“Analytical support for forming the strategy of export-import activity development of enterprises in Ukraine”

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ARTICLE INFO	Lyudmyla Malyarets, Mimo Draskovic, Nadiia Proskurnina, Oleksandr Dorokhov and Volodymyr Vovk (2018). Analytical support for forming the strategy of export-import activity development of enterprises in Ukraine. *Problems and Perspectives in Management*, *16*(3), 423-431. doi:10.21511/ppm.16(3).2018.33
DOI	http://dx.doi.org/10.21511/ppm.16(3).2018.33
RELEASED ON	Friday, 14 September 2018
RECEIVED ON	Wednesday, 20 June 2018
ACCEPTED ON	Friday, 31 August 2018

JOURNAL	"Problems and Perspectives in Management"
ISSN PRINT	1727-7051
ISSN ONLINE	1810-5467
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
21	3	0

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10, Sumy, 40022, Ukraine

www.businessperspectives.org

Received on: 20th of June, 2018
Accepted on: 31st of August, 2018

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ANALYTICAL SUPPORT FOR FORMING THE STRATEGY OF EXPORT-IMPORT ACTIVITY DEVELOPMENT OF ENTERPRISES IN UKRAINE

Abstract

The current economic situation in Ukraine is conditioned by the efficiency of the export-import activity of industrial enterprises. In turn, the effectiveness of the strategy for the development of this activity depends on the scientific substantiation of its analytical support. This confirms the relevance of the topic of the article. The purpose of the article is to present the content of analytical support for forming the strategy of development of export-import activity of the enterprises in Ukraine. The object of the study is the development of analytical support for the formation of this strategy. The main methods of developing this analytical support is the multicriterial optimization method, which uses a genetic algorithm, multidimensional regression analysis, and a taxonomic method for calculating the integral index of development. The article also examines the peculiarities of the implementation of export-import activity of industrial enterprises in modern conditions, analyzes the criteria for its development, provides a system of indicators for the evaluation of this activity and the setting of a multicriteria optimization task of maximizing the development of export-import activity of the enterprise, the solution of which is recommended with the help of software MatLab. It is recommended that the optimal values obtained are taken as the basis for determining the desired values of the export-import performance indicators.

Keywords criteria of development of export-import activity, factors of influence, multicriteria optimization task of export-import activity, desired (planned) values of indicators, logic of stages of formation of strategy

JEL Classification C02, C61, L1, M2

INTRODUCTION

The entry of Ukraine into the world economy is carried out thanks to the development of export-import activity of enterprises. In this regard, one of the main strategies of enterprises in the modern socio-economic conditions is the strategy of development of their export-import activity. The analysis of dynamics of export and import of goods to Ukraine during the last five years testifies to favorable conditions for economic development of the country in 2015. However, the balance decreased compared to the period 2012–2013, and during the period 2016–2017, it began to increase. If we analyze the ratio of exports and imports of goods during the years 2012–2017, then, from 2016, there is a decrease in this value, which indicates a deterioration of the economic development of Ukraine in comparison with the period 2014–2015, but this state has improved in comparison with the period 2012–2013. Consequently, the urgency of the decision of the problem of development of export-import activity of enterprises is conditioned by the necessity to find ways of economic development of the country, when a positive balance is ensured for its foreign trade in goods.

1. LITERATURE REVIEW

The question of the formation and development of the theory of export-import activity in the context of international economic theory was the subject of research by many world-known scholars. Thus, Spiridon Pralea (2012) proposes to improve the traditional theory of international trade by studying the impact of growth on foreign trade within the framework of neoclassical analysis, based on the use of Keynesian tools and determining the role of foreign trade as a growth factor. The author analyzes new theories and models of "export-oriented growth" or "export-led growth", which explains the complex role of foreign trade in the dynamics of development, new segments of international trade, and provides the basis for trading strategies of development. In the context of regionalization and globalization of competition, the author considers strategy for competitive development, oriented towards external interests as the most rational one for the countries.

In his work, Minh Quang Dao (2014) examines the economic and mathematical model for solving the simultaneous shifts between GDP change and export growth rates, namely improving the model developed by Esfahani (1991), which reflects the relationship between exports and economic growth in semi-industrialized countries. The work by Stephen C. Cooke and Philip Watson (2011) is devoted to the comparison of export and import substitution strategies and the quantitative determination of their relationship. In this paper, it is substantiated that both strategies have the same direct impact on the economy, but the replacement of imports increases indirect effects due to additional endogenous purchases, which then increases the rate of return and profitability. While examining the impact of the overall international marketing strategy on the efficiency of exports at the enterprises based on the lagging effect of internal and external variables in the structural equations of the system of one-time equations, Maria Cristina Stoian, Alex Rialp, Josep Rialp (2015) share this effect at various enterprises, namely small enterprises, as well as enterprises belonging to low-tech industries. The paper by Draghescu (2015) is devoted to determining the factors influencing the level of export of glass products. In order to solve the problem, the author recommends combining a static gravity model with a dynamic gravity model. Scientists Bilal Lotfi, Mohamed Karim (2017) determine the importance of diversification of exports for the country's economic growth. But such an export strategy is contrary to generally accepted theories of international trade, in particular the Ricardian model, which assumes that countries must specialize in the production of goods with comparative advantages. However, studies have shown that more diversified countries tend to have faster and more comprehensive economic growth, which contributes to increasing the international competitiveness of the country.

Mishra (2011) suggests to revise the dynamics of the relationship between exports and economic growth of the country. He is doing this on data for India between 1970 and 2009. Using popular econometric methods for estimating the cointegration time and estimating vector errors, the author demonstrates evidence of the stationarity of a one-hour series, the existence of a long-term equilibrium relationship between them. Muhammad Ullah, Kazuo Inaba (2012) consider Bangladesh's growth strategy based on the use of the gravity model, while the analysis of signs of the coefficients of the signs allows to establish positive and negative factors of influence on this process.

Smorodinskaya, Katukov (2017) consider business strategies (offshoring, re-equipment, intelligence search) that generate the increasing complexity of global chains of value creation. The authors prove the need to take into account the importance of increasing the country's economic openness, increasing the cost of exports through broad liberalization of imports and using the competitive advantages of foreign partners in the interests of national competitiveness.

Suzuki (2012) in his work proves that the countries of East and South-East Asia, which are recognized as successful in the field of export-oriented industrialization, are less restricted by the presence of foreign currency with a stronger export potential than Latin American countries, that inertly carried out a certain import-substitute industrialization policy until the 1980s.

Obešlo (2017) analyzes the ratio of imports and exports of goods and services to GDP, using the Czech data as an example. He proposes to develop models using error correction method on the basis of cointegration analysis for the determination and analysis of explanatory variables that affect the import and export of goods.

It should be noted that many scientists believe that ensuring a good balance of exports and imports is possible on the basis of solving the problems of the effectiveness of export-import activities directly by business entities engaged in foreign trade operations. Therefore, these enterprises must rebuild their export-import activities in such a way as to ensure their efficiency and development. To implement this strategic goal, it is necessary to correctly formulate a strategy for the development of export-import activities of enterprises. Objectivity and the possibility of achieving this strategy are provided by an appropriate analytical justification.

In the strategic management system, one of the main places is occupied by assessing the factors of the external and internal environment, evaluating the capabilities of the enterprise, selecting and creating alternative functional strategies, ensuring implementation of the strategy and monitoring the implementation of strategies at the enterprise. This was discussed in detail in the scientific works by foreign specialists whose works were analyzed above. Scientists recommend forming strategies based on various methodological approaches, based on various analytical procedures and tools. Recommendations on the formation of strategies for export-import activities of enterprises are reflected in the works of Ukrainian scientists (Kuzmin et al., 2016; Mazaraki & Melnyk, 2010; Malyarets & Proskurnina, 2014; Ponomarenko & Piddubna, 2011).

2. OBJECTIVE

For successful implementation of the strategies of development of export-import activity of the enterprise, it is necessary that its strategic objectives are achieved, which is reflected in achieving the planned values of the indicators of the strategy. That is, strategies for the development of export-import activities should have a well-founded analytical support, which includes both the planned targets of the indicators of this activity and the analytical methods of their substantiation.

In the strategic management of the export-import activities of the enterprise, the choice and formulation of the strategy is carried out on the basis of many criteria that take into account the influence of the factors of the internal and external environment. Therefore, finding compromise alternatives to solving problems with many criteria such as the level of development of export activity, the level of development of import activity, their overall level, is possible on the basis of solving a multi-objective optimization problem.

3. DATA AND METHODS

To show the development of export-import activities, it is necessary to justify the system of indicators. These indicators must satisfy the following requirements: complexity, systemicity, representativeness, reliability, comparability, informality, optimality, controllability, adaptability, timeliness, and precision orientation. Indicators are important for industrial production enterprises, since they not only reflect the problems of their export-import activities in the current operating conditions, but also address key issues regarding the identification of possible reserves for increasing the efficiency and development of this activity.

Thus, the analysis of works of well-known scientists and practitioners on the set of factors of the external environment influence on the export-import activity of the industrial enterprise made it possible to distinguish the following macroeconomic factors: GDP at actual prices (UAH billion, z_1), capital investments (USD million, z_2), export volumes (USD million, z_3), import volumes (USD million, z_4), consumer price index $(z_5, \%)$, inflation index (z_6), tax revenues to the state budget (z_7, UAH million), dollar exchange rate relative to hryvnia (z_8), country competitiveness index (z_9) (Kuzmin, Todoschuk, & Melnyk, 2016; Mazaraki & Melnyk, 2010; Malyarets, 2014; Ponomarenko & Piddubna, 2011). In the system of indicators, which reflect the development of export-import activities of an industrial enterprise in modern conditions, it is

necessary to include such indicators as: x_1 – the share of exports in the volume of sales; x_2 – share of imports in the volume of sales; x_3 – export density of the enterprise in the foreign market; x_4 – the rate of change in export supply; x_5 – the pace of import changes; x_6 – the level of product diversification of exports; x_7 – the economic efficiency of exports; x_8 – economic efficiency of imports; x_9 – profitability of export; x_{10} – profitability of export operations; x_{11} – profitability of import; Y – income from sales of enterprise products. Indicators of the environmental impact are reflected on the website of the State Statistics Service of Ukraine (Publication of documents of the State Service of Statistics of Ukraine), and indicators of development of export-import activity of the enterprise – in the financial and statistical reporting of machine-building enterprises of Ukraine.

4. RESULTS

To assess the levels of development of export and import activities, the system of partial indicators should be reduced to integral indicators using one of the mathematical methods for constructing them (Ponomarenko & Malyarets, 2009). The most popular methods of folding partial indicators into an integral indicator are additive, multiplicative, and also statistical-mathematical methods of calculation – the taxonomic indicator of development and the Harrington quality index.

Based on the advantages of calculating the taxonomic indicator of development, the levels of development of export and import activity of the industrial enterprise PAT "Turboatom" were calculated, which are shown in Figure 1.

An analysis of the levels of development of export and import activities of the enterprise indicates the need for urgent development of a program of measures to increase the level of export activity of the enterprise. Figure 2 shows the dynamics of the general level of development of export-import activity of the enterprise, which is calculated as the average geometric level of the export activity and the level of import activity of the enterprise.

Consequently, at the given enterprise over the last four years there has been a decrease in the general level of development of export-import activity. To correct this situation, it is necessary to analyze the influence of levels of development of export and import activity of the enterprise on the income from sales of the enterprise's products. The model of the dependence of this indicator of the effectiveness of the activity from the levels of development has the form: $Y = 2.164 - 1.9609II + 3.5434IE$, with the determination coefficient $R^2 = 0.555$, calculated Fisher's criterion 1.25. That is, with an increase in the level of development of export activity by 0.1, the income from sales of the enterprise will increase by UAH 0.35434 billion, while with a decrease in the level of development of import activity by 0.1, this revenue will increase by UAH 0.19609 billion. The management of an enterprise should take into account this fact in order to increase the efficiency of management of its export-import activity. Next, to determine the influence of the factors of external and internal

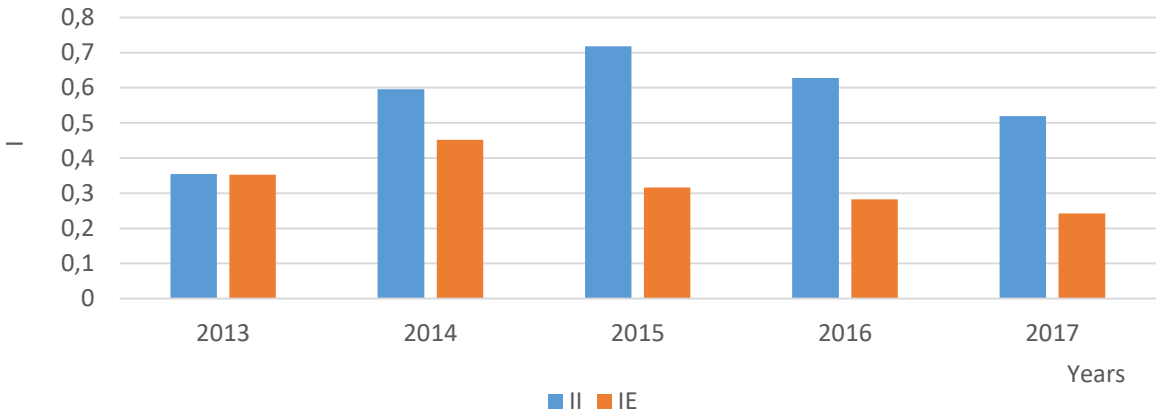

Figure 1. Dynamics of levels of development of export activity (IE) and import activity (II) of the enterprise PAT "Turboatom"

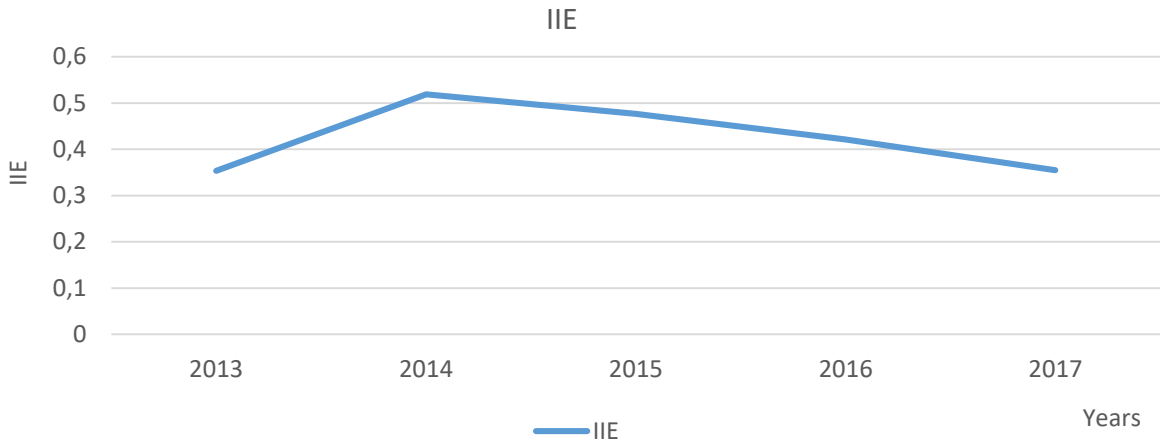

Figure 2. Dynamics of the general level of development of export-import activity of PAT "Turboatom"

environment at the level of development of export-import activity of the enterprise, it is necessary to calculate multifactorial regression models. Such models of influence of environmental factors at the level of development of export-import activity of PAT "Turboatom" are as follows:

$$IE = 0.72\frac{1}{28.26+2.11\ln z_1}+0.356\frac{1}{1.03+1.323E-8z_2^2}+$$
$$+0.88\frac{1}{4.91-4.879E-10z_3^2}+0.88\frac{1}{4.47-2.66E-10z_4^2}+$$
$$+0.398\sqrt{-0.126+\frac{27.36}{z_6}}+0.795\frac{1}{-15.91+4.035\ln z_6}+$$
$$+0.84\frac{1}{5.67-\frac{807917}{z_7}}+0.86\frac{1}{0.011-1.22\ln z_8}+$$
$$+0.23\sqrt{-0.58+\frac{2.84}{z_9}};$$

$$II = 0.1\sqrt{0.228+4.451E-12z_1^2}+$$
$$+0.487\sqrt{-0.28+\frac{5741.29}{z_2}}+0.05\frac{1}{1.563+8.967E-11z_3^2}+$$
$$+0.048\frac{1}{1.647+4.847E-11z_4^2}+0.423\left(1.162-\frac{68.37}{z_5}\right)+$$
$$+0.03\sqrt{0.153+\frac{20.03}{z_6}}+0.023\frac{1}{1.563+\frac{103274}{z_7}}+$$
$$+0.181\left(1.39-\frac{5.76}{z_8}\right)+0.18\frac{1}{21.14-\frac{78.77}{z_9}}.$$

Calculations show that factors of the external environment in different ways affect the level of export and import activities of the enterprise. These factors have a greater influence on the change in the level of export activity and less influence on the change in the level of import activity of the enterprise.

Next it is advisable to determine the impact of factors of the internal environment on the appropriate levels of export and import activities of the enterprise. Models of influence of factors of the internal environment on the level of development of export and import activities, as well as on the general level of development of export-import activity of PAT "Turboatom" are as follows:

$$IE = 0.94\sqrt{-0.014+0.414x_1^2}+$$
$$+0.882\sqrt{0.477-\frac{4040.36}{x_3}}+0.9\sqrt{0.029+0.058x_4^2}+$$
$$0.037\sqrt{-0.103+\frac{0.188}{x_6}}+0.63e^{-3.58+\frac{2.87}{x_7}}+$$
$$+0.97\sqrt{0.086+0.124\ln x_9}+$$
$$+0.57\frac{1}{2.46+2.297E-7x_{10}^2};$$

$$II = 0.25\sqrt{0.087+\frac{0.09}{x_2}x_1^2}+0.051\frac{1}{2.12-0.13x_5^2}+$$
$$+0.85\frac{1}{-0.344+\frac{3.29}{x_8}}+0.89\frac{1}{1.54+\frac{0.069}{x_{11}}};$$

$$IIE = 0.27\sqrt{0.107 + 0.254x_1^2} +$$
$$+0.012\frac{1}{2.61 - \frac{0.07}{x_2}} +$$
$$+0.512\sqrt{0.069 + (8.74E - 10)x_3^2} +$$
$$+0.37\sqrt{0.124 + 0.042x_4^2} +$$
$$+0.71\sqrt{0.459 - \frac{0.342}{x_5}} + 0.15\sqrt{0.432 - 0.33x_6^2} +$$
$$+0.06\sqrt{-0.021 + \frac{0.243}{x_7}} + 0.19\frac{1}{1.633 + \frac{1.15}{x_8}} +$$
$$+0.47\sqrt{0.14 + 0.017x_9^2} +$$
$$+0.058\sqrt{0.205 - (6.419E - 9)x_{10}^2} +$$
$$+0.31\frac{1}{2.26 + \frac{0.03}{x_{11}}}.$$

In the equations of the levels dependence on the factors, the coefficients were determined as the normalized values of the determination coefficients. It should be noted that the factors of the internal environment also have a bigger impact on the export activity of the enterprise than on the import one.

To find compromise alternatives for solving the task of developing export-import activities of an enterprise, it is necessary to solve the multi-objective optimization problem (MOP). Modern approaches to solving MOP are approaches that are based on simulation models and use genetic algorithms (Jin et al., 2002; Rasheed & Hirsh, 2000; Persson et al., 2007; Schwartz, 2013). To solve MOP using simulation models and genetic algorithms, it is recommended to use the following software products: AutoStat AutoSimulations (Inc AutoMod); AutoSched simulation programs, search procedures: evolution strategies; OptQuest Optimization (Technologies, Inc.), simulation software: Arena, Micro Saint, QUEST search procedures: search with dispersion, search with prohibition, neural networks; OPTIMIZ (Visual Thinking International Ltd.), search procedure modeling programs: evolution strategies, neural networks; SimRunner2 (PROMODEL Corp.), simulation programs: MedModel, ProModel, Service Model search procedures: evolution strategies, genetic algorithms; WITNESS Optimizer (Lanner Group, Inc.), WITNESS modeling programs, search procedures: imitation of annealing, search with a ban. In most optimization packages, evolutionary strategies and genetic algorithms are used as decision-search procedures,which have proven themselves as universal algorithms for global search, which allow finding quasi-optimal solutions for a reasonable time.

Thus, the following algorithms for realizing the search for solutions using evolutionary calculations and neural network metamodels are known: an algorithm based on the control of individuals and an algorithm based on the control of generations, and an algorithm based on the strategy of informing operators of genetic algorithms, which in turn involves the generation of large quantities descendants in the operators of the crossing and mutation of the genetic algorithm and further calculations of their utility functions using a metamodel (Jin et al., 2002; Rasheed & Hirsh, 2000; Persson et al., 2007; Schwartz, 2013).

Consequently, in order to formulate the strategy of development of export-import activity of enterprises, it is necessary to have optimal values of the indicators of this activity, and therefore, it is necessary to solve a multi-objective optimization problem, where as the partial criteria there are levels of development of export and import activity of the enterprise. The development of partial criteria must take into account the impact of each individual factor. To do this, it is necessary to calculate the paired dependencies of the respective levels on each individual factor of the internal environment, that is, the general economic-mathematical model of the multi-objective optimization task of export-import activity has the form:

$$IE = f(x_1, x_3, x_4, x_6, x_7, x_9, x_{10}) \to \max,$$

$$II = f(x_2, x_5, x_8, x_{11}) \to \min,$$

$$IIE = f\begin{pmatrix} x_1, x_2, x_3, x_4, x_5, \\ x_6, x_7, x_8, x_9, x_{10}, x_{11} \end{pmatrix} \to \max,$$

where the system of constraints are the intervals of real changes in the values of these indicators of a particular enterprise. For example, based on the statistical analysis of the real changes in the values

of these partial indices of export-import activity of PAT "Turboatom", the system of restrictions MOP looks as follows:

$$0.4 \le x_1 \le 0.8; 0.2 \le x_2 \le 0.6; 14000 \le x_3 \le 15500;$$
$$0.8 \le x_4 \le 1.9; 1.0 \le x_5 \le 2.0; 0.75 \le x_6 \le 1.0;$$
$$1.0 \le x_7 \le 1.4; 1.0 \le x_8 \le 2.0; 0.7 \le x_9 \le 2.7;$$
$$1000 \le x_{10} \le 2700; 0.04 \le x_{11} \le 1.0.$$

To successfully solve the multi-objective optimization problem using the genetic algorithm, the following steps should be followed: 1) creating an initial population; 2) determination (task) of the adaptation function for individuals of the population (evaluation); 3) calculating the adaptability of each individual in the population, and then the average adaptability of the entire population; 4) selection of individuals from the current population as two parents for the implementation of the crossover operator. The choice is performed randomly in proportion to the adaptability of the parents; 5) formation of the genotype of descendants. This requires, with a given probability, a crossover operation over the genotypes of selected individuals and with the probability of 0.5 selecting one of the descendants and keeping it as a member of the new population; 6) implementation of the mutation operator with given probabilities and obtaining the genotype of the descendant; 7) determination of the number of individuals to exclude them from the population so that its size remains constant. The current population should be updated by the replacement of the remaining individuals; 8) the determination of adaptability (to estimate the value of the target function) and recalculation of the average adaptability; 9) in case of execution of the stop condition it is the end of the cycle, otherwise the beginning of the cycle.

It is expedient to find the set of Pareto solutions by using the MatLab software environment, namely by implementing the multi-objective optimization using Genetic Algorithm procedure, abbreviated "gamultiobj". Genetic algorithm repeats a certain number of times the procedure for population modification (a set of individual solutions), thus obtaining new sets of solutions (new populations). At the same time, at each step of the population, "paternal individuals" are selected, that is, the solutions, the joint modification of which (crossing) leads to the formation of a new species in the next generation. The algorithm uses three types of rules, on the basis of which a new generation is formed: the rules of selection, crossing and mutation. The characteristics inherent in the genetic algorithm contribute to their effective application for solving multi-objective optimization problems, since they are based on the use of a multitude of potential solutions – the population and the global search in several directions. The genetic algorithm does not put forward any requirements for the type of target function and constraints. In the computational procedure, the population type was taken into account as a double vector with a population size of 120, and the selection function is realized as a random selection of two individuals with reproduction parameters of 0.3 and 0.5. The function of the mutation depends on the constraints, with the average crossing, the direction of migration – forward, that is, in the direction of the last subpopulation and every 20 generations. Figure 3 shows the results of these calculations.

The optimum values of the indicators and levels of export-import activity of this enterprise are as follows:

$$x_1 = 0.7822,\ x_2 = 0.4965,\ x_3 = 15120.09,$$
$$x_4 = 1.8782,\ x_5 = 1.9474,\ x_6 = 0.7769,$$
$$x_7 = 1.0134,\ x_8 = 1.0776,\ x_9 = 2.6888,$$
$$x_{10} = 1548.468,\ x_{11} = 0.0636.$$

At the same time, the level of development of export activity will be 0.4564, and the level of development of import activity – 0.3982, the total level of export-import activity will be equal to 0.492. Thus, if as the basis for the planned values of the indicators in the strategy optimal values will be taken, the real conditions of the enterprise's activity, as well as the natural correlation between export and import activities for ensuring the efficiency of the overall activity of the enterprise will be taken into account. The optimal values of the indicators are the basis for the comparative assessment and serve as the basis for developing other strategies for the development of the overall activity of the enterprise.

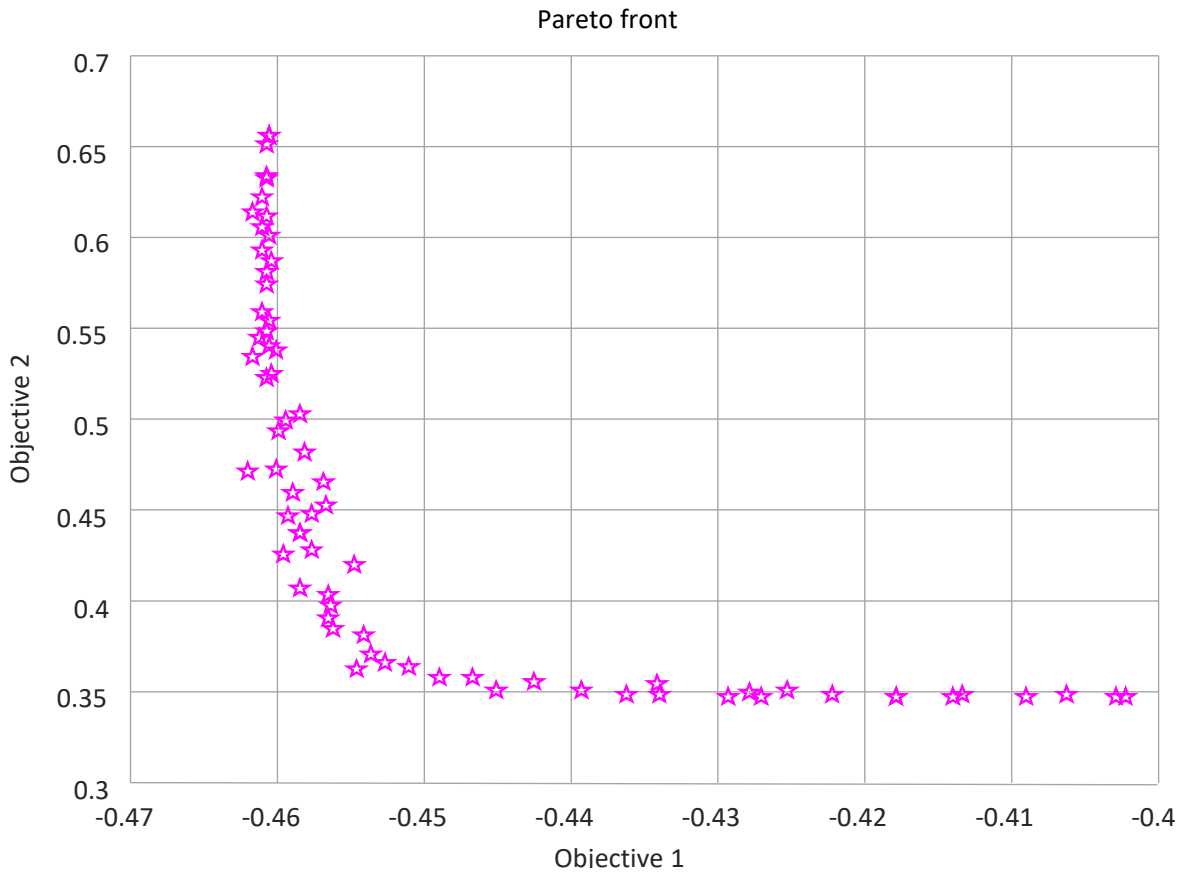

Figure 3. Results of calculations of multi-objective optimization problem of determination of optimal values of indicators and levels of development of export-import activity of PAT "Turboatom"

CONCLUSION

The optimal values of the indicators obtained on the basis of solving the multi-objective optimization problem should be used as a basis for comparative estimation and substantiation of the planned values of the indicators of the development strategy of the export-import activity of the enterprise. These values are recommended to be used to form the basic strategies of the enterprise, namely: growth, stabilization, survival, as well as functional strategies not only for the development of export-import activities, but also for other enterprise development strategies.

Thus, it is recommended to include in the analytical support of the strategy for the development of export-import activities of enterprises in Ukraine the systems of partial indicators reflecting the export and import activities of the enterprise, the levels of their development and the overall level of development, determine the factors influencing the external and internal environment, determine the optimal values of these indicators taking into account the influence of these factors. The formation of the strategy of development of export-import activity is proposed to be implemented according to the following logic stages: 1) assessment of the state of this activity in the enterprise; 2) analysis of the influence of factors of external and internal environment at the level of development of this activity in a concrete enterprise; 3) determination of optimal values of indicators of development of this activity on the basis of solving a multi-objective optimization problem; 4) final determination of desirable (planned) values of indicators in the strategy of development of export-import activity.

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