CHAPTER 5
IMPROVEMENT OF THE HIGH-TECH PRODUCTS COMMERCIALIZATION STRATEGY OF DOMESTIC ENTERPRISES IN THE SYSTEM OF INTERNATIONAL ENTERPRENEURSHIP

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5.1. Improvement of the commercialization mechanism

The implementation of projects with a high innovative component by enterprises of the high-tech sector involves commercialization of the product. The prerequisite for commercialization is the determination of the organizational and economic model and economic mechanism, which, in turn, requires the determination of competitive advantages of the product being created and the production capabilities of the enterprise. The finalizing component of the commercialization process is the formation of its strategy.

The intensification of commercialization of high-tech products is one of the determining factors in the implementation of tasks and the formation of the results of the national innovation system of the country. The international component of this process is an organic and integral component in the system of international entrepreneurship. Systematic strengthening of international competitiveness within the framework of the convergence of enterprise practices in this aspect will act as a driving force for the further rapid renewal of the technological structure of the domestic industrial and production complex.

As a result of study on current developments, it is proposed to consider a functional organizational and economic mechanism that can be analytically presented in the form of a multi-level vertically integrated model of enterprise management [88]. This model is considered as the basic model for the commercialization of innovations, its improvement will be the implementation of the strategy of forming a functional mechanism for the commercialization of high-tech products, respectively.

The organizational and planning model of the mechanism of high-tech product commercialization takes into account the structural form of interaction of tools and means of creation, modification and commercialization of a

high-tech product in the aspect of constant interaction and the presence of mutual influences of the innovative system of the enterprise [113].

In order to determine the prospects and risks of commercialization, the organizational and planning model should contain a separate block of information support, which is a pool of target repositories (information base) and defined analytical tools, structural capital and specialists in target directions.

The formation of the commercialization mechanism includes a number of stages:

1. Information stage. At this stage, an intra-corporate analysis of the state and international opportunities of the enterprise is carried out, monitoring of world market demand for certain high-tech products, analysis of marketing prospects and trends in the development of the market segment. Internal corporate analysis of current state of the enterprise's resource potentials is not targeted at the information stage of the model. This type of analysis is the result of a separate study in the form of an audit, scheduled inspection, marketing activities, etc. The application of the research results will be used at the stage of strategic planning, which will allow to clearly display the relationship between the resource capabilities of the enterprise and the prospective goals of commercialization of the product [75].

It follows from the above that from the point of view of analysis of the informational stage, the informational and analytical stages are inseparable, consecutive, have a cyclical nature of multistage reproduction and are characterized by a state of dialectical interaction. In turn, the process of monitoring information series needs further detailing in order to diversify the possibilities of applying the commercialization mechanism.

Detailed information for monitoring is presented in the form of a dichotomous classification:

1) by the location of the source of information regarding the enterprise: internal (information about the effectiveness of each stage of the innovation process); external (information from insiders of other enterprises, independent development agents, intermediary agents, potential or current investment partners, sources of specialized scientific information, etc.);

2) by the scope of application of the innovative component: innovation – process (improvement of production technology, optimization of the technological cycle, etc.); innovation – product (creation of a

fundamentally new product, which involves the development of a complex innovation project);

3) by the complexity of application of innovation-process: at one stage of production; at several stages;

4) by the degree of codification of information (the degree of complexity of transforming information into knowledge): requires significant efforts and competencies; requires sufficient efforts, taking into account the internal capabilities of the enterprise;

5) in the position of the initiative (responsible) person for information search: an authorized representative of management;

6) according to the degree of participation in the production proccess: final (main) producer; contractor;

7) based on the fact of the existence of an authorized information collection center or a similar task: available; missing;

8) by the nature of trend detection: induced; off-line. The proposed classification more clearly illuminates the multifacetedness of the target information for building a mechanism for the commercialization of a high-tech product.

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From the foregoing, it follows that the preliminary selection of a promising product and its market can occur both as a result of an idea and as a result of purposeful analytical work, because the collection of information involves its processing from the state of developing of the idea of product commercialization to a concrete goal. This process requires information support, finding answers to correctly formulated questions: in the case of a positive connection, the process is cyclic, with the possibility of returning to the previous stage for the purpose of clarification, i.e. it is characterized by a multiplicity of feedbacks, the purpose of which is the final transformation of masses of information into knowledge, i.e. the crystallization of tasks at the preparatory stage of the mechanism, which should be outlined by the preparatory stage of the mechanism.

2. **Analytical stage** (determination of goals and tasks of commercialization). Analytical understanding and substantiation of the goals and objectives of commercialization of a high-tech product will be

determined by their identification, assessment and gradation according to the criteria of importance for the enterprise or for the purposes of the development of the national economy. The details of goals and objectives are carried out in the context of the marketing innovation policy of the enterprise (choice of tools for marketing research, outline of potential demand for a high-tech product, formation of a marketing strategy for the expansion, preservation or narrowing of activities), the financial policy of the enterprise in relation to the analysis of the availability and assessment of the feasibility of choosing sources of financing for the innovation policy the enterprise, the infrastructural component of the implementation of the development strategy with the aim of forming an adaptive matrix or project organizational structure of the enterprise.

3. **Strategic planning stage** (definition of tools for commercialization of high-tech products).

It is determined by the need to justify the commercialization strategy for certain products: stages, terms, methods, forms, etc.; establishing the main priorities of the enterprise's production and commercial behavior in accordance with the content and form of commercialization, choosing a market behavior strategy based on the expected effects of commercialization in relation to the relevant products.

It is worth noting that the stage of strategic planning of the basic model takes into account the systematized principles of strategy construction: systematicity: careful accounting of needs, state and dynamics of demand, conditions of business activity in making production and marketing decisions on national and international markets; consideration of feedback (from the market to the design stage): creation of conditions for adaptation of production, namely: subsystems of management of scientific research, production and sales activities to the structure and dynamics of demand; the nature of marketing policy activity: influence on demand, structure of market conditions with the help of available means and tools (advertising, product and price policy, control over the sphere of movement of goods, etc.); determination of the type of innovative activity: the creation of new types of products at a faster pace compared to the life cycle of the product, the style of product promotion: flexible, aggressive, etc.

In view of the above, we consider the above principles to be insufficient for building a commercialization strategy, because they are, only a reflection

of the nature of the stage (element) of the mechanism, which is only part of the strategy at best.

The core principles of strategy construction include: integrity, adaptability [124] structurality, interdependence, hierarchy, proportionality, complementarity [156], dynamism [127], decomposition, efficiency and suboptimization [170].

The principle of systematicity as a general principle of systematic theory is an integral component of the mental activity of subjects when making decisions; building a mechanism without taking this principle into account is impossible, because feedback and continuum of the mechanism itself will not be ensured. The factors of the principle fully correspond and do not contradict the tasks of the second sub-stage of the analytical stage of the basic model, but only to a small extent expand the component of its marketing support, they are also partially fulfilled in terms of defining the market segment and product specification, because they make it possible to study the nature of the demand of a separate targeted market segment. Systematicity is a characteristic of each stage, as well as the mechanism of commercialization of a high-tech product as a whole. The principles that correlate and complement the perception of commercialization as a systemic phenomenon are determined by other principles that should be included in the model of the commercialization mechanism, namely:

– the principle of integrity consists in mutual coordination of interests of all commercialization participants. Usually, the agents of this process determine their own priorities which are reflected in financial results and social effects, which proves the integrity of interests of all elements: enterprises, state institutions, educational and academic institutions; it will provide the company with a synergy effect from the spent resources;

– the principle of adaptability is determined by the flexibility of influence of external and internal effects on the mechanism and take into account the delay of the counter reaction to the corresponding effect (time lag);

– the principles of structure and hierarchy reveal the mechanism of commercialization in the aspect of building a system of responsibilities and powers, which leads to a reduction of risk threshold in decision-making at each of the stages of the process of commercialization of a high-tech product;

– the principle of proportionality is determined by the distribution of responsibility and reward for the results of a successful process between the participants of the commercialization process. The sharing of benefits should, of course, be determined by the documentation of agreements regarding licenses, technology transfer and copyright;

– the principle of complementarity consists of the systemic logically conditioned dialectical interdependence and non-contradiction of the target functions of economic agents and thus reveals the rigid casual connection of the functional toolkit of the mechanism. It is determined by the spatial and structural correspondence of the parts of the whole to create specific forms of the process or phenomenon. In the mechanism of commercialization of a high-tech product, this will be reflected in the correspondence of technology, human potential, finance and institutional opportunities for the creation and commercialization of innovations (Figure 5.1);

– the principle of dynamism consists in constant growth of requirements for the research object. High-tech products are characterized by a high level of requirements of various kinds for their creation. The implementation of international cooperation plans of domestic enterprises is reflected in the high level of dynamism of the innovative potential of enterprises;

– the principle of decomposition is determined by the system's ability to synthesize and induce, from determining the general goal of commercialization of a high-tech product to the local goals of all structural units involved in the process;

– the principle of efficiency is determined by the ratio of the effect of commercialization and the level of resources spent. In the mechanism of commercialization, the efficiency criteria that are taken as a basis for determining the success criterion of this process should be defined: the amount of income from the commercialization of a high-tech product; the level of competitiveness of the enterprise; the dynamics of profit from the export of a high-tech product, etc.;

– the principle of suboptimization determines the possibility of choosing the best of the alternatives when making decisions according to defined criteria, i.e. the very product of high-tech production that will provide the enterprise with a high level of income and additional competitive advantages.

Determination of the main forms of production and commercial behavior of the enterprise, depending on the state of the market situation, is another expansion of the marketing support measures of the second stage of the model in terms of risk forecasting and software algorithms of price and non-price behavior of the enterprise.

As a result of a critical understanding of the second and third stages of the basic model, it is proposed to group the tasks of the components, to combine the components of the mechanism into a single planning stage, which will allow to optimize and relieve the mechanism, to eliminate the duplication of tasks and the resource load for their provision, thus increasing efficiency, flexibility and ergonomics of the mechanism's architecture.

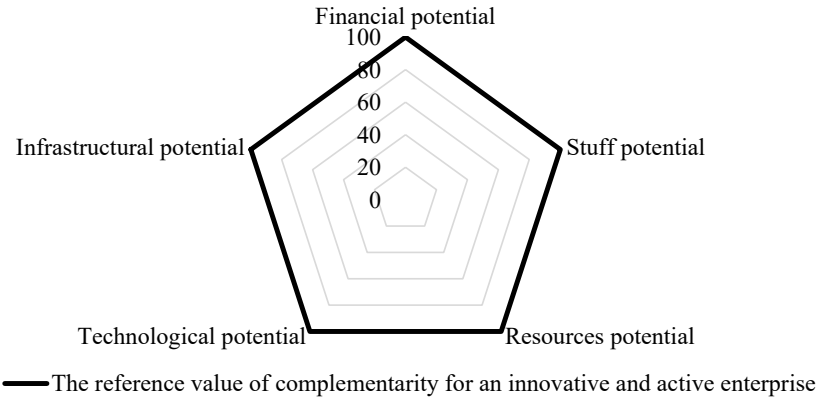


Figure 5.1. The form of the reference plane of the vector of complementarity of the enterprise in the formation of the high-tech product commercialization mechanism

Source: author's investigation

4. **Operational stage** (realization of goals and objectives of the commercialization of a high-tech product). An operational (tactical) commercialization plan is being developed in the direction of defining and distributing the tasks and responsibilities of process participants, analyzing the impact of objective and subjective pricing parameters, and determining measures to stimulate demand and sales.

The peculiarity of the operational stage is determined by the choice of specific forms and channels of commercialization, which will ensure the distribution of tasks by centers of responsibility with further adjustment and clarification of the forms of commercialization of a high-tech product, and will also provide active marketing measures. At this stage, legal support for commercialization in the form of auditing the product for patentability, providing industrial property objects with security documents, etc., is of great importance. It is appropriate to determine the degree of dependence of the enterprise on the factors of the external environment: factors of the market environment, market conditions, etc. [105; 106]. The tasks reflected at this stage are clarification and adjustment in individual cases of pricing methods, as well as price and non-price parameters of competition, a certain form of commercialization of a high-tech product, the selection of measures to stimulate demand, coordination of interaction with investors, especially when conflicts of interest arise [107].

The tasks set at the operational stage accurately reflect the features inherent in operational efficiency and are intended to correct, clarify, supplement, repair and adjust the operation of the mechanism. However, it should be emphasized that all the tasks of this stage must be pre-programmed, narrowing the corridor of actions of responsibility centers and ensuring horizontal interaction of management.

5. The control stage consists in identifying the ratio of actual and planned values of indicators, intermediate tasks and the general goal of product commercialization, includes a component of formal and informal control. Formal control involves the collection, processing and analysis of data on the economic results of the enterprise. Informal control consists in calculating the efficiency of the mechanism based on the indicators of the effectiveness of the tools of product commercialization: economic, scientific and technical, financial, marketing and resource. The correction will be reflected in constant feedback with the background block of information support (Figure 5.2).

The improvement of the existing basic mechanism consists in the identification and critical understanding of systemic flaws embedded in its structure, proposals for their correction and the presentation of fundamentally new solutions for the existing model, namely: taking into account previous developments into economic solutions inherent to the specifics of the high-tech products market.

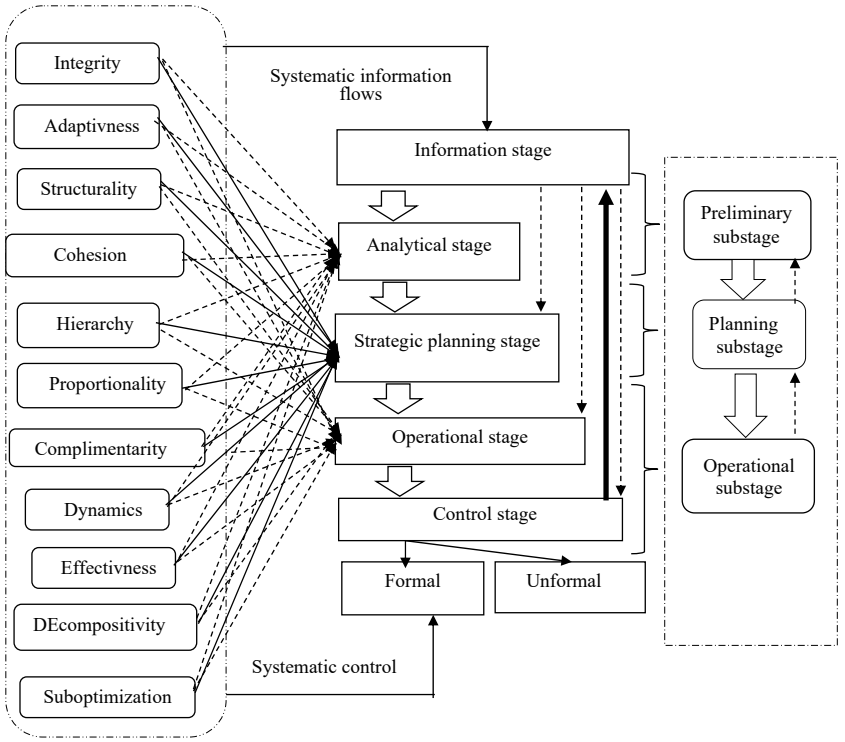


Figure 5.2. Organizational-planning model of the high-tech product commercialization mechanism

Source: author's investigation

The improved model contains three stages of implementation of the mechanism of commercialization of a high-tech product: preparatory, planning and operational, which are under the constant influence of background information noise and control. Improving the basic organizational and planning model will make it possible to more accurately forecast demand and increase the efficiency of resource base implementation in the process of further commercialization of products.

The preparatory stage involves:

– analysis and characterization of trends in the development of the high-tech market segment;

– specification and technical and economic justification of the specified high-tech product;

– economic assessment of product implementation cost. The planning stage takes into account:

1) approval and clarification of the goals of commercialization of a high-tech product:

– specification of the specified high-tech product;

– analysis of the specifics and structure of the market segment;

– construction of technological, sales and value chains;

– definition and assessment of priority forms of commercialization;

– identification of partners according to the selected forms of commercialization and calculated value chains.

2) a statement of the means of realizing the goals of commercialization of a high-tech product:

– project planning, including individual measures of auxiliary processes;

– formulation, substantiation and systematization of a set of marketing support measures (including forms of commercialization);

– financial support (determination of financial and credit instruments and reserves for financing the product commercialization process);

– specified technical and economic justification of the process;

– legislative provision of various aspects of commercialization;

– management planning (distribution of the project load by centers of responsibility, determination of indicators for evaluating the effectiveness of units and their interaction).

The implementation of the mechanism of commercialization of a high-tech product is carried out on the basis of the use of organizational and economic levers of the external and internal environment, which reflect the effectiveness of the entire innovation system of the enterprise and the national innovation system.

Organizational levers include: level of personnel training; peculiarities of management hierarchy (methods, means, corporate culture); information provision (availability of sources, protection, information processing technology) [78]. The organizational factors of the external environment include: the regulatory and legal framework for the support and

development of innovative business and high-tech industries, in particular: the regulatory and legal framework of partner countries, customs and non-customs barriers, the level of development of the innovation market infrastructure, etc.

The economic levers of the commercialization mechanism at the enterprise level are: awarding the order, training, forming the basis of economic cooperation between structural units, available types of material and non-material incentives.

External economic levers are: depreciation and tax policy, insurance of innovative business risks, financing of innovative activities (banking and non-banking), etc. (Figure 5.3).

Considering the importance of the influence of the toolkit of each lever will allow high-tech industries to formulate an adaptive innovation policy in the system of international entrepreneurship. Considering the specifics of work, it is advisable to use social and psychological levers aimed at working in creative groups on projects of varying complexity.

In order to determine the prerequisites for the application of the proposed mechanism of commercialization of a high-tech product, it is advisable to determine the compliance of the investigated enterprises with the principles that are laid down in its basis. If we interpret the method of the square of the potential to our research conditions, it will be appropriate to consider the degree of efficiency of the enterprise in directions of the following opportunities: financial, personnel, commercial, resource.

A weight (sensitivity coefficient) is determined for each of the indicators [91]. For each research object, we identify the sum of places (Pj), obtained during the ranking, using the formula:

$$\text{Pj}=\sum_{i=1}^{n} aij \times k\,, \tag{5.1}$$

where aij – initial data by groups of indicators for the research object; k – sensitivity coefficient (specific gravity).

We determine the length of the vector that creates the square of the company's potential (Bk, where k = 1, 2, 3, 4):

$$\text{Bk}=100-(\text{Pj}-\sum_{i=1}^{n} k \times n\frac{100}{\sum_{i=1}^{n} n(m-1)}\,. \tag{5.2}$$

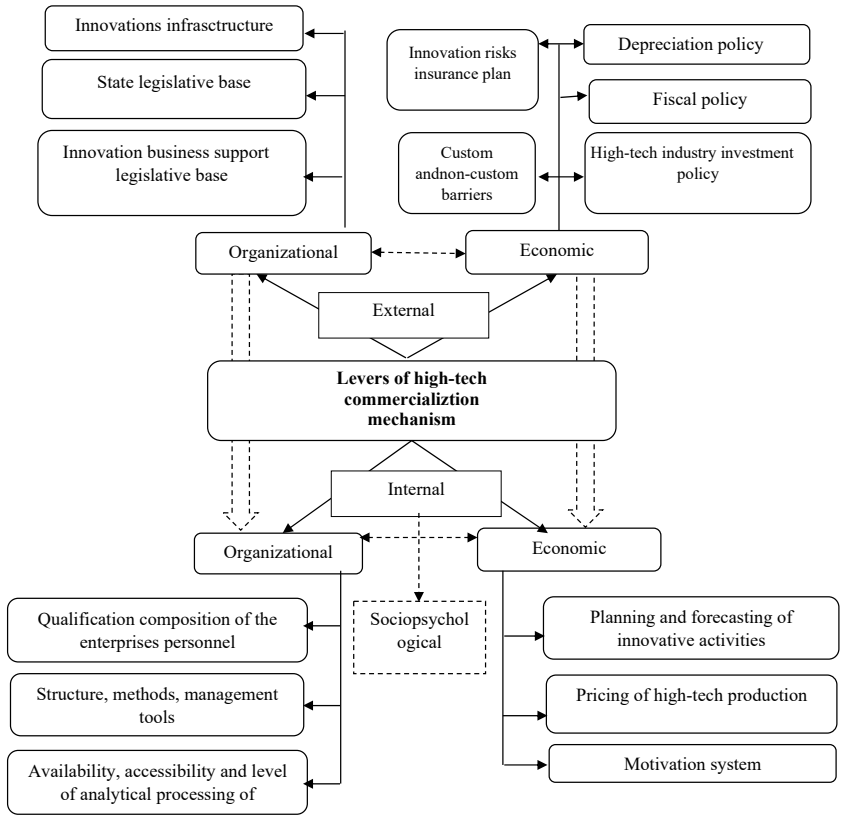


Figure 5.3. Levers of the high-tech product commercialization mechanism

Source: author's investigation

Based on the calculations, we build a square for each of the enterprises, which aims to reflect its compliance with the principles of system, complexity, coherence, etc. This characteristic will reflect the level of probability of using the proposed mechanism in practice (Figure 5.4).

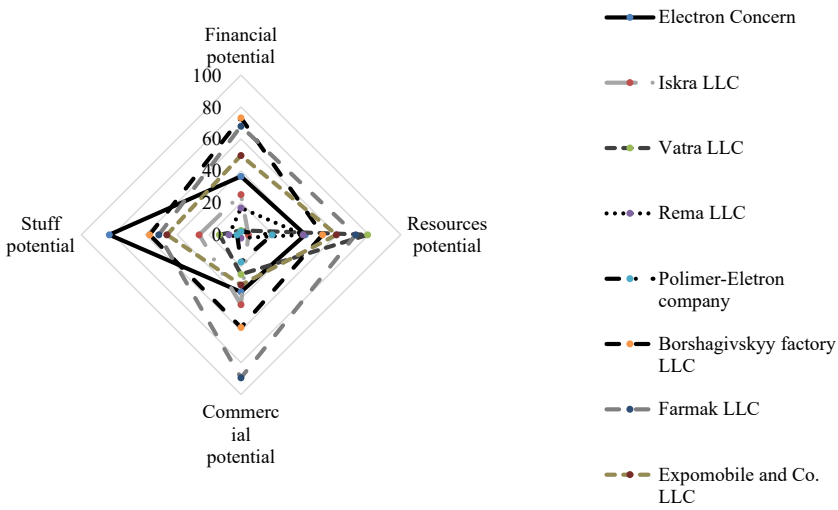


Figure 5.4. Correspondence of calculated values of innovative potential with reference values

Source: author's investigation

The performed calculations indicate gaps in the given vectors. Taking into account the difference in capacities and market niches, it is worth noting that enterprises feel the greatest need for qualified personnel, which would lead to the transition to high-tech production. In general, the sufficiently proportional form designed for enterprises makes it possible to use the proposed mechanism of commercialization of a high-tech product in the enterprise's innovation policy.

5.2. Development of commercialization effectiveness tools model

The peculiarities of the market of high-tech products requires expression of unorthodox assumptions regarding elements of the toolkit for evaluating the effectiveness of commercialization of products of this sector.

In addition, in the high-tech sector, the effectiveness of international entrepreneurship should be considered depending on the specific level of its direct implementation (Table 5.1).

Table 5.1

Vertically integrated classification of efficiency levels of commercialization of high-tech products *(author's investigation)*

Level of functioning	Effectiveness of high-tech market subjects
Microlevel	Scientific, research, production, brokerage, venture, trade, consulting organizations, individual innovators and entrepreneurs
Mesolevel	TNC, MNC, domestic enterprises, NTC, local infrastructure
Macrolevel	State, national innovation system
Megalevel	Interstate formations, integration groups
Metalevel	International organizations, the world market of high-tech products

Further analysis of the effectiveness of commercialization should be based on the systematic consideration of the criteria for the effectiveness of tools and the experience of models of leading countries in international entrepreneurship. Therefore, a multi-criteria model for evaluating the effectiveness of tools for the commercialization of high-tech products should be formed.

Such a model is based on the need to define efficiency criteria based on the distinctive features inherent in these criteria. This interpretation of the approach will make it possible to fully implement the most effective projects in the long leg with a low potential for short-term effectiveness. The impossibility of adequately assessing the effectiveness of these projects is due to the lack of attention to actual, not fully traditional market performance indicators, namely: scientific and technical, social, environmental, integration, etc.

The evaluation of the effectiveness of the commercialization of high-tech products should be calculated on the basis of a systematic approach in the presence of a significant information base of quantitative indicators; in the absence of such indicators to a sufficient extent, which makes it possible to fully and clearly implement such an assessment; in our opinion, it is worth applying the method of expert assessments. The essence of the systematic approach consists in decision-making, with strict adherence to the targeted indicators, the selection of appropriate criteria for evaluating these decisions at different levels of the existing system.

The method of expert evaluations can be applied in the following research practices: provided that mathematical formalization or description of the

researched object is impossible; in the absence of reliable statistical data on the properties of the object; under conditions of significant volatility of the facility's operating environment; in medium- and long-term modeling and forecasting of market trends with a high specific weight of radical resource renewal; under the conditions of resource limitations in the analysis and forecasting of management and financial decisions; in unpredictable situations where the possible modeling is too informational and potentially not visual [104].

The practical application of a multi-criteria approach to determining the effectiveness of product commercialization can be based on the use of the method of paired comparisons involving the mechanism of expert evaluations. The method involves the use of expert evaluation, which is based on the assessment of a number of criteria. The essence of the method of paired comparisons consists in the sequential comparison of the available performance criteria. Each separate selection of criteria is assigned with a defined priority. The method is applied to all possible paired samples without exclusion. The determined priority is evaluated according to the scale determined by the researcher. The analysis of the matrix of the obtained evaluations means the quantitative determination of the specific weight of the criteria, according to the degree of relative priority. This analytical tool makes it possible to quantitatively determine the priority of various heterogeneous criteria [14; 158].

To determine the feasibility of the proposed methodology, we evaluate the selected enterprises embedded into 4 groups of high-tech branches according to a multi-criteria model. Implementation of evaluation according to the multi-criteria approach is carried out in a number of stages. At the first stage, using the method of pairwise comparisons, the weight of the criteria and their impact on the multi-criteria assessment of the investigated enterprises is determined.

We recommend using a five-level scoring system: almost unimportant (1); less important (2); equally important (3); more important (4); much more important (5). According to the developed scale, we determine the importance of each of the studied factors on the resulting indicator. Using the scale and primary and secondary documentation of the studied enterprises, we evaluate them and find the importance of the criterion for

each enterprise in particular (Table 5.2). For each factor, the values of the vector of local priorities are calculated according to the formulas:

$$U_{i\,cep} = \sqrt[n]{\prod_{j=1}^{n} aij}\,, \tag{5.3}$$

where aij is the ith element of the jth column of the matrix of pairwise comparisons of criteria; n – number of criteria;

$$U_i = \frac{Ui\,cep}{\bullet \sum_i^{T} Ui\,cep}. \tag{5.4}$$

For the "Electron-Karat" SOE of the "Concern-Electron" SOE, the calculation of the local vector will have the following form (Table 5.3).

Table 5.2

Information support for the calculation of the local vector for the "Electron-Karat" NVP "Concern-Electron"

(author's investigation)

$U_{av.\ economical} = \sqrt[9]{25920} = 3.0932$	$a_{i1} = 1+3+2+2+2+3+3+3+1=20$
$U_{av.\ scientific} = \sqrt[9]{32400} = 3,171$	$a_{i2} = 3+1+2+2+1+3+3+3+1= 19$
$U_{av.\ Financial} = \sqrt[9]{1728} = 2,29$	$a_{i3} = 4+4+1+3+3+4+4+3+3= 28$
$U_{av\ marketing} = \sqrt[9]{1152} = 2,19$	$a_{i4} = 4+4+3+1+3+4+4+4+3=30$
$U_{av\ \ resources} = \sqrt[9]{1728} = 2,29$	$a_{i5} = 4+5+4+4+1+5+5+4+3 = 35$
$U_{av\ social} = \sqrt[9]{32400} = 3,171$	$a_{i6} = 3+3+2+2+2+1+3+3+1=20$
$U_{av\ ecological} = \sqrt[9]{32400} = 3,171$	$a_{i7} = 3+3+2+2+4+3+1+3+1=22$
$U_{av\ integration} = \sqrt[9]{15552} = 2,92$	$a_{i8} = 3+3+3+2+2+3+3+1+2=22$
$U_{av\ brand} = \sqrt[9]{54} = 1,56$	$a_{i9} = 5+5+3+3+3+5+5+4+1= 34$

$\bullet \sum_i^{T} Ui\,cep. = 3,092+3,171+2,29+2,19+2,29+3,171+3,171+2,92+1,56=23,86.$

λ_{max}=0,12×20+0,13×19+0,097×28+0,091×30+0,097×35+0,13×20+0,13×22+0,12×22+0,065×34= 2,4+2,47+2,716+2,73+3,375+2,86+2,64+2,21=21,4.

To determine the relative indices of agreement, we calculate the index of agreement and the index of relative agreement.

Table 5.3

A pairwise comparison of the criteria for the commercialization of high-tech products of domestic enterprises *(author's investigation)*

Electron Concern											
Comparison factors										**Local priority vector components $U_{i\,av}$**	**Local priorities (U_i)**
General evaluation factors	**Econom**	**Scient**	**Fin**	**Mark**	**Res**	**Soc**	**Ekol.**	**Integr**	**Brand**		
Economic	1	3	4	4	4	3	3	3	5	3,092	0,12
Scientific and technical	3	1	4	4	5	3	3	3	5	3,171	0,13
Financial	2	2	1	3	4	2	2	3	3	2,29	0,097
Marketing	2	2	3	1	4	2	2	2	3	2,19	0,091
Resources	2	1	3	3	1	2	4	2	3	2,29	0,097
Social	3	3	4	4	5	1	3	3	5	3,171	0,13
Ecological	3	3	4	4	5	3	1	3	5	3,171	0,13
Integration	3	3	3	4	4	3	3	1	4	2,92	0,12
Brand	1	1	3	3	3	1	1	2	1	1,56	0,065
Maximum eigenvalue of the inverse-symmetric matrix of pairwise comparisons $\lambda_{max} = \sum_{j}^{n} uj \left(\sum_{j}^{n} aij \right)$											21,4
Consistency index											1,55
Iskra Public company											
Economic	1	4	4	3	4	2	2	3	4	2,76	0,13
Scientific and technical	2	1	3	3	4	3	3	3	4	2,7	0,12
Financial	2	3	1	3	4	2	2	2	3	2,29	0,097
Marketing	3	3	3	1	4	2	2	2	3	2,39	0,1

(End of Table 5.3)

Resources	2	2	3	3	1	2	2	2	3	2,12	0,09
Social	4	3	4	4	4	1	3	3	5	3,19	0,14
Ecological	4	3	4	4	4	3	1	3	5	3,19	0,14
Integration	3	3	4	4	4	3	3	1	5	3,09	0,13
Brand	2	2	3	3	3	1	1	1	1	1,68	0,07
Maximum eigenvalue of the inverse-symmetric matrix of pairwise comparisons											26,89
Consistency index											2,23
Rema plant LLC											
Economic	1	4	3	3	5	4	4	4	3	3,26	0,13
Scientific and technical	2	1	3	3	4	4	4	4	4	2,98	0,12
Financial	3	3	1	3	4	2	2	3	3	2,5	0,1
Marketing	3	3	3	1	4	2	2	3	3	3,11	0,13
Resources	1	2	2	2	1	2	2	2	3	2,5	0,1
Social	2	2	4	4	4	1	3	3	4	2,75	0,11
Ecological	2	2	4	4	4	3	1	3	4	2,75	0,11
Integration	2	2	3	3	4	3	3	1	4	2,59	0,1
Brand	3	2	3	3	3	2	2	2	1	2,2	0,09
Maximum eigenvalue of the inverse-symmetric matrix of pairwise comparisons											24,31
Consistency index											1,9
Polimer Elektron Plant											
Economic	1	2	3	4	4	2	2	3	4	2,98	0,15
Scientific and technical	4	1	4	3	4	2	2	2	3	2,55	0,13
Financial	3	2	1	3	4	2	2	3	3	2,29	0,12
Marketing	2	3	3	1	4	2	2	2	3	2,59	0,13
Resources	2	2	3	3	1	2	2	3	3	2,22	0,11
Social	4	4	4	4	5	1	3	3	5	3,38	0,17

(End of Table 5.3)

Ecological	4	4	4	4	5	3	1	3	5	2,56	0,17
Integration	3	4	3	4	5	3	3	1	4	3,09	0,16
Brand	2	3	3	3	3	4	2	2	1	2,39	0,12
Maximum eigenvalue of the inverse-symmetric matrix of pairwise comparisons											22,02
Consistency index											1,62
Borschagivskyy chemical plant Public company											
Economic	1	4	4	3	4	4	2	3	4	2,98	0,11
Scientific and technical	5	1	3	5	4	3	4	3	4	3,27	0,12
Financial	3	3	1	3	5	3	4	3	4	3	0,11
Marketing	3	3	3	1	4	2	2	3	4	2,59	0,096
Resources	2	2	3	3	1	2	4	2	3	2,29	0,085
Social	4	4	4	4	4	1	3	3	5	3,84	0,14
Ecological	4	3	5	4	5	3	1	3	5	3,54	0,13
Integration	3	3	4	4	4	3	3	1	5	3,09	0,11
Brand	2	2	3	3	3	3	2	2	1	2,2	0,08
Maximum eigenvalue of the inverse-symmetric matrix of pairwise comparisons											33,57
Consistency index											3,07
Farmar Public company											
Economic	1	3	4	4	4	3	3	3	5	3,09	0,12
Scientific and technical	4	1	4	4	5	3	3	3	5	3,27	0,13
Financial	2	2	1	3	5	2	2	3	3	2,36	0,09
Marketing	2	2	3	1	4	2	2	2	3	2,19	0,086
Resources	2	1	3	3	1	3	3	5	5	2,52	0,1
Social	3	3	4	4	5	1	3	3	5	3,17	0,12
Ecological	3	4	4	4	5	3	1	3	5	3,17	0,12
Integration	3	3	3	4	4	3	3	1	4	3,07	0,12
Brand	4	4	3	3	3	4	2	2	1	2,67	0,1

(End of Table 5.3)

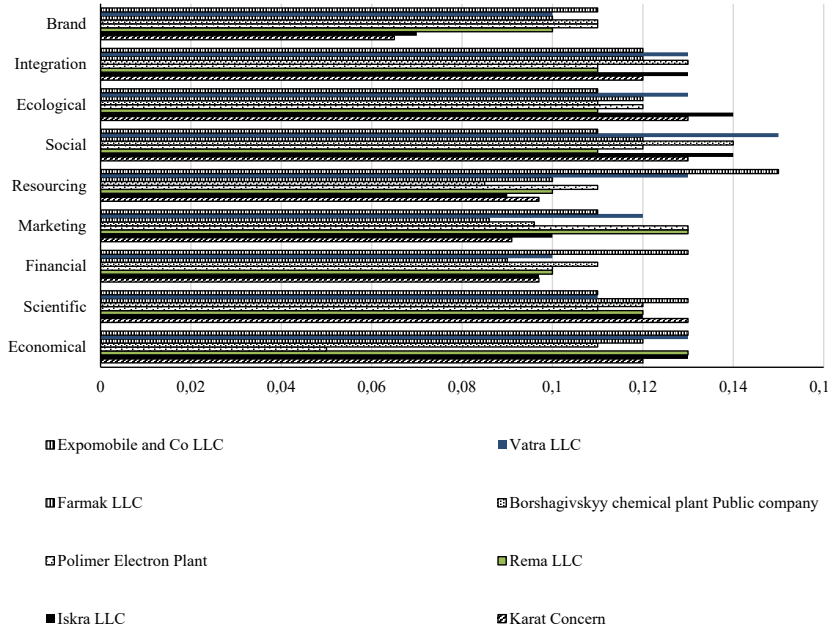
Maximum eigenvalue of the inverse-symmetric matrix of pairwise comparisons											27,74
Consistency index											2,34
Vatra LLC											
Economic	1	4	4	3	4	2	2	3	4	2,76	0,13
Scientific and technical	2	1	3	3	4	3	2	3	4	2,6	0,11
Financial	2	3	1	3	4	2	2	5	3	2,5	0,1
Marketing	3	3	3	1	3	2	2	2	3	2,2	0,12
Resources	2	2	3	3	1	2	2	2	3	1,9	0,5
Social	4	3	4	4	4	1	3	3	4	3,2	0,2
Ecological	4	3	4	4	4	3	3	3	4	3,3	0,23
Integration	3	3	4	4	4	3	3	1	4	3,09	0,13
Brand	2	2	3	3	3	1	1	2	1	1,68	0,1
Maximum eigenvalue of the inverse-symmetric matrix of pairwise comparisons											26,64
Consistency index											3,2
Expomobile and Co. LLC											
Economic	1	2	3	4	4	2	2	3	4	2,98	0,13
Scientific and technical	4	1	2	3	6	2	2	2	1	2,31	0,11
Financial	3	5	1	3	4	2	2	3	3	3,1	0,13
Marketing	2	3	3	1	5	2	2	2	3	2,89	0,12
Resources	2	2	3	3	1	2	2	3	3	2,45	0,11
Social	4	4	4	4	5	1	3	3	5	3,38	0,15
Ecological	4	4	4	4	3	3	1	3	5	2,56	0,11
Integration	3	4	3	4	5	3	3	1	4	2,9	0,12
Brand	2	5	3	3	3	4	2	2	1	2,52	0,11
Maximum eigenvalue of the inverse-symmetric matrix of pairwise comparisons											25,21
Consistency index											2,02

The specified values will serve as additional criteria for comparing the significance of the impact criteria for each of the investigated enterprises:

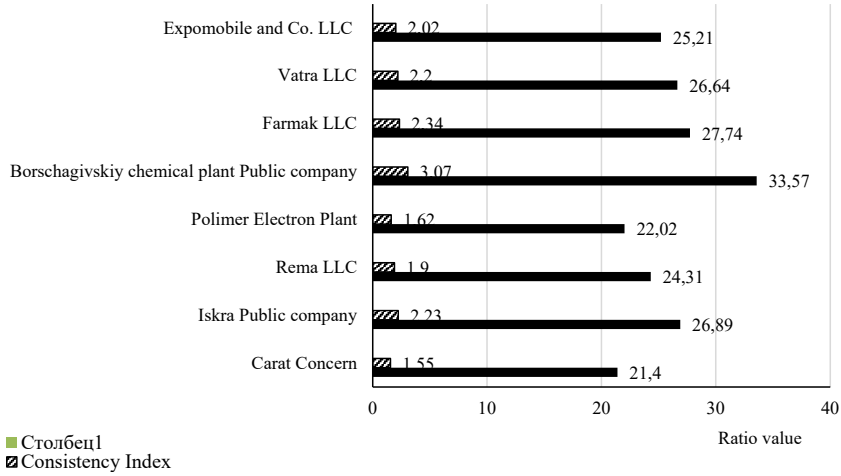
$$I_y = \frac{\lambda \max - n}{n-1}, \quad (5.5)$$

$$I_y = \frac{21,4-9}{9-1} = 1,55.$$

Similarly, we calculate the local vectors and the maximum eigenvalue of the inverse-symmetric matrix of pairwise comparisons for all the investigated enterprises. On the basis of the proposed multi-criteria model and the method of pairwise comparisons, it is advisable to draw a conclusion about the total influence of factors reflecting the dependence of the enterprise on the external and internal conditions of the system of international entrepreneurship (Fig. 5.5).



a)



b)

Figure 5.5. The value of local priorities of influencing factors on the commercialization of high-tech products on international markets (a) and the maximum value of the matrix of pairwise comparisons and the consistency index of the studied enterprises (b) (*author's investigation)*

The companies with the highest values belong to the "Pharmaceutical products" group, since the biotechnology market is characterized by significant progressiveness and competition and forces companies to be highly active in relation to the latest trends, in particular, market trends, indicators of human well-being and the level of human development. From the "Electronics and Telecommunications" group, such an enterprise is PJSC "Lviv Electric Lamp Factory "Iskra" which, despite the scale of production, feels the impact of fierce competition on the international market.

In its turn, NVP "Electron-Karat" of SE PRAJ "Concern-Electron" is characterized by an insignificant value of the matrix of inverse comparisons, since the scope of the enterprise's activity is not voluminous enough, it needs to build up specific technical knowledge, and it functions in a relatively narrow market segment.

In contrast to the five-level gradation when determining the weight of each individual criterion, it is possible in a situation of time constraints to use a three-level evaluation structure that takes into account the peculiarities of each influencing factor [196]

Economical: profitable (3); undefined (2); not profitable (1).

Scientific and technological (technologies): latest (3); existing (2); obsolete (1).

Financial (raising of funds): not significant (3); acceptable (2); significant (1).

Marketing (research): does not require (3); acceptable (2); essential (1).

Resources (additional involvement): does not need (3); acceptable (2); significant (1).

Social (development): contributes significantly (3); reasonably contributes (2); neutral (1).

Ecological (impact on the situation): significant (3); average (2); neutral (1).

Integration (to the global economy): significantly integrated (3); moderately integrated (2); requires integration (1).

Brand: significantly increases (3); moderately increases (2); neutral (1).

It is advisable to continue the logically determined development of the multi-criteria approach in the direction of in-depth specification of the proposed criteria, which involves their breakdown into sub-criteria, convenient for further analysis of the toolkit for increasing the effectiveness of commercialization (Table 5.4).

Table 5.4

The system of sub-criteria of the multi-criteria model of commercialization of high-tech products *(formed after [77; 158])*

Criterion	Subcriteria
1	2
Economic	Effectiveness of international specialization and production cooperation. Currency efficiency of export and import of technologies, equipment. Percentage of profit from the sale of licenses. Percentage of profit from consulting, engineering and technological services. Production productivity thanks to R&D. Effects of the introduction of new technologies in production.
1	2

(End of Table 5.4)

Scientific and technical	Automation ratio. The specific gravity of advanced technological processes. Coefficients of unification and standardization. The level of innovativeness of the enterprise/production. The level of knowledge of the product.
Financial	Operating profit (EBITDA). Net profit, Net present (discounted) income (NPV). Yield index (ID). Added value due to the release of a high-tech product (EVA). Profitability of the results of international cooperation. Index (coefficient) of profitability.
Marketing	The share of the enterprise in the high-tech product market. Increase in product sales in foreign markets. International competitiveness of the product. Advertising and PR expenses on the domestic and international market. The level of consumer loyalty. Nomenclature and assortment of high-tech products. The share of sales of innovative products in the structure of sales volumes. Indicators of compliance of education and competence of personnel to the requirements of the modern standard of production organization.
Resources	The level of provision of the enterprise with personnel for the creation of a high-tech product. The level of labor productivity. The level of labor intensity of production. The coefficient of renewal of fixed assets. Fund return. Fund capacity. Labor empowerment. Material capacity of products. Product yield.
Social	The level of quality of life of the population. GDP per capita. Number of new jobs. The level of human development.
Ecological	The level of saving resources due to the use of high-tech production. The amount of hazardous substances per product unit. The amount and type of waste arising from the production of a high-tech product.
Integration	The share of product exports in the total volume of manufactured products. Share of imports of products/technologies. The share of direct foreign investments in the total volume of capital investments.

(End of Table 5.4)

1	2
	The number of employees who have completed training (internship) abroad and their ratio to the total number of personnel. The number of foreign specialists and their ratio to the total number of personnel. Positive perception of the enterprise by investors.
Brand	Goodwill. Coefficient of increasing the image of the company. The number of mentions of the company in the mass media.

The algorithm for calculating individual criteria is presented in (Appendix F).

This example illustrates an important aspect of the analysis of the effectiveness of commercialization of products: a multi-criteria approach has advantages over a mono-criteria approach, as it more meaningfully reveals the essence of efficiency.

According to the conducted studies of the developed multi-criteria model, it is advisable to focus attention on determining the influence of the most important sub-criteria on the activity of enterprises using the method of paired evaluations. For this purpose, it is worth using a more detailed scale (Table 5.5).

Table 5.5

The overall significance of the influence of the subfactors of the scientific and technical criterion on the success of the commercialization of a high-tech product *(author's investigation)*

Weight scale	The magnitude of the impact of the i-th subfactor on the effectiveness of the commercialization process
0-0,25	The impact is insignificant, characterized by possible modifications of the product
0,25-0,50	The impact is medium, characterized by the possibility of changing the marketing concept of product promotion, changing resource limitations, etc
0,50-0,75	The weight of the impact is high, characterized by a significant modification of the product, a possible change in the sales market, consumer segment
0,75-1	The impact is significant, determined by a change in the product concept

Using the proposed evaluation scale, we can determine the priority of the impact of the sub-criteria of the specified group for the above-mentioned domestic enterprises under investigation (Tables 5.6-5.14).

Table 5.6

Determining the priority of the influence of the subfactors of the scientific and technical criterion *(author's investigation)*

No	Subcreteria	Subcreteria No						$V_{ij\ cep}$	V_j
		1	2	3	4	5	6		
1	Automation ratio.	1,0	0,25	0,3	0,5	0,25	0,1	0,3	0,1
2	The specific gravity of advanced technological processes.	0,5	1,0	0,5	0,5	0,4	0,5	0,54	0,18
3	Coefficients of unification and standardization.	0,7	0,5	1,0	0,7	0,5	0,4	0,6	0,2
4	The level of innovativeness of the enterprise/production.	0,4	0,5	0,2	1,0	0,2	0,2	0,34	0,11
5	The level of knowledge of the product.	0,7	0,5	0,5	0,7	1,0	0,5	0,63	0,21
6	Scientific staff	0,7	0,5	0,6	0,7	0,5	1,0	0,65	0,21

Table 5.7

Determining the priority of the influence of the subfactors of the economic criterion *(author's investigation)*

No	Subcreteria	Subcreteria No					$V_{ji\ cep}$	V_i
		1	2	3	4	5		
1	Effectiveness of international specialization and production cooperation.	1	0,5	0,3	0,4	0,3	0,45	0,17
2	Currency efficiency of export and import of technologies, equipment.	0,5	1	0,7	0,7	0,5	0,65	0,25
3	Percentage of profit from the sale of licenses.	0,4	0,5	1	0,6	0,4	0,54	0,21
4	Percentage of profit from consulting, engineering and technological services.	0,3	0,5	0,2	1	0,3	0,39	0,15
5	Production productivity thanks to R&D.	0,4	0,4	0,5	0,6	1	0,54	0,21

Table 5.8

Determining the priority of the influence of the subfactors of the financial criterion *(author's investigation)*

No	Subcreteria	Subcreteria No							$V_{ij\ cep}$	V_{ij}
		1	2	3	4	5	6	7		
1	Operating profit (EBITDA).	1,0	0,5	0,3	0,5	0,4	0,4	0,5	0,48	0,13
2	Net profit, Net present (discounted) income (NPV).	0,5	1,0	0,5	0,5	0,5	0,4	0,5	0,53	0,14
3	Yield index (ID).	0,6	0,7	1,0	0,5	0,4	0,6	0,6	0,61	0,16
4	Added value due to the release of a high-tech product (EVA).	0,4	0,5	0,5	1,0	0,4	0,4	0,5	0,5	0,13
5	Profitability of the results of international cooperation.	0,6	0,6	0,7	0,6	1,0	0,4	0,7	0,73	0,2
6	Index (coefficient) of profitability.	0,6	0,5	0,6	0,6	0,4	1,0	0,4	0,56	0,15
7	Financial leverage	0,3	0,3	0,4	0,3	0,3	0,3	1,0	0,37	0,1

Table 5.9

Determining the priority of the influence of the subfactors of the marketing criterion *(author's investigation)*

No	Subcreteria	Subcreteria No							$V_{ij\ cep}$	V_i
		1	2	3	4	5	6	7		
1	The share of the enterprise in the high-tech product market.	1,0	0,5	0,4	0,6	0,6	0,7	0,5	0,63	0,17
2	Increase in product sales in foreign markets.	0,6	1,0	0,5	0,6	0,5	0,5	0,4	0,47	0,13
3	International competitiveness of the product.	0,7	0,5	1,0	0,7	0,6	0,5	0,7	0,65	0,18
4	Advertising and PR expenses on the domestic and international market.	0,5	0,6	0,4	1,0	0,7	0,3	0,4	0,52	0,14
5	The level of consumer loyalty.	0,4	0,3	0,3	0,6	1,0	0,3	0,3	0,41	0,11
6	Nomenclature and assortment of high-tech products.	0,7	0,5	0,3	0,6	0,6	1,0	0,3	0,53	0,14
7	The share of sales of innovative products in the structure of sales volumes. Indicators of compliance of education and competence of personnel to the requirements of the modern standard of production organization.	0,5	0,5	0,4	0,5	0,4	0,3	1,0	0,48	0,13

Table 5.10

Determining the priority of the influence of the subfactors of the resourcing criterion *(author's investigation)*

No	Subcreteria	Subcreteria No								$V_{ij\ cep}$	V_{ij}
		1	2	3	4	5	6	7	8		
1	The level of provision of the enterprise with personnel for the creation of a high-tech product.	1,0	0,7	0,7	0,6	0,7	0,7	0,7	0,7	0,69	0,18
2	The level of labor productivity.	0,3	1,0	0,6	0,6	0,5	0,7	0,4	0,3	0,52	0,13
3	The level of labor intensity of production.	0,4	0,5	1,0	0,4	0,6	0,6	0,5	0,7	0,56	0,14
4	The coefficient of renewal of fixed assets.	0,5	0,6	0,5	1,0	0,6	0,6	0,5	0,6	0,6	0,15
5	Fund return. Fund capacity.	0,4	0,3	0,4	0,3	1,0	0,3	0,2	0,4	0,36	0,1
6	Labor empowerment.	0,3	0,3	0,4	0,2	0,3	1,0	0,4	0,3	0,34	0,1
7	Material capacity of products.	0,4	0,4	0,3	0,4	0,3	0,3	1,0	0,4	0,42	0,11
8	Product yield.	0,5	0,4	0,4	0,3	0,3	0,4	0,5	1,0	0,42	0,11

Table 5.11

Determining the priority of the influence of the subfactors of social criterion *(author's investigation)*

No	Subcreteria	Subcreteria No					$V_{ij\ cep}$	V_{ij}
		1	2	3	4	5		
1	The level of quality of life of the population.	1,0	0,5	0,6	0,4	0,5	0,57	0,19
2	GDP per capita.	0,5	2,0	0,6	0,6	0,7	0,66	0,22
3	Number of new jobs.	0,4	0,5	3,0	0,4	0,3	0,47	0,16
4	The level of human development.	0,5	0,4	0,7	4,0	0,6	0,6	0,2
5	External effects	0,7	0,7	0,6	0,5	1,0	0,68	0,23

Table 5.12

Determining the priority of the influence of the subfactors of the ecological criterion *(author's investigation)*

No	Subcreteria	Subcreteria No			$V_{ij\ cep}$	V_{ij}
		1	2	3		
1	The level of saving resources due to the use of high-tech production.	1,0	0,4	0,4	0,54	0,27
2	The amount of hazardous substances per product unit.	0,6	1,0	0,5	0,67	0,34
3	The amount and type of waste arising from the production of a high-tech product.	0,6	0,7	1,0	0,75	0,38

Table 5.13

Determining the priority of the influence of the subfactors of the integration criterion *(author's investigation)*

No	Subcreteria	Subcreteria No					$V_{ij\ cep}$	V_{ij}
		1	2	3	4	5		
1	The share of product exports in the total volume of manufactured products.	1,0	0,7	0,7	0,6	0,6	0,7	0,23
2	The share of direct foreign investments in the total volume of capital investments.	0,4	1,0	0,4	0,3	0,3	0,47	0,16
3	The number of employees who have completed training (internship) abroad and their ratio to the total number of personnel.	0,5	0,7	1,0	0,5	0,5	0,62	0,21
4	The number of foreign specialists and their ratio to the total number of personnel.	0,4	0,6	0,4	1	0,6	0,57	0,19
5	Positive perception of the enterprise by investors.	0,5	0,7	0,6	0,6	1	0,66	0,22

For each group of subcriteria, we calculate the local priorities Vij (Appendix F). In order to generalize the research based on proposed multi-criteria model, it is worth calculating the global priorities and forming the functions of the multi-factor model. Global priorities for each enterprise are calculated according to the formula:

$$Z_{ij} = V_{ij} \times U_{i}, \tag{5.6}$$

where Zij is the global vector of the j-th subfactor and the i-th criterion for a specific enterprise; Vij is the local vector of the j-th subcriterion and the i-th criterion for a specific enterprise (Table 5.15).

Table 5.14

Determining the priority of the influence of the subfactors of the brand criterion *(author's investigation)*

No	Subcreteria	Subcreteria No				$V_{ij\ cep}$	V_{ij}
		1	2	3	4		
1	Goodwill.	1,0	0,5	0,7	0,7	0,7	0,29
2	Coefficient of increasing the image of the company.	0,5	1,0	0,6	0,6	0,65	0,27
3	The number of mentions of the company in the mass media.	0,4	0,4	1,0	0,6	0,56	0,24
4	Public image	0,5	0,3	0,3	1,0	0,46	0,19

Table 5.15

Information support for the calculation of global priorities of the subcriteria of the multi-criteria model using the example of the "Electron-Karat" SOE of the "Concern-Electron" Public Enterprise *(author's investigation)*

Scientific and technical	Economic	Financial
1	2	3
$Z_{11}=\frac{0,1}{0,13}=0,83$ $Z_{12}=\frac{0,18}{0,13}=1,2$ $Z_{13}=\frac{0,2}{0,13}=1,67$ $Z_{14}=\frac{0,11}{0,13}=0,92$ $\mathbf{Z_{15}=\frac{0,21}{0,13}=1,71}$ $Z_{16}=\frac{0,21}{0,13}=1,7$	$Z_{21}=\frac{0,17}{0,12}=1,42$ $\mathbf{Z_{22}=\frac{0,25}{0,12}=2,08}$ $Z_{23}=\frac{0,21}{0,12}=1,75$ $Z_{24}=\frac{0,15}{0,12}=1,25$ $Z_{25}=\frac{0,21}{0,12}=1,75$	$Z_{31}=\frac{0,13}{0,096}=1,35$ $Z_{32}=\frac{0,14}{0,096}=1,46$ $Z_{33}=\frac{0,16}{0,096}=1,67$ $Z_{34}=\frac{0,13}{0,096}=1,35$ $\mathbf{Z_{35}=\frac{0,2}{0,096}=2,08}$ $Z_{36}=\frac{0,15}{0,096}=1,56$ $Z_{37}=\frac{0,1}{0,096}=1,04$

(End of Table 5.15)

1	2	3
Marketing	**Resources**	**Social**
$\mathbf{Z_{41}}=\frac{0,17}{0,091}=\mathbf{1,87}$ $Z_{42}=\frac{0,13}{0,091}=1,43$ $Z_{43}=\frac{0,18}{0,091}=1,97$ $Z_{44}=\frac{0,14}{0,091}=1,54$ $Z_{45}=\frac{0,11}{0,091}=1,21$ $Z_{36}=\frac{0,14}{0,091}=1,53$ $Z_{37}=\frac{0,13}{0,091}=1,42$	$\mathbf{Z_{51}}=\frac{0,18}{0,097}=1,86$ $Z_{52}=\frac{0,13}{0,097}=1,34$ $Z_{53}=\frac{0,14}{0,097}=1,44$ $Z_{54}=\frac{0,15}{0,097}=1,55$ $Z_{55}=\frac{0,1}{0,097}=1,03$ $Z_{46}=\frac{0,1}{0,097}=1,03$ $Z_{47}=\frac{0,11}{0,097}=1,13$ $Z_{48}=\frac{0,11}{0,097}=1,1$	$Z_{61}=\frac{0,19}{0,13}=1,46$ $\mathbf{Z_{62}}=\frac{0,22}{0,13}=1,69$ $Z_{63}=\frac{0,16}{0,13}=1,23$ $Z_{64}=\frac{0,2}{0,13}=1,54$ $Z_{65}=\frac{0,23}{0,13}=1,6$
Ecological	**Integration**	**Brand**
$Z_{71}=\frac{0,27}{0,13}=2,07$ $\mathbf{Z_{72}}=\frac{0,34}{0,13}=2,16$ $Z_{71}=\frac{0,38}{0,13}=2,92$	$\mathbf{Z_{81}}=\frac{0,23}{0,12}=1,92$ $Z_{82}=\frac{0,16}{0,12}=1,33$ $Z_{83}=\frac{0,21}{0,12}=1,75$ $Z_{81}=\frac{0,19}{0,12}=1,58$ $Z_{81}=\frac{0,22}{0,12}=1,9$	$\mathbf{Z_{91}}=\frac{0,29}{0,065}=\mathbf{4,46}$ $Z_{92}=\frac{0,27}{0,065}=4,15$ $Z_{93}=\frac{0,24}{0,065}=3,69$ $Z_{94}=\frac{0,19}{0,065}=2,92$

Based on the obtained information, we can draw a conclusion about the most influential subcriteria of each criterion in the model on the example of the studied enterprises. Based on the research, a list of the most significant factors for all the investigated enterprises was identified: Z15; Z22; Z35; Z43; Z51; Z62; Z72; Z81; Z91. These factors are: the level of innovativeness of the enterprise/production (Z15); the percentage of profit from the sale of licenses in the total structure of received profits (Z22); added value due to the release of a high-tech product (EVA) (Z35); international competitiveness of the product (Z43); staff qualification (Z51); GDP per capita (Z62); the amount of hazardous substances per production unit (Z72); the share of product exports in the total volume of manufactured products (Z81); positive perception of the enterprise by investors (Z91). Each of the specified subcriteria is, in our opinion, the most important and will require the development of strategic solutions to strengthen them. In an aftermath, we can offer a general model for calculating the integral indicator for enterprises with a similar production structure, scale of activity and profit rate, or on condition that relative performance indicators are used for comparison:

$$Wi = \sum_{i=1}^{n} Wij*Zij, \quad (5.7)$$

where Wi is the global priority for a specific enterprise;

Wij is the local priority of the enterprise in the studied group according to the specified criterion;

Zij is the global priority of the sub-criterion of the selected criterion.

In this way, a formalized version of the multi-criteria model for assessing factors influencing the commercialization of high-tech products was obtained, where the largest value of the Zij index reflects the most influential criterion to be taken into account during commercialization.

As a result of the determination of methodological approaches to the evaluation of the effectiveness of the toolkit of commercialization of high-tech products, it is proposed to use a multi-criteria method based on the method of expert evaluations specifically for the market of high-tech products, which has a difficult to predict nature, taking into account the significance of the multiplicity of the proposed effects.

$$
\begin{cases}
W_{(1)}=W_{11}1,71+W_{12}2,08+W_{13}2,08+W_{14}1,87+W_{15}1,86+W_{16}1,69+W_{17}2,16+W_{18}1,92+W_{19}4,46 \\
W_{(2)} = W_{21}1,7+W_{22}1,92+W_{23}2,06+W_{24}1,8+W_{25}2+W_{26}1,57+W_{27}2,42+W_{28}1,76+W_{29}\ 4,16 \\
W_{(3)} = W_{21}1,9+W_{22}1,9+W_{23}2+W_{24}1,8+W_{25}2+W_{26}1,2+W_{27}1,7+W_{28}\ 1,76+W_{29}\ 2,9 \\
W_{(4)} = W_{41}1,7+W_{42}1,92+W_{43}2+W_{44}1,8+W_{45}1,8+W_{46}1,94+W_{47}\ 3,01+W_{48}\ 2,03+W_{49}\ 3,22 \\
W_{5)} = W_{51}1,4+W_{52}1,92+W_{53}1,67+W_{54}1,8+W_{55}1,63+W_{56}1,94+W_{57}\ 2,23+W_{58}\ 2,3+W_{59}\ 3,22 \\
W_{(6)} = W_{61}1,9+W_{62}2,6+W_{63}2,35+W_{64}1,8+W_{65}1,63+W_{66}1,3+W_{67}\ 2,23+W_{68}\ 2,3+W_{69}\ 3,22 \\
W_{(7)} = W_{71}1,75+W_{72}1,92+W_{72}2,35+W_{74}1,8+W_{75}1,5+W_{76}1,94+W_{77}\ 2,83+W_{78}\ 1,93+W_{79}\ 2,9 \\
W_{(8)} = W_{21}1,9+W_{22}1,9+W_{23}1,5+W_{24}1,8+W_{25}1,6+W_{26}1,47+W_{27}3,45+W_{28}1,8+W_{29}\ 2,8.
\end{cases}
$$

The developed multi-criteria model for evaluating the effectiveness of tools for the commercialization of high-tech products and the proposed criteria for evaluating the effectiveness, namely: economic, technological, financial, marketing, resource, social, ecological, image, integration, – will contribute to the further initiative in the issue of developing complex programs of cross-industry commercialization and will make it possible to simplify the decision-making process regarding the depth and focus of scientific and technical collaboration at the initial stage of the cooperation process.

5.3. Improvement of the commercialization strategy in international context

The development of the national innovation system is currently a priority for the implementation of strategic development, realization of opportunities and prospects for the development of enterprises, educational and academic institutions. The systematic increase of international competitiveness by domestic enterprises requires the development of a strategy for the commercialization of their production results. Integration in the scientific and technical sphere involves: unification of approaches and practices of the scientific and research sphere and science-intensive branches of the economy; increasing the productivity of scientific, technical and innovative activities; elimination of direct and indirect obstacles to cooperation; minimization of costs and transactions, scientific and technical exchange, productivity improvement.

The urgency of forming a national innovation system poses the task of studying the most priority trends in the development of the high-tech sphere in the system of international entrepreneurship. The in-depth nature of the cooperation of domestic enterprises with influential subjects of the high-tech market and international entrepreneurship as a whole is capable of becoming a catalyst for accelerating the formation of the national innovation system of the state, which will allow to significantly expand the use of industries, V and VI technological systems in the domestic economy.

As mentioned, the current geostrategic stage of the development of the world economy is characterized by increasing global competition, which primarily concerns the market of high-tech products. Marketing strategies aimed at researching the markets of high-tech products should be considered as a sufficiently effective plan for product commercialization in the system of international entrepreneurship.

The main industries of the fifth and sixth technological systems are currently clear guidelines for the commercialization of high-tech products in the system of international entrepreneurship (Table 5.16).

In the process of reconstruction of the national economy, the development of the investment market, the newest industries and markets for high-tech products is an urgent issue. Commercialization of science-intensive products and technologies (especially NBIC technologies) is considered a priority [Pro skhvalennia Stratehii rozvytku sfery innovatsiinoi].

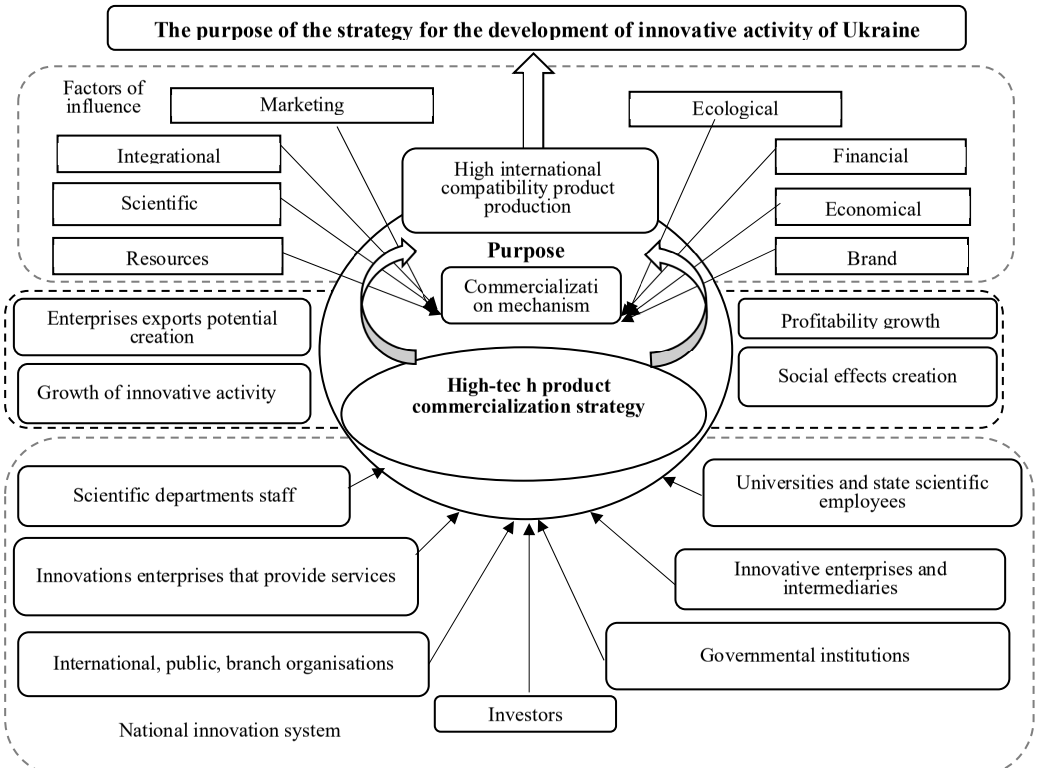


Figure 5.6. Ecosystem strategy for creation and commercialization of high-tech products by domestic enterprises (*author's investigation)*

Taking into account the proposed mechanism and multi-criteria model of commercialization of a high-tech product, it is advisable to determine strategic priorities for each identified most significant sub-criterion at each stage of the product creation and commercialization process.

Each of the investigated enterprises is in the sphere of implementation of the Strategy for the Development of the Sphere of Innovative Activity until 2030, where the target landmarks are clearly defined, which should be the basis for the formation of goals and objectives of the strategy for the development of high-tech industries (Figure 5.6).

Table 5.16

The main branches of the fifth and sixth technological orders

(*formed after [40; 41; 189])*

5th technological order	6th technological order
Automation tools; computers; optical fibers; telecommunication equipment; aviation industry; robot construction; microelectronics; satellite communication; biotechnology of microorganisms; oil and nuclear energy; software and information services.	Nanotechnology; biotechnology; artificial intelligence systems; cognitive technologies; photonics and optoelectronics; aerospace industry; CALS technologies; global information networks; computer education; formation of network business associations; integrated high-speed vehicles; unconventional energy.

Taking into account the information basis of the mechanism of commercialization of a high-tech product and the significant dynamism of the market, it is advisable to propose D. Abel's three-dimensional model for choosing the most optimal strategy for the enterprises under investigation, which allows taking into account the technology of the enterprise as one of the decisive factors in determining strategic priorities and strategic management tools (Figure 5.7).

The model has a three-dimensional measurement system, the coordinates of which are market segments, characteristics of needs and technologies. Moving along each plane of the coordinate system, the company chooses new market niches, defines unoccupied segments, etc

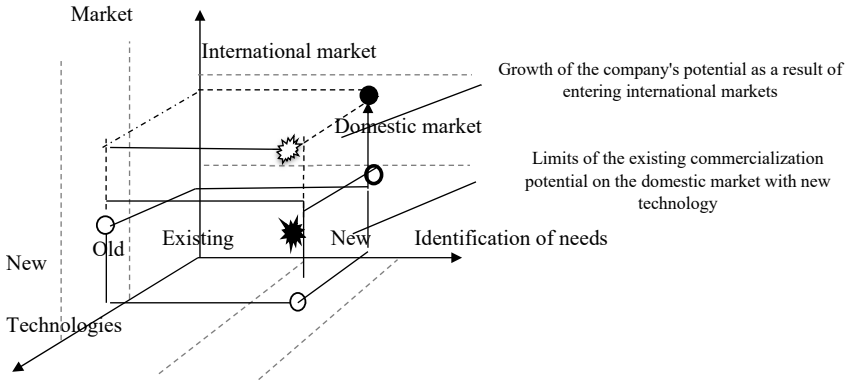


Figure 5.7. D. Abel's matrix for forming a strategy for the high-tech product commercialization strategy *(formed after [130])*

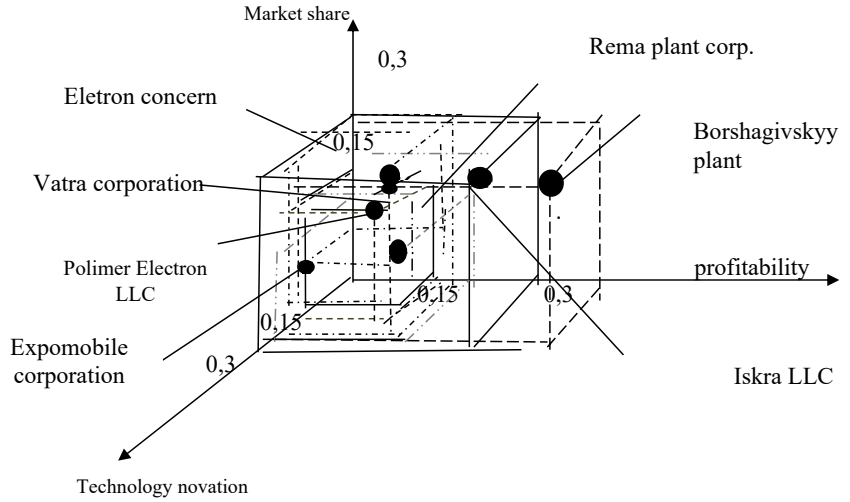


Figure 5.8. Positions of the studied enterprises in D. Abel's matrix with the coordinates «market share-new technology-profitability» *(author's investigation)*

Table 5.17

Calculation of global priorities of the studied domestic enterprises

(author's investigation)

Technologigy novation level										
No	**Criteria**	**Enterprises poitions**								**Ui**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Ui cep**
1	Electron Concern	1	3	4	4	4	2	2	4	2,4	0,15
2	Iskra LLC	4	1	2	3	4	3	3	4	2,74	0,18
3	Vatra LLC	2	3	1	2	3	4	2	4	3,23	0,13
4	Rema LLC	3	3	4	1	4	3	3	4	2,6	0,17
5	Polimer Electron plant	2	2	2	4	1	2	2	4	2	0,13
6	Borshagivskiy chemical plant LLC	3	4	3	4	4	1	3	3	2,9	0,19
7	Farmac LLC	3	4	4	4	4	3	1	4	2,9	0,19
8	Expomobile and Co. LLC	2	2	3	4	2	2	3	1	2,9	0,13
Market share on domestic market										
No	**Criteria**	**Enterprises poitions**								**Ui**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Ui cep**
1	Electron Concern	1	4	2	4	4	3	4	4	3,06	0,19
2	Iskra LLC	4	1	3	5	4	4	4	4	3,29	0,2
3	Vatra LLC	2	3	1	3	3	3	3	4	3,53	0,15
4	ТзОВ "Львівський завод РЕМА"	2	2	3	1	4	2	2	4	2	0,13
5	Polimer Electron plant	3	2	3	4	1	2	2	4	2,14	0,13
6	Borshagivskiy chemical plant LLC	3	3	4	4	4	1	3	4	2,74	0,17
7	Farmac LLC	3	3	4	4	3	2	1	3	2,69	0,17
8	Expomobile and Co. LLC	2	3	2	2	2	2	2	1	2,4	0,12
Profitability										
No	**Criteria**	**Enterprises positions**								**Ui**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Ui cep**
1	Electron Concern	1	3	4	2	4	3	3	4	2,24	0,14
2	Iskra LLC	2	1	2	3	4	4	4	4	2,54	0,14
3	Vatra LLC	3	3	1	4	3	2	3	4	4,43	0,14
4	ТзОВ "Львівський завод РЕМА"	4	3	3	1	4	2	2	3	2,6	0,17
5	Polimer Electron plant	3	3	2	3	1	2	2	3	2,18	0,14
6	Borshagivskiy chemical plant LLC	4	3	4	4	4	1	3	4	2,9	0,19
7	Farmac LLC	4	3	3	4	4	3	1	4	2,79	0,18
8	Expomobile and Co. LLC	3	2	2	2	2	2	2	1	2,4	0,15

Using the gradation of each axis and the Ansoff matrix, choosen the direction and goals of development necessary for the company. The enterprise's entry into the international market for the sale of a high-tech product necessitates the growth and accumulation of potential. To determine the rating of the investigated enterprises, it is advisable to compare them according to the criteria of the availability of new technologies, size of the market niche and profitability (Table 5.17).

We shall form a plane of possibilities for each investigated enterprise taking into account the data obtained by the method of hierarchies (comparative evaluations according to three selected criteria (Figure 5.8)).

According to the conducted research, we can note that the largest potential is stated the NVP «Electron-Karat» of the Private Enterprise «Concern-Electron», since a specific market share and a high-tech product provide the company with opportunities to enter the international market, PJSC «Lviv Electric Lamp Plant «Iskra», despite significant production capacity and profitability, serves the entire domestic market and does not require strategic decisions regarding production diversification. As for the enterprises of the «Pharmaceutical products» group, the growing demand for their products leads to the possibility of product diversification, expansion of export opportunities, creation of a new base for the introduction of high technologies into the production process (Appendix G).

The strategy of product diversification in the aspect of international entrepreneurship in the direction of commercialization will be reflected at each stage of product creation and implementation: taking into account the specifics of international sales markets (economic, socio-cultural, financial, political and legal), features of the customer's consumption function (purchasing motives, sales channels, information sources , perception of changes in price policy, etc.) and other general and special requirements for exported goods and technology transfer.

Evaluation of the effectiveness of the implementation of the chosen strategy of commercialization of high-tech products on the international market is carried out using a list of a portfolio of indicators specified in the multi-criteria model, with an emphasis on the possibility of expanding export opportunities, namely: the specific weight of the high-tech product in the volume of output, the amount of product exports, the level of innovativeness of the enterprise, etc. (Table 5.18).

Table 5.18

Information base for calculating the rating of the enterprise in order to expand the possibilities of commercialization of high-tech products on international markets (author's investigation)

Enterprises	Values of detailed indicators of commercialization of a high-tech product			
	The share of income from innovative products in the total income of the enterprise, %	The amount of export of the enterprise's products, %	The specific weight of the high-tech product in the volume of output, %	
Concern Elektron	0,3	0,2	0,7	1,22
Iskra LLC	0,4	0,11	0,18	1,35
Vatra corporation	0,2	0,9	0,2	1,13
Polimer-Electron plant	0,002	0,1	0,15	1,27
Rema factory LLC	0,001	0,08	0,13	1,6
Borshagivskyt medical-chemical facility	0,24	0,19	0,41	126
Farmac LLC	0,15	0,27	0,37	1,28
Expomobile and Co corporation	0,001	-	0,002	1,41

$R_1 = \sqrt{(1-0,3)^2 + (1-0,2)^2 + (1-0,4)^2} = 1,22;$

$R_2 = \sqrt{(1-0,4)^2 + (1-0,11)^2 + (1-0,18)^2} = 1,35;$

$R_3 = \sqrt{(1-0,2)^2 + (1-0,9)^2 + (1-0,2)^2} = 1,13;$

$R_4 = \sqrt{(1-0,002)^2 + (1-0,1)^2 + (1-0,15)^2} = 1,27;$

$R_5 = \sqrt{(1-0,001)^2 + (1-0,08)^2 + (1-0,13)^2} = 1,6;$

$R_6 = \sqrt{(1-0,24)^2 + (1-0,19)^2 + (1-0,41)^2} = 1,26;$

$R_7 = \sqrt{(1-0,15)^2 + (1-0,27)^2 + (1-0,37)^2} = 1,28;$

$R_8 = \sqrt{(1-0,001)^2 + (1-0,002)^2} = 1,41.$

The calculation of the rating of the enterprise based on the potential of commercialization of the product on international markets will be carried out according to the formula:

$$R_j = \sqrt{\sum_{i=1}^{n}(1 - Xij)^2}, \quad (5.8)$$

where Rj is the rating of the investigated enterprise.

Note that the highest rating in the sample will be the enterprise with the minimum value of Rj.

$$\sum_{i-1}^{n}(1 - Xij)^2$$

Based on the calculations of the rating of enterprises regarding the full-scale entry of enterprises to international markets, it was found that the most strategically successful in this direction will be the NVP «Electron-Karat» SE PRJSC «Concern-Electron», LLC «Lviv Plant REMA» and the enterprises of the «Pharmaceutical Products» group.

Intensification of the commercialization of high-tech products is necessary to achieve goals of modernizing the scientific and technological base of the state, creating a national innovation system, strengthening the integration potential in the region and the world, and entering Ukrainian society into the post-industrial stage of development. Ukraine has the opportunity to occupy a worthy place in the world market of high-tech products, which requires significant efforts, systematic and comprehensive actions in the direction of real progress.

AFTERMATH

Conceptual bases of commercialization strategy formation for a specific high-technology product are defined. The conceptual foundations of «commercialization» and «high tech» economic categories have been restructured. Definitions of the «high-tech product» and «commercialization of a high-tech product» economic categories are proposed. The specific strategy is conceptually rethought through the reformation of high – technology and high – tech product life cycle strategic guidelines. The epistemological value of the synergetic research method application for high-tech sector is actualized considering the stochastic nature of international entrepreneurship. The purpose of the system-forming synergetic concept is identified, which is to stratify determinants of innovative systems genesis, determine their internal dialectic, taking into account the key role of the synergetic paradigm of international entrepreneurship. The study makes it possible to reveal the architecture of international entrepreneurship of modern high-tech sector and outline approaches to determining the commercialization strategy within world economy trends.

The essential characteristics of product commercialization models are determined, special attention is given to the models of "technological push" and "market pull", based on the causal link between the stages of innovation process and the definition of demand as a key factor in implementing a high-tech product. The expediency of additional dependencies appliance is argued: "by the number of influencing factors"; «based on emergence of commercial ideas.» Monocomponent and multifactor econometric models application is justified within the high – tech products commercialization tools improvement process, given the high accuracy and indisputability as well as convincing adaptive and synergetic potentials of gained results of both abstract component and universal multifactor business models.To form a holistic view of commercialization modeling process in the work of the model of multiple generations, which differs functionally, by numbers as well as in scope of participants on creation of a commercially successful high-tech project.

The institutional bases of the infrastructural environment of commercialization of a high-tech product are investigated. The use of the system of institutions in context of the sixth technological stage model in

the aspect of high-tech products commercialization is offered. Based on the study of domestic and international experience, namely the United States, Japan and Germany, public – private partnership is identified as a a priority platform to ensure the effectiveness of an innovative product commercialization process at all production stages. System of innovative infrastructure institutional factors within context of the sixth technological wave is generalized, in particular the institutional macromodel outline is formed, which reveals interrelations of the following institutes: technology transfer; innovation culture, generation of ideas instrumentation, intermediation, regulation, HR and data support, financing, R & D branches support.

High-tech product commercialization trends within international business are outlined, which consist in balanced use of public administration levers, promotion of public-private partnership policies and systematic approach to stimulating SMEs activityto ensure development, interaction and diversification of high – tech products commercialization of domestic enterprises. System features of of the high-tech products market current state are highlighted: synergy; polybranch; unpredictability; hyperdynamic development. The expediency of using the system of indicators of scientific resources of countries is argued: the share of R&D expenditures in GDP; R&D expenditures per capita; the share of budget allocations for R&D in state budget expenditures; number of employees in R&D; number of international scientific awards; citation index; share of science – intensive products in GDP; the state's of high – tech products world market share. It is substantiated that the most accurate diagnosis is achieved under the conditions of an adaptive indicators system application, based on macro- and microlevels market analysis, focused on shortcomings and potentials of its state and development. Peculiarities of development, production and commercialization of the leading countries innovation activities are investigated, formation of export potential branch priorities of the enterprises identified.

Theoretical and methodological basis of commercialization internal corporate factors analysis of international business reintegrated to the high-tech sector specifics. Enterprises grouped by field of production using the NBIC international classification, approximated to domestic specifics: pharmaceutical; electronics and communications; chemical. Intracorporate

factors are grouped as follows: economic relations; resource potentials. Further compact classification of resource potentials group offered: production; scientific and technical; financial; marketing; HR; public image. A questionnaire, comprised of grouped according to the proposed classifications questions is developed. Taxonomy method calculations performed.

Product commercialization mechanism adapted to the specifics of the high-tech sector. Core parameters of the composition of planning and economic model of the mechanism are reconfigured: preparatory; planned; operational; background blocks: systematical; controlling. Principles of backbone symphony of the mechanism are reconsidered: integrity; adaptability; structure; interdependence; hierarchy; proportionality; complementarity; dynamism; efficiency; decomposition; suboptimization. This study makes it possible to increase the efficiency of high-tech products commercialization in the system of international business and allows a comprehensive approach to solving interrelated problems of growth of competitive advantages of the domestic economy.

High-tech product commercialization multicriteria model of tools efficiency formed on basis of following system of criteria: economic; technological; financial; marketing; resources; social; ecological; public image; integration. The criteria are detailed to subcriteria level based on qualitative and quantitative performance indicators. Method of expert evaluations is used in order to apply qualitative indicators. The method of pairwise comparisons is used to calculate tools efficiency. Multicriteria corresponding values are the following: consistency index, maximum eigenvalue of inversely symmetric matrix of pairwise comparisons and local vector criteria. The model was tested within the pool of domestic high-tech enterprises data processing activities, the list of integrated high – priority efficiency subcriteria was determined: the level of production innovation; percentage of profit from the sale of licenses; added value of high-tech product (EVA); international product competitiveness; share of exports; investment rating; GDP per capita; depth of specialization of labor resources; number of hazardous substances per unit; business public image. The identified sub – criteria require development of strategic decisions on the mechanism further implementation.

High-tech product commercialization strategy, which is composed of a pairwise comparison of significance factors that determine the potential of studied enterprises improved. Abel's three-dimensional model successfully applied to determine strategic directions of development, which will allow to calculate product commercialization effect within context of international business. Complex ecosystem of a high-tech product commercialization strategy for the 5th and 6th technological waves formed.