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Structuring of high-tech products by priority as a precondition for the innovative development of engineering enterprises

Abstract. The article is devoted to structuring of high-tech machine building products by priority as a precondition for their innovation development. We have identified high-tech machine building products produced by domestic enterprises of mechanical engineering. Clustering of products is reflected in terms of exports to different countries except the Russian Federation, whose market is instable in the current context. We have formed different clusters to define how engineering enterprises will act in the context of focusing on foreign and domestic markets. They are: «High-tech products of active exports», «High-tech export products with increasing sales in the domestic market», «High-tech products with a low level of exports and increasing sales in the domestic market». The results of the study will allow engineering enterprises to better allocate the resources in production and replace products with high-tech items according to their types of activities.

Keywords: High-tech Products Export; Clustering of High-tech Products; Machine Building

JEL Classification: L20; L50; L60; M20

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Структуризація пріоритетності високотехнологічних продуктів як передумова інноваційного розвитку підприємств машинобудування

Анотація. Статтю присвячено структуруванню за пріоритетністю високотехнологічних продуктів підприємств машинобудування як передумови їх інноваційного розвитку. Виявлено високотехнологічні продукти підприємств машинобудування, які виробляються вітчизняними підприємствами машинобудування. Здійснено кластеризацію продуктів за обсягом експорту до різних країн за винятком Російської Федерації, ринок якої за наявних умов є нестабільним. Сформовано кластери для визначення поведінки підприємств машинобудування в контексті орієнтації на зовнішній та внутрішній ринки: «Високотехнологічні продукти активного експорту», «Високотехнологічні продукти експорту з активацією збуту на внутрішньому ринку», «Високотехнологічні продукти низького експорту з розширенням збуту на внутрішньому ринку». Результати дослідження дозволять підприємствам машинобудування зорієнтуватись у розподіленні ресурсів, які залучаються у виробництво та заміщенні продукції високотехнологічною, враховуючи вид власної діяльності.

Ключові слова: високотехнологічні продукти; експорт; кластеризація високотехнологічних продуктів; підприємства машинобудування.

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Структуризация приоритетности высокотехнологичных продуктов как предпосылка инновационного развития предприятий машиностроения

Аннотация. Статью посвящено структурированию по приоритетности высокотехнологичных продуктов предприятий машиностроения как предпосылки их инновационного развития. Выявлено высокотехнологичные продукты предприятий машиностроения, которые производятся отечественными предприятиями машиностроения. Осуществлено кластеризацию продуктов по объему экспорта в различные страны за исключением Российской Федерации, рынок которой в существующих условиях является нестабильным. Сформировано кластеры для определения поведения предприятий машиностроения в контексте ориентации на внешний и внутренний рынки: «Высокотехнологичные продукты активного экспорта», «Высокотехнологичные продукты экспорта с активацией сбыта на внутреннем рынке», «Высокотехнологичные продукты низкого экспорта с расширением сбыта на внутреннем рынке». Результаты исследования позволят предприятиям машиностроения сориентироваться в распределении ресурсов на производство и замещение продукции на высокотехнологичную, учитывая собственный вид деятельности.

Ключевые слова: высокотехнологичные продукты; экспорт; кластеризация высокотехнологичных продуктов; предприятия машиностроения.

1. Introduction

The high-tech production of engineering enterprises is the basis for innovation development of both the enterprises and the real sector of the national economy on the whole. The identification of high-tech produce / products which can be prioritized according to each activity determined by CEA (Classification of Economic Activities) for engineering enterprises is of particular importance in the context of European integration process ensuring the transformation of part of such output to the final integrated product.

2. Brief Literature Review

A number of domestic and foreign scholars, such as E. Viardot (2004), L. I. Fedulova (2009), O. B. Salikhova (2010),

V. V. Dykan (2013); M. O. Kyzym, A. D. Oliynyk, I. Y. Matyushenko, V. Y. Khaustova, S. A. Omarov, Yu. M. Moiseyenko, I. Y. Buntov (2014) [1-7], have dedicated their works to the issues related to the promotion and realization of high-tech products.

More specially, L. Fedulova defines the high-tech sector as a complex systematic scientific and reproducing structure, which according to its role in the economic development and supply of resources is much more important and consistent than it is interpreted in scientific works and covered in the normative legal acts of Ukraine [1, 47]. E. Viardot views a high-tech product as a product created by using advanced technologies, which: 1) requires advanced technologies; 2) is often replaceable and subject to constant renewal; 3) is characterized by

innovativeness in the market; 4) requires significant investments in research and development; 5) is developed for specialized markets [2, 6].

Scientists, such as M. O. Kyzym, A. D. Oliynyk, I. Y. Matyushenko, V. Y. Khaustova, S. A. Omarov, Y. M. Moiseyenko, I. Y. Buntov, have analyzed the structure of exports and imports of the Ukrainian machinery in the European Union and the Customs Union, as well as in other countries and proved that import potential and competitiveness of domestic products are the most urgent issues of the Ukrainian engineering [3, 59].

The research conducted by Y. Demkiv is dedicated to considerations related to the main approaches to classification of engineering products as high-tech products and to evaluation of the share of high-tech products to the total volume of sales regarding domestic engineering [4, 172]. As V. V. Dikan notes, the material base of Ukraine's economy should become a pillar of a highly developed mechanical engineering, the core of which would form high-tech industries providing automation, computerization and intellectualization of production processes and fundamentally new organization of production, which means that structural economic imbalances towards industries whose products are classified as high-tech and those which have high adaptability should be redressed [5]. High-tech production in Ukraine should be based on three main factors: cooperation between the state and business; domestic consumption growth due to the implementation of large-scale national projects, and external consumption growth due to the improvement of the competitiveness of domestic high-tech sector industry [6]. A Research regarding exports of high-tech products in the context of their value as indicators of implementation of innovation policies was conducted by O. Salikhova, who notes that the efficiency indicators of innovative activity and the achieved level of technological capacity of an industry, public and private cost deficiency with regard to innovation development are determined by the scale of production and exports of high-tech products in the country [7, 14].

L. Fedulova emphasizes the need of structuring high-tech products by priority: 1) identification of priority markets for high-tech products and services; 2) a group of priorities that would ensure the development of high-tech industries to promote the modernization of technological base of industry in the new scientific basis, increasing scientific, innovative and production potential; 3) a group of priorities which include technologies, most of them focused on solving social problems and supporting domestic manufacturers of mass demand [1, 48]. However, despite the significant role of scientists considering the study point, clustering of high-tech products for machine building concerning the selection of production and replacement of products according to the given types of activity requires further research.

3. The purpose of the article is to structure high-tech products in machine building by priority as a precondition for their innovation development.

4. Results

Taking into account the present economic problems and military actions in Ukraine, it will be efficient to orient engineering enterprises on markets of different countries, which will reduce the risk of such a situation when a significant amount of revenue is lost by rejecting of the existing consumer sector. It is necessary to define the production of high-tech engineering companies which other countries, apart from Russia, may be interested in. A need to increase sales of high-tech products to substitute imports in the domestic market is becoming more obvious.

The research has been carried out applying statistical indicators of high-tech products export in the context of 2010-2014 dynamics [8] based at the classifiers [9; 10] corresponding to

CEA, namely: 1) production of computers, electronic and optical products (CEA 26); 2) manufacturing of electrical equipment (CEA 27); 3) production of machinery and equipment, other groups (CEA 28); 4) manufacturing of vehicles and other transport equipment (CEA 30). The level of exports of high-tech products according to CEA 29 «production of motor vehicles, trailers and semi-trailers» is too low, thus it is not taken into account.

To work out a mathematical model we used a model relevant to a dynamic model of conflict game in the market economy conditions and situations according to which the participants of the game (enterprises with different or the same types of production) may unite their efforts to counter a larger opponent to get the most profit for the least costs. To identify the link between the studied traits, we applied the determination coefficient equal to 52.95%. The level of exposure to other unaccounted factors is 47.05%. The correlation (empirical) ratio is 0.7276, which indicates that the type of high-tech export product has a significant impact on profits from exports. The excess value calculated by Fisher criterion ($769.27 > 2.99$) confirms a link between the material kind of high-tech equipment and the level of income from exports. The above statement has enabled a more detailed study by using cluster analysis.

Under the provisions of the game theory fundamental theorem, we have defined the following strategies: 1) the first strategy – the least profit from the exports of high-technology equipment by the ordinary values of indicators lies within $1 \leq \sum z_i \leq 1.83$; 2) the second strategy – the average earnings from the exports of high-technology equipment by the ordinary values of indicators lies within $1.83 < \sum z_i \leq 2.62$; 3) the third strategy – the biggest profit from the export of high-technology equipment by the ordinary values of indicators lies within $2.62 < \sum z_i \leq 3.44$. The lowest income sample included 75 objects (46% of the market), the average income sample included 61 objects (37% of the market), the biggest income sample included 27 objects (17% of the market), which confirms the major market laws of distribution of profits from exports.

As a result of the conducted cluster analysis of high-tech machine building products, we have identified the following three clusters (Figure 1):

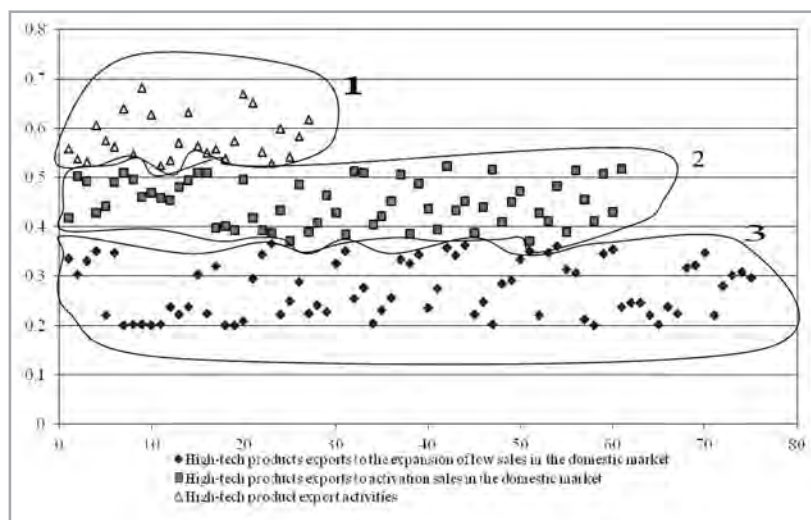


Fig. 1: Clusters of high-tech export products for foreign market, excluding the Russian Federation

Source: Compiled by the author

Cluster 1. «High-tech products of active exports». High-tech products of engineering enterprises that have the biggest revenue from their sales on the foreign market are grouped in this cluster. In our view, it is advisable to actively increase production of such products because other foreign market enterprises are interested in them (as it has already been mentioned, the research does not cover exports to the Russian Federation). This will allow the domestic machine-building sector to expand

the range of products and generate the interest of foreign investors towards both the available production and the development of production with the purpose of receiving profit. The profit gained can be accumulated for further innovation development and intensification of production of other high-tech engineering products. According to the results of modelling, the range of such products consists of finished products their parts and accessories (Figure 2).

It is worth noting that finished products account for 70% of the range, which once again confirms a need for a full closed-

cycle production. It should be noted that the national machinery for active exports has in its structure the products belonging to the group «other» (the products that do not belong to the main types, which foreign customers are primarily interested in).

Cluster 2. «High-tech export products with increasing sales in the domestic market». The cluster contains high-tech products with the average yield (62 positions). The interest of foreign customers towards the line of items in this cluster is lower if compared to the products mentioned in the previous cluster. It is advisable to expand the domestic market and the markets of

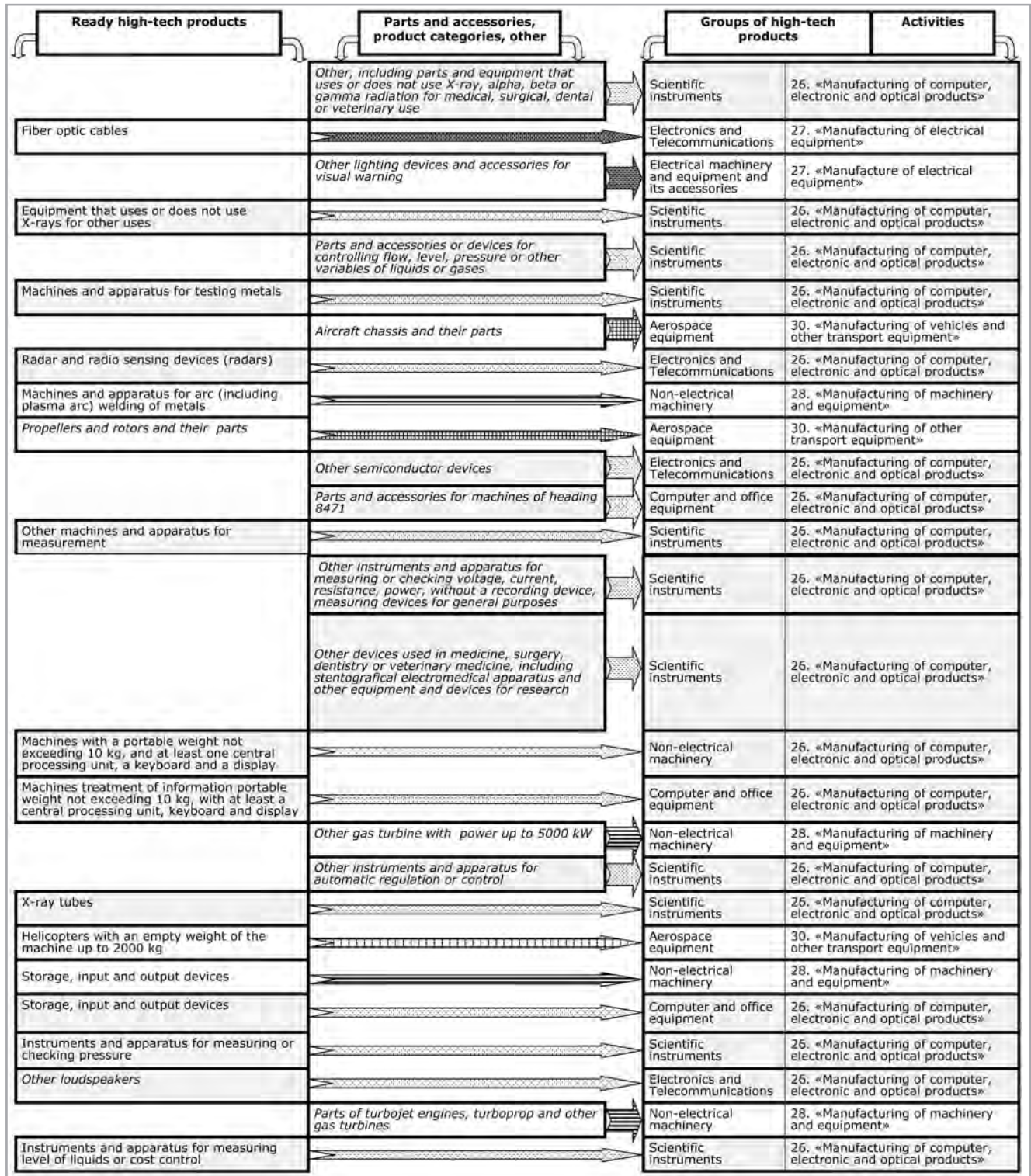


Fig. 2: High-tech products for machine building cluster 1 «High-tech products of active exports» in descending order of importance

Source: Compiled by the Author based on classifiers [9; 10]

the CIS countries (except Russia), as well as the markets of Asia and Latin America. The range of finished products is 62%, other types of products account for 23%, parts and accessories comprise 15%.

The Top-5 high-tech products are: high frequency tubes, except grid control tubes; klystron (manufacture of electrical equipment); airplanes and other aircraft with gross total empty weight over 2000 kg but not exceeding 15,000 kg (manufacture of vehicles and other transport equipment); ceramic capacitors with multiple layers of dielectric (manufacture of electrical equipment); other milling machines with numerical control (production of machinery and equipment); parts and accessories for aerometers, swimming hydrometers and similar instruments, thermometers, pyrometers, barometers, hygrometers and psychrometers, with or without recording devices, combined or not combined with each other (production of computers, electronic and optical products).

The lowest income according to the average value (from minimum to higher) corresponds to products such as the parts of turbojet or turboprop engines (manufacturing of machinery and equipment); electrocardiographs (manufacturing of computers, electronic and optical products); thermometers, pyrometers, not combined with other instruments: liquid, direct read (manufacturing of computers, electronic and optical products); parts and accessories of oscilloscope, spectrum analyzers and other instruments and apparatus for measuring or checking electrical, measuring and detecting alpha, beta, gamma, x-ray, cosmic or other ionizing radiations (manufacturing of computers, electronic and optical products); others constant capacitance capacitors, tantalum capacitors (manufacturing of computers, electronic and optical products).

Cluster 3. «High-tech products with a low level of exports and increasing sales in the domestic market». This cluster includes products that have a low level of profitability in the foreign market, which determines the need to expand their sales in the domestic market. The range of products includes 75 positions, 61% of which are finished products, of which 71% corresponds to the activity «Manufacturing of computer, electronic and optical products», 9% – «Manufacturing of electrical equipment»; 13% – «Manufacturing of machinery and equipment»; 7% – «Manufacturing of vehicles and other transport equipment». The following five products have the lowest demand in the foreign market: transmitters, which include receivers (manufacturing of electrical equipment); other electrical machines and apparatus that perform certain functions (production of electrical equipment); transmitters (manufacturing of electrical equipment); other apparatus for cable communication systems for carrier frequency or digital wired communication systems (manufacturing of computers, electronic and optical products); telephones for wire line combined with the cordless handset (manufacturing of computers, electronic and optical products).

5. Conclusions

Based on the research, we have identified high-tech machine building products by priority as a precondition for their innovation development. We have identified high-tech machine building products produced by domestic enterprises of mechanical engineering. Clustering of products is reflected in terms of exports to different countries except the Russian Federation, whose market is instable in the current context. We have formed three clusters to define how engineering enterprises will act in the context of focusing on foreign and domestic markets. They are «High-tech products of active exports», «High-tech export products with increasing sales in the domestic market» and «High-tech products with a low level of exports and increasing sales in the domestic market».

The conducted research will allow companies to allocate engineering resources for production and replace products to high-tech to personal activity: manufacture of computer, electronic and optical products (CEA 26); manufacture of electrical equipment (CEA 27); manufacture of machinery and equipment, other groups (CEA 28); manufacture of vehicles other transport equipment (CEA 30).

Further studies can be used to identify high-tech products, which may be subject to import substitution, and to form a mechanism of realization of organizational and economic measures relevant to machine building to expand production of such products.

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