0.168174219	−2.53490426	0.487123147	−2.53490426	0.487123147
Variable X_{22}	0	0	65535	0	0	0	0	0
Variable X_{23}	−0.719569883	0.55737419	−1.290999647	0.213239783	−1.915018626	0.475878861	−1.915018626	0.475878861
Variable X_{24}	0.999568228	0.945467934	1.057220654	0.308313092	−1.028258812	3.027395267	−1.028258812	3.027395267
Variable X_{25}	−0.155276876	0.318007269	−0.488280903	0.632909885	−0.837334632	0.52678088	−0.837334632	0.52678088
Variable X_{26}	−201.2780823	258.0194995	−0.780088647	0.448327255	−754.6748701	352.1187054	−754.6748701	352.1187054

Table A27. Regression analysis of the operating profit of enterprises (iteration 1).

Regression Statistics								
			Analysis of Variance					
Multiple R		1	Parameters	df	SS	MS	F	Significance of F
R-squared		1	Regression	6	34,032,266.04	5,672,044.34	7.50191×10^{31}	1.0138×10^{-219}
Normalized R-squared		0.875	Remainder	16	1.81459×10^{-24}	1.13412×10^{-25}		
Standard error		3.36767×10^{-13}	In total	22	34,032,266.04			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y_3-intersection	−5	8.07053×10^{-14}	-6.19538×10^{13}	1.7905×10^{-212}	−5	−5	−5	−5
Variable X_{31}	3.79631×10^{-14}	1.90977×10^{-14}	1.987836773	0.064220617	-2.5222×10^{-15}	7.84484×10^{-14}	-2.5222×10^{-15}	7.84484×10^{-14}
Variable X_{32}	6.56658×10^{-15}	1.21292×10^{-14}	0.541387379	0.595699316	-1.91461×10^{-14}	3.22793×10^{-14}	-1.91461×10^{-14}	3.22793×10^{-14}
Variable X_{33}	100	6.01196×10^{-15}	1.66335×10^{16}	2.4565×10^{-251}	100	100	100	100
Variable X_{34}	0	0	65535	0.07	0	0	0	0
Variable X_{35}	3.09652×10^{-14}	2.77766×10^{-14}	1.114794133	0.387721	-2.79186×10^{-14}	8.98489×10^{-14}	-2.79186×10^{-14}	8.98489×10^{-14}
Variable X_{36}	0	0	65535	0.5989	0	0	0	0

Table A28. Regression analysis of liquid assets of enterprises (iteration 1).

Regression Statistics								
			Analysis of Variance					
Multiple R		0.567557688	Parameters	df	SS	MS	F	Significance of F
R-squared		0.322121729	Regression	6	73,198.07191	12199.67865	1.108779262	0.405188182
Normalized R-squared		0.031602471	Remainder	14	154,039.2276	11002.80197		
Standard error		104.8942418	In total	20	227,237.2995			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y_4—intersection	58.96582155	30.59389568	1.927372119	0.074472893	−6.65155864	124.5832017	−6.65155864	124.5832017
Variable X_{41}	−1.880646518	12.45239376	−0.151026907	0.882109036	−28.58837489	24.82708186	−28.58837489	24.82708186
Variable X_{42}	−1.678531818	5.148992426	−0.325992287	0.749251857	−12.72202223	9.364958593	−12.72202223	9.364958593
Variable X_{43}	4.22015009	1.927495941	2.18944694	0.046000706	0.086082454	8.354217726	0.086082454	8.354217726
Variable X_{44}	−0.400124988	0.526185248	−0.760426085	0.459615826	−1.528680104	0.728430128	−1.528680104	0.728430128
Variable X_{45}	2.748484403	7.76073376	0.354152647	0.728501754	−13.89663405	19.39360286	−13.89663405	19.39360286
Variable X_{46}	−10.32898569	10.2678223	−1.005956803	0.331507439	−32.35127426	11.69330288	−32.35127426	11.69330288

Table A29. Regression analysis of the market value of enterprises (iteration 1).

Regression Statistics									
			Analysis of Variance						
Multiple R		1	Parameters	df	SS	MS	F	Significance of F
R-squared		1	Regression	6	4213,1192	702.1865334	3.88255×10^{31}	1.0193×10^{-217}
Normalized R-squared		0.875	Remainder	16	4.34056×10^{-28}	2.71285×10^{-29}		
Standard error		5.20851×10^{-15}	In total	22	4213,1192			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y_5—intersection	0.02788	1.3259×10^{-15}	2.10273×10^{13}	5.7748×10^{-205}	0.02788	0.02788	0.02788	0.02788
Variable X_{51}	−0.2568	5.32648×10^{-16}	-4.82119×10^{14}	9.8988×10^{-227}	−0.2568	−0.2568	−0.2568	−0.2568
Variable X_{52}	2.420666667	2.39859×10^{-16}	1.0092×10^{16}	7.2843×10^{-248}	2.420666667	2.420666667	2.420666667	2.420666667
Variable X_{53}	0	0	65535	$6{,}252 \times 10^{-255}$	0	0	0	0
Variable X_{54}	−0.258	7.78228×10^{-17}	-3.31523×10^{15}	0	−0.258	−0.258	−0.258	−0.258
Variable X_{55}	0	0	65535	3.2120×10^{-245}	0	0	0	0
Variable X_{56}	−0.258	2.14242×10^{-16}	-1.20424×10^{15}	0	−0.258	−0.258	−0.258	−0.258

Table A30. Regression analysis of profitability of sold products (iteration 1).

Regression Statistics								
			Analysis of Variance					
Multiple R		0.250899793	Parameters	df	SS	MS	F	Significance of F
R-squared		0.062950706	Regression	6	20,735.24727	3455.874544	0.604617451	0.72277665
Normalized R-squared		−0.263388104	Remainder	18	308,653.3893	17147,41052		
Standard error		130.9481215	In total	24	329,388.6366			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	Top 95%	Bottom 75.0%	Top 75.0%
Y_6—intersection	22.60120098	30.88929547	0.731683926	0.473780671	−42.29480068	87.49720263	−42.29480068	87.49720263
Variable X_{61}	−0.444006121	1.81423898	−0.244734087	0.809430531	−4.255580781	3.367568538	−4.255580781	3.367568538
Variable X_{62}	0	0	65535	0	0	0	0	0
Variable X_{63}	0	0	65535	0	0	0	0	0
Variable X_{64}	0	0	65535	0.82132	0	0	0	0
Variable X_{65}	0	0	65535	0	0	0	0	0
Variable X_{66}	−2.114473929	1.923955913	−1.099024107	0.37209973	−6.156555311	1.927607453	−6.156555311	1.927607453

Table A31. Regression analysis of the coefficient of enterprise autonomy (iteration 1).

Regression statistics					**Analysis of variance**			
Multiple R		0.454902007	Parameters	df	SS	MS	F	Significance of F
R-squared		0.206935836	Regression	6	55.58023296	9.26337216	1.043728087	0.438864662
Normalized R-squared		−0.116330205	Remainder	16	213.0065623	13.31291014		
Standard error		3.648686085	In total	22	268.5867953			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y_7—intersection	−0.857438714	0.862381793	−0.994268108	0.334892126	−2.685606446	0.970729019	−2.685606446	0.970729019
Variable X_{71}	0.163727816	0.172717511	0.947951455	0.357252982	−0.202416952	0.529872584	−0.202416952	0.529872584
Variable X_{72}	0.095576415	0.057147365	1.672455338	0.113871903	−0.025570586	0.216723416	−0.025570586	0.216723416
Variable X_{73}	−0.022274273	0.033981333	−0.655485544	0.521469407	−0.09431148	0.049762935	−0.09431148	0.049762935
Variable X_{74}	0	0	65535	0	0	0	0	0
Variable X_{75}	0	0	65535	0	0	0	0	0
Variable X_{76}	0.058168558	0.054409063	1.069096846	0.807132	−0.057173503	0.173510619	−0.057173503	0.173510619

Table A32. Regression analysis of the coefficient of general liquidity of enterprises (iteration 1).

Regression Statistics					**Analysis of Variance**			
Multiple R		0.497490177	Parameters	df	SS	MS	F	Significance of F
R-squared		0.247496477	Regression	6	2258.865034	376.4775056	0.767427342	0.607694957
Normalized R-squared		−0.075005033	Remainder	14	6867.992307	490.570879		
Standard error		22.14883471	In total	20	9126.85734			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y_8—intersection	0.32456489	6.1823512	0.052498617	0.958873142	−12.93525966	13.58438944	−12.93525966	13.58438944
Variable X_{81}	0.142944246	2.418206687	0.059111674	0.953698643	−5.043593265	5.329481758	−5.043593265	5.329481758
Variable X_{82}	1.434175815	1.773025092	0.808886361	0.432112752	−2.368584799	5.23693643	−2.368584799	5.23693643
Variable X_{83}	−1.163893566	1.873733065	−0.621162954	0.544474102	−5.1826513	2.854864167	−5.1826513	2.854864167
Variable X_{84}	2.485086356	1.695543614	1.465657583	0.164838762	−1.151493017	6.121665728	−1.151493017	6.121665728
Variable X_{85}	−0.067657905	0.446621505	−0.151488239	0.881751857	−1.025565763	0.890249953	−1.025565763	0.890249953
Variable X_{86}	0.078592995	0.175668942	0.447392662	0.661435701	−0.298179412	0.455365403	−0.298179412	0.455365403

Table A33. Regression analysis of return on capital of enterprises (iteration 1).

Regression Statistics			Analysis of Variance					
Multiple R		0.600573267	Parameters	df	SS	MS	F	Significance of F
R-squared		0.360688249	Regression	6	9218.639362	1536.439894	1.316424913	0.312864927
Normalized R-squared		0.086697499	Remainder	14	16,339.82942	1167.130673		
Standard error		34.16329423	In total	20	25,558.46878			
	Coefficients	Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y_9—intersection	52.27083004	10.15535704	5.147118886	0.000148276	30.48975544	74.05190464	30.48975544	74.05190464
Variable X_{91}	1.526205448	1.763587794	0.865398055	0.401406987	−2.256314177	5.308725072	−2.256314177	5.308725072
Variable X_{92}	−1.415327441	0.950753123	−1.488638224	0.158760344	−3.454490083	0.623835202	−3.454490083	0.623835202
Variable X_{93}	−0.260637645	0.318247303	−0.81897833	0.426520716	−0.943210225	0.421934935	−0.943210225	0.421934935
Variable X_{94}	2.018370799	0.949402353	2.125938273	0.051782986	−0.017894729	4.054636328	−0.017894729	4.054636328
Variable X_{95}	0.05206894	1.521818383	0.03421495	0.973188785	−3.211906869	3.316044748	−3.211906869	3.316044748
Variable X_{96}	1.166429165	1.375440847	0.848040225	0.410680587	−1.783598053	4.116456384	−1.783598053	4.116456384

Table A34. Regression analysis of net income from product sales (iteration 2).

Regression Statistics			Analysis of Variance					
Multiple R		0.999180346	Parameters	df	SS	MS	F	Significance of F
R-squared		0.998361364	Regression	6	8272.031327	1378.671888	1421.614781	1.13877×10^{-18}
Normalized R-squared		0.997659091	Remainder	14	13.57710027	0.969792876		
Standard error		0.984780624	In total	20	8285.608427			
	Coefficients	Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y'_1 -intersection	−1.939320068	0.728240491	−2.663021476	0.018551221	−3.501240579	−0.377399557	−3.501240579	−0.377399557
Variable X'_{11}	0.046943668	0.061363089	0.76501475	0.456965697	−0.084667068	0.178554404	−0.084667068	0.178554404
Variable X'_{12}	32.21216113	0.376173513	85.63112514	1.91313×10^{-20}	31.40534919	33.01897307	31.40534919	33.01897307
Variable X'_{13}	−0.10627775	0.062022759	−1.713528248	0.108660734	−0.239303339	0.026747838	−0.239303339	0.026747838
Variable X'_{14}	0.07617295	0.094990091	0.80190417	0.436009108	−0.127560533	0.279906434	−0.127560533	0.279906434
Variable X'_{15}	−0.036154666	0.020793609	−1.738739347	0.104012162	−0.080752522	0.00844319	−0.080752522	0.00844319
Variable X'_{16}	0.059771023	0.042800355	1.396507646	0.184309464	−0.032026609	0.151568656	−0.032026609	0.151568656

Table A35. Regression analysis of cost of goods sold (iteration 2).

Regression Statistics			Analysis of Variance					
Multiple R		0.604162705	Parameters	df	SS	MS	F	Significance of F
R-squared		0.365012574	Regression	6	4344.205438	724.0342396	1.34128011	0.303266115
Normalized R-squared		0.092875105	Remainder	14	7557.317283	539.8083773		
Standard error		23.23377665	In total	20	11,901.52272			
Coefficients		Standard error	t-statistics	p-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y'_2 -intersection	207.2798233	172.6519247	1.2005648	0.249840413	−163.0217263	577.581373	−163.0217263	577.581373
Variable X'_{21}	−13.53452069	83.30528737	−0.162468927	0.873258282	−192.2065921	165.1375507	−192.2065921	165.1375507
Variable X'_{22}	109.4440873	666.1185458	0.164301216	0.871842553	−1319.238102	1538,126277	−1319.238102	1538,126277
Variable X'_{23}	−3.03033239	1.605745682	−1.887180781	0.080045149	−6.474314353	0.413649573	−6.474314353	0.413649573
Variable X'_{24}	0.236130005	2.100878896	0.11239582	0.912105246	−4.269807084	4.742067095	−4.269807084	4.742067095
Variable X'_{25}	−0.749283075	0.35989076	−2.081973638	0.056173329	−1.521171987	0.022605836	−1.521171987	0.022605836
Variable X'_{26}	−161.7350462	183.4731376	−0.881518942	0.39292015	−555.2457894	231.7756969	−555.2457894	231.7756969

Table A36. Regression analysis of the operating profit of enterprises (iteration 2).

Regression Statistics			Analysis of Variance					
Multiple R		0.999957724	Parameters	df	SS	MS	F	Significance of F
R-squared		0.999915449	Regression	6	414,822.6869	69,137.11448	27594,43517	1.11191×10^{-27}
Normalized R-squared		0.999879213	Remainder	14	35.07662312	2.50547308		
Standard error		1.582868624	In total	20	414,857.7635			
Coefficients		Standard error	t-statistics	p-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y'_3 -intersection	−2.489989396	0.824531577	−3.019883609	0.009182311	−4.258433747	−0.721545044	−4.258433747	−0.721545044
Variable X'_{31}	0.192440257	0.190358898	1.010933865	0.329201971	−0.215838974	0.600719488	−0.215838974	0.600719488
Variable X'_{32}	−0.097163227	0.054778224	−1.773756414	0.097846603	−0.214650833	0.02032438	−0.214650833	0.02032438
Variable X'_{33}	77.32937307	67.28732626	1.149241282	0.269712151	−66.98758855	221.6463347	−66.98758855	221.6463347
Variable X'_{34}	23.72652427	70.77675048	0.335230483	0.742421467	−128.074508	175.5275565	−128.074508	175.5275565
Variable X'_{35}	−0.012316199	0.124391289	−0.099011748	0.922532685	−0.27910898	0.254476582	−0.27910898	0.254476582
Variable X'_{36}	0.986038151	1.139210751	0.865544984	0.401329088	−1.457325903	3.429402204	−1.457325903	3.429402204

Table A37. Regression analysis of liquid assets of enterprises (iteration 2).

Regression Statistics					Analysis of Variance			
Multiple R		0.603809943	Parameters	df	SS	MS	F	Significance of F
R-squared		0.364586447	Regression	6	133.8709994	22.31183323	1.338815807	0.304204785
Normalized R-squared		0.092266353	Remainder	14	233.3148918	16.66534942		
Standard error		4.082321572	In total	20	367.1858912			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y'_4 -intersection	3.523816856	1.149680338	3.06504055	0.00839541	1.057997771	5.989635941	1.057997771	5.989635941
Variable X'_{41}	0.183640801	0.427861392	0.429206291	0.674304599	−0.734030617	1.101312219	−0.734030617	1.101312219
Variable X'_{42}	0.152411305	0.24667987	0.617850596	0.54659363	−0.376664396	0.681487005	−0.376664396	0.681487005
Variable X'_{43}	−0.01763497	0.206884903	−0.085240485	0.933277216	−0.461358955	0.426089016	−0.461358955	0.426089016
Variable X'_{44}	−0.117938361	0.393527893	−0.29969505	0.768813192	−0.961971748	0.726095025	−0.961971748	0.726095025
Variable X'_{45}	0.644600996	0.35758549	1.802648637	0.093005556	−0.122343602	1.411545594	−0.122343602	1.411545594
Variable X'_{46}	−0.327335301	0.414159489	−0.790360499	0.442500093	−1.215619061	0.560948459	−1.215619061	0.560948459

Table A38. Regression analysis of the market value of enterprises (iteration 2).

Regression Statistics					Analysis of Variance			
Multiple R		1	Parameters	df	SS	MS	F	Significance of F
R-squared		1	Regression	6	3566.243057	594.3738428	6.55265×10^{31}	2.6135×10^{-219}
Normalized R-squared		1	Remainder	14	1.2699×10^{-28}	9.07075×10^{-30}		
Standard error		3.01177×10^{-15}	In total	20	3566.243057			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y'_5-intersection	4.71845×10^{-16}	1.86754×10^{-15}	0.252655572	0.804206227	-3.53363×10^{-15}	4.47732×10^{-15}	-3.53363×10^{-15}	4.47732×10^{-15}
Variable X'_{51}	−0.2568	3.1654×10^{-16}	-8.11273×10^{14}	4.1275×10^{-202}	−0.2568	−0.2568	−0.2568	−0.2568
Variable X'_{52}	2.23	9.86604×10^{-15}	2.26028×10^{14}	2.4308×10^{-194}	2.23	2.23	2.23	2.23
Variable X'_{53}	0.298	2.94941×10^{-14}	1.01037×10^{13}	1.9111×10^{-175}	0.298	0.298	0.298	0.298
Variable X'_{54}	−0.258	4.96042×10^{-17}	-5.20117×10^{15}	2.0826×10^{-213}	−0.258	−0.258	−0.258	−0.258
Variable X'_{55}	0.548	2.57644×10^{-15}	2.12697×10^{14}	5.6933×10^{-194}	0.548	0.548	0.548	0.548
Variable X'_{56}	−0.258	1.96484×10^{-16}	-1.31308×10^{15}	4.8745×10^{-205}	−0.258	−0.258	−0.258	−0.258

Table A39. Regression analysis of profitability of sold products (iteration 2).

Regression Statistics			**Analysis of Variance**					
Multiple R		0.956316026	Parameters	df	SS	MS	F	Significance of F
R-squared		0.914540342	Regression	6	12,193.73597	2032.289329	42.8057104	$3.23658 \times 10{-}08$
Normalized R-squared		0.768175428	Remainder	16	1139.449467	71.21559167		
Standard error		8.438933088	In total	22	13,333.18544			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y'_6-intersection	−2.243423323	2.039426206	−1.100026721	0.287596281	−6.566813745	2.0799671	−6.566813745	2.0799671
Variable X'_{61}	−0.044251263	0.121100881	−0.365408263	0.719592389	−0.300973663	0.212471137	−0.300973663	0.212471137
Variable X'_{62}	10.26593463	2.460869698	4.171669325	0.000719922	5.04912392	15.48274535	5.04912392	15.48274535
Variable X'_{63}	0	0	65535	0	0	0	0	0
Variable X'_{64}	0.53819801	0.239901291	2.2434144	0.156432291	0.029629993	1.046766027	0.029629993	1.046766027
Variable X'_{65}	0	0	65535	0	0	0	0	0
Variable X'_{66}	−0.023387112	0.174484139	−0.134035747	0.10816171	−0.393276964	0.34650274	−0.393276964	0.34650274

Table A40. Regression analysis of the coefficient of enterprise autonomy (iteration 2).

Regression Statistics			**Analysis of Variance**					
Multiple R		0.847723778	Parameters	df	SS	MS	F	Significance of F
R-squared		0.718635604	Regression	6	193.0160338	32.16933897	5.959589888	0.002860491
Normalized R-squared		0.598050863	Remainder	14	75.57076143	5.39791153		
Standard error		2.323340597	In total	20	268.5867953			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y'_7-intersection	−3.077160224	0.992929327	−3.099072754	0.00784683	−5.206781826	−0.947538621	−5.206781826	−0.947538621
Variable X'_{71}	0.068799843	0.146614471	0.469256841	0.646110427	−0.245656922	0.383256609	−0.245656922	0.383256609
Variable X'_{72}	0.003225822	0.039692741	0.081269815	0.936377793	−0.08190664	0.088358284	−0.08190664	0.088358284
Variable X'_{73}	0.040701084	0.038445637	1.058665894	0.30767686	−0.041756606	0.123158774	−0.041756606	0.123158774
Variable X'_{74}	9.106859677	3.935426711	2.314071725	0.036366153	0.666208857	17.5475105	0.666208857	17.5475105
Variable X'_{75}	2.05916476	0.786163557	2.619257458	0.020205175	0.373011628	3.745317891	0.373011628	3.745317891
Variable X'_{76}	−0.01854621	0.045874485	−0.404281604	0.692114162	−0.116937194	0.079844774	−0.116937194	0.079844774

Table A41. Regression analysis of the ratio of total liquidity of enterprises (iteration 2).

Regression Statistics					**Analysis of Variance**			
Multiple R		0.839514289	Parameters	df	SS	MS	F	Significance of F
R-squared		0.704784242	Regression	6	223.3404715	37.22341192	5.570490458	0.003877529
Normalized R-squared		0.578263203	Remainder	14	93.55150517	6.682250369		
Standard error		2.585004907	In total	20	316.8919767			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y'_8 -intersection	−2.475976184	0.893276355	−2.771791919	0.014989328	−4.39186342	−0.560088948	−4.39186342	−0.560088948
Variable X'_{81}	0.317344279	0.278417761	1.139813342	0.273490198	−0.279802429	0.914490986	−0.279802429	0.914490986
Variable X'_{82}	−0.343191563	0.196534789	−1.746212796	0.102668238	−0.764716761	0.078333636	−0.764716761	0.078333636
Variable X'_{83}	−0.536858266	0.235479155	−2.279854731	0.038802954	−1.041910823	−0.031805709	−1.041910823	−0.031805709
Variable X'_{84}	0.875234323	0.187858202	4.659015764	0.000368725	0.472318553	1.278150094	0.472318553	1.278150094
Variable X'_{85}	0.400556342	0.4254151	0.941565876	0.362379315	−0.511868302	1.312980985	−0.511868302	1.312980985
Variable X'_{86}	0.0249593	0.020692139	1.206221382	0.24772141	−0.019420924	0.069339524	−0.019420924	0.069339524

Table A42. Regression analysis of return on capital of enterprises (iteration 2).

Regression Statistics					**Analysis of Variance**			
Multiple R		0.639274241	Parameters	df	SS	MS	F	Significance of F
R-squared		0.408671555	Regression	6	2983,373252	497.2288753	1.612584294	0.215828691
Normalized R-squared		0.155245079	Remainder	14	4316.800233	308.3428738		
Standard error		17.55969458	In total	20	7300.173484			
Coefficients		Standard error	t-statistics	*p*-value	Bottom 95%	top 95%	Bottom 75.0%	Top 75.0%
Y'_9-intersection	50.80555468	4.360726485	11.65070886	1.36531×10^{-8}	41.45272656	60.15838279	41.45272656	60.15838279
Variable X'_{91}	−1.078181527	1.148729564	−0.938586035	0.363855034	−3.541961405	1.385598351	−3.541961405	1.385598351
Variable X'_{92}	−1.368486428	1.21382062	−1.127420647	0.2785172	−3.971872736	1.234899879	−3.971872736	1.234899879
Variable X'_{93}	−0.461794979	0.291177553	−1.585956656	0.13507134	−1.086308719	0.162718761	−1.086308719	0.162718761
Variable X'_{94}	1.177693676	1.02614655	1.147685656	0.270332784	−1.023171784	3.378559136	−1.023171784	3.378559136
Variable X'_{95}	1.422726196	1.18366955	1.201962319	0.249315588	−1.115992496	3.961444889	−1.115992496	3.961444889
Variable X'_{96}	−1.032545506	0.73277217	−1.409094872	0.180630412	−2.604185501	0.539094488	−2.604185501	0.539094488

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