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КОНЦЕПТУАЛЬНІ ЗАСАДИ СУТНОСТІ ВИСОКОТЕХНОЛОГІЧНОГО СЕКТОРУ ПЕРЕРОБНОЇ ПРОМИСЛОВОСТІ ТА МЕТОДИЧНІ ЗАСАДИ ОЦІНКИ ЙОГО ТЕХНОЛОГІЧНОГО РІВНЯ В КОНТЕКСТІ КАПІТАЛІЗАЦІЇ

Актуальність. Економіка України має стати високотехнологічною, з високим рівнем заробітних плат і новими вимогами до системи професійної освіти, з високим рівнем продуктивності праці на основі автоматизації, цифровізації та нових систем управління, з якісними сучасними робочими місцями та умовами праці. Тому важливе значення мають дослідження щодо визначення сутності технологічного ядра переробної промисловості та методичних засад оцінки технологічного рівня розвитку її галузей.

Питання дослідження сутності високотехнологічного сектору переробної промисловості та методичних засад оцінки його технологічного рівня в контексті капіталізації широко визнані у вітчизняних та зарубіжних науковців. Однак багатоаспектність цієї категорії не відображає багатовимірність сутності високотехнологічного сектору переробної промисловості, в якій на дослідження та розробки витрачається відносно висока частина їхнього доходу.

Визначення високотехнологічного сектору переробної промисловості як сутності капіталізації в контексті дослідження та розробки витрачається відносно високій частина їхнього доходу, що відображає багатовимірність сутності високотехнологічного сектору, які в контексті дослідження та розробки витрачаються відносно високій частина їхнього доходу, що відображає високу значущість сутності високотехнологічного сектору переробної промисловості.

Мета та завдання. Розуміння концептуальних засад визначення сутності високотехнологічного сектору переробної промисловості та методичних засад оцінки його технологічного рівня в контексті капіталізації.

Матеріали та методи. В роботі були використані загальна наукова та спеціальні методи дослідження: порівняння, узагальнення, синтезу, системний аналіз, логіко-діалектичний аналіз і інші. Інформаційну базу
дослідження стали монографії, спеціальна література, інформаційно-аналітичні матеріали, вітчизняні та зарубіжні публікації наукових видань, дані Державного комітету статистики.

Результати. Традиційно технологічним ядром переробної промисловості вважається машинобудування. Це - найбільш складна і диференційована частина переробної промисловості, яка виробляє машини та верстати, прилади та агрегати, різноманітні механізми промислового, побутового і військового призначення, та для наукових досліджень. Машинобудування визначає розвиток інших галузей промисловості. Крім того, вони є важливим фактором створення нових робочих місць, підвищення життєвого рівня людей та забезпечення економічного розвитку країн.

Чимало дослідників високий технологічний рівень галузей переробної промисловості пов'язують зі значними та систематичними інвестиціями у НДДКР, але такий підхід обмежує уявлення про фактори, які обумовлюють технологічний рівень галузей, бо окрім значних витрат на НДДКР, для високотехнологічних компаній характерно наявність сучасного високопродуктивного обладнання, технологій та нематеріальних активів, наявність висококваліфікованих кадрів, розробка та впровадження нових ефективних методів управління та організації виробництва, орієнтація бізнесу на глобальний ринок, доступність фінансових ресурсів.

Запропоновано визначення технологічного ядра (високотехнологічного сектору) як системи галузей переробної промисловості, які базуються на значних інвестиціях у НДДКР, наявності значних обсягів інтелектуальної власності, нематеріальних активів, сучасного обладнання та технологій, наявності висококваліфікованого людського капіталу, сучасних методів управління та організації виробництва. Це забезпечує створення високотехнологічних товарів з високим рівнем наявності різних видів капіталу та високий рівень ефективності їх використання.

Виділено два методичних підходи до оцінки технологічного рівня галузей переробної промисловості: ресурсний та результатний. Згідно першого підходу оцінка технологічного рівня галузей переробної промисловості здійснюється на основі наявності ресурсів: наукоемні (нематеріальні активи), основні засоби, людський капітал (рівень освіти і кваліфікації працівників), організаційний капітал. Згідно другого підходу оцінка технологічного рівня галузей переробної промисловості здійснюється на основі їх результативності в частині виконання своїх функцій (призначення, місії), які визначаються інтересами населення, бізнесу та держави, у тому числі щодо створення високотехнологічної продукції з високим рівнем доданої вартості та високої продуктивності праці.

В якості головного показника оцінки технологічного рівня галузей переробної промисловості пропонується використовувати валову додану вартість, яка за своєю сутністю є інтегральним показником результативності діяльності галузей і відображає вплив таких факторів як наукоемність, фондоозброєність, рівень людського та організаційного капіталу та ін. Оцінка технологічного рівня галузей на основі цього показника базується на гіпотезі - чим вища технологічний рівень галузі, тим вище продуктивність праці (валова додана вартість на 1 зайнятого).


**Ключові слова:** технологічне ядро, високотехнологічний сектор, промисловість, галузь, капіталізація, валова додана вартість, методи оцінки

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CONCEPTUAL PRINCIPLES OF THE HIGH-TECH SECTOR OF MANUFACTURING INDUSTRY ESSENCE AND METHODOLOGICAL PRINCIPLES OF ASSESSING ITS TECHNOLOGICAL LEVEL IN THE CONTEXT OF CAPITALIZATION

Topicality. Ukraine's economy should become high-tech, with a high level of wages and new requirements for the professional education system, with a high level of labor productivity based on automation, digitization and new management systems, with high-quality modern workplaces and working conditions. That is why this research is important and is to determine the essence of the technological core of the processing industry and methodological principles for assessing the technological level of development of its branches. Many scientific studies by foreign and domestic scientists have been devoted to the question of the essence research of the high-tech sector of the processing industry and the methodological principles of its assessment. The definition of the high-tech sector of the manufacturing industry as a set of industries in which a relatively high proportion of their income is spent on research and development has received the most widespread recognition. The definition of the high-tech sector of the processing industry as a set of industries in which a relatively high share of their income is spent on research and development does not reflect the multifaceted nature of this category, because it limits the understanding of the factors that determine the technological level of industries.

Aim and tasks. To develop the conceptual principles of the essence of the high-tech sector of the processing industry and the methodological principles of assessing its technological level in the context of capitalization.

Materials and methods. General scientific and special research methods were used in the work: comparison, generalization, synthesis, system analysis, logical-dialectical analysis, and others. The information base of the research include monographs, special literature, informational and analytical materials, domestic and foreign periodicals, data of the State Statistics Committee.

Research results. Mechanical engineering is traditionally considered as the technological core of the processing industry. This is the most complex and differentiated part of the processing industry, which produces machines and machines, devices and aggregates, various mechanisms for industrial, household and military purposes, and for scientific research. Mechanical engineering determines the development of other branches of industry. In addition, it is an important factor in creating new jobs, raising people's living standards and ensuring the economic development of countries.

Many researchers associate the high technological level of the processing industry with significant and systematic investments in R&D, but this approach limits the understanding of the factors that determine the technological level of industries, because in addition to significant expenditures on R&D, high-tech companies are characterized by the presence of modern high-performance equipment, technologies and intangible assets, availability of highly qualified personnel, development and implementation of new effective methods of management and organization of production, orientation of business to the global market, availability of financial resources.

The proposed definition of the technological core (high-tech sector) is the processing industry, which is based on significant investments in research and development, the presence of significant amounts of intellectual property, intangible assets, modern equipment and technologies, the presence of highly qualified human capital, modern methods of management and production organization. This ensures the creation of high-tech goods with a high level of added value and a high level of labor productivity, which is higher than in other branches of the processing industry.

The general formula of the technological core (high-tech sector) of the processing industry is proposed - these are industries that have a high level of availability of various types of capital and a high level of efficiency in their use.

Two methodological approaches to the assessment of the technological level of processing industry branches are distinguished: resource-based and result-oriented. According to the first approach, the assessment of the technological
level of branches of the processing industry is carried out on the basis of the availability of resources: knowledge-intensive (intangible assets), fixed assets, human capital (level of education and qualification of employees), organizational capital. According to the second approach, the assessment of the technological level of the branches of the processing industry is carried out on the basis of their effectiveness in terms of the performance of their functions (purposes, missions), which are determined by the interests of the population, business and the state, including the creation of high-tech products with a high level of added value and high labor productivity.

As the main indicator for assessing the technological level of processing industries, it is proposed to use the gross added value, which in its essence is an integral indicator of the effectiveness of the industries and reflects the influence of such factors as scientific capacity, capital resources, the level of human and organizational capital, etc. The assessment of the technological level of industries based on these indicators is based on the hypothesis - the higher the technological level of the industry, the higher the labor productivity (gross added value per 1 employee).

Conclusion. Based on the analysis of existing points of view on the essence of the concepts of "technological core", "high-tech industries", "high-tech sector" of industry, a definition of the concept of "high-tech industry" is proposed, as well as the formula of this concept in the context of capitalization. Determined methodical approaches to the assessment of the technological level of branches of the processing industry.

Key words: technological core, high-tech sector, processing industry, industry, capitalization, gross added value, valuation methods

Problem statement and its connection with important scientific and practical tasks. Ukraine's economy should become high-tech, with a high level of wages and new requirements for the professional education system, with a high level of labor productivity based on automation, digitization and new management systems, with high-quality modern workplaces and working conditions. That is why research is important and dedicated to the determining of the essence of the technological core of the processing industry and methodological principles for assessing the technological level of development of its branches.


Allocation of previously unsolved parts of the general problem. The definition of the high-tech sector of the manufacturing industry as a set of industries in which a relatively high proportion of their income is spent on research and development has received the most widespread recognition.

The definition of the high-tech sector of the processing industry as a set of industries in which a relatively high share of their income is spent on research and development does not reflect the multifaceted nature of this category, because it limits the understanding of the factors that determine the technological level of industries.

Formulation of research objectives (problem statement). To develop the conceptual principles of technological development of the branches of the processing industry and the methodological principles of their assessment in the context of capitalization.

Materials and methods. General scientific and special research methods were used in the work: logical-dialectical analysis; comparison, generalization and synthesis of the development of the conceptual apparatus; system analysis, systematization of methodological approaches to the assessment of the high-tech sector. The information base of the research was monographs, special literature, informational and analytical materials, periodical scientific domestic and foreign publications, legislative and regulatory acts, data of the State Committee of Statistics of Ukraine and Internet resources.

An outline of the main results and their justification. There are no examples in the world of a developed, rich, successful and relatively large country not having high-tech production. Because there is a relationship between the level of technological development and the wealth of society. The development of the high-tech sector of the economy is a determining factor of economic growth, since the transition of the economy to the production of high-tech products is accompanied by a drastic decrease in the level of material and
energy intensity of production, an increase in labor productivity and an increase in the competitiveness of the country's economy. The emergence of knowledge-intensive industries is the result of the evolution of technological development, when the costs of science, education and new technologies increase and require the creation of a closed reproductive loop in the economy, which ensures the return on capital investments. The main characteristics of the high-tech sector of the economy are: the modernity of production technologies and technological equipment; high level of qualification of employees and production management; use of all types of innovations in the production process; high level of added value in the products created and high labor productivity.

1. Conceptual principles of determining the technological core of the processing industry

Mechanical engineering is traditionally considered the technological core of the processing industry. This is the most complex and differentiated part of the processing industry, which produces machines and machines, devices and aggregates, various mechanisms for industrial, household and military purposes, devices and equipment for scientific research. Mechanical engineering is a basic branch of industry, on which the leading branches of the economy and the stability of their functioning depend. The main branches of mechanical engineering: space industry, aircraft manufacturing, electronics, machine tool construction, robotics, wagon and locomotive manufacturing, transport and agricultural engineering.

In the modern world, mechanical engineering is a leading factor in the development of new technologies, such as robotics, artificial intelligence, autonomous systems, etc., which have great potential for further development and providing new opportunities for increasing the efficiency of all social production. In addition, mechanical engineering is an important factor in creating new jobs, raising people's living standards and ensuring the economic development of countries. Mechanical engineering is a kind of indicator that indicates the general level of socio-economic development of the country - the greater the range of products it produces, the stronger its position in the international market, the higher the level of development of the country and its defense capability (Burkinskyi B.V., 2020).

In the 1960s and 1970s, new approaches were proposed to define the technological core of the processing industry based on the concepts of "science-intensive industries", "technologically intensive industries" and "high-tech industries". As the main criterion for determining such industries, it was proposed to use the share of R&D expenses in the volume of sales. The latest reports of the Organization for Economic Co-operation and Development (OECD) give the following definition of high-tech industries - "in which a relatively high proportion of their income is spent on research and development, including aerospace, pharmaceutical, computer and office equipment, communications equipment and scientific (medical, precision and optical) devices" (Denisyuk V.A., 2004, 2005).

The definition of the concept of "high technologies" was proposed by V. A. Denisyuk, agrees with the interpretation of the OECD - "technologies based on fundamentally new knowledge of the modern stage of scientific and technical progress, which are created for the manufacture and supply of products with a high level of scientific intensity, which corresponds to a certain list in the structure of the world commodity market and the priorities of scientific, technical and innovation policy developed countries" (Denisyuk, 2004; Denisyuk, 2005).

Experts also offer the following definition of a high-tech industry: "this is a branch of the economy in which science-intensive technologies play a predominant, key role, and the costs of scientific research and development exceed the average value of this indicator in other sectors of the economy..." (Bulkin I.A., 2001)

And also the following definition: "The classification of an industry or production as science-intensive or high-tech is conventionally accepted in both foreign and domestic literature: this group includes those industries that are characterized by R&D expenditures that exceed a certain fixed level, relative to the volume output or shipped products, added value or the value of the main factors of production (production assets and labor)" (Krehivskyi O.V., 2008).

Enterprises in high-tech industries are characterized by the presence of ownership rights to developments protected by patents or special agreements, which allows manufacturers to receive additional profits until newer technologies and even more unique products with absolute advantages appear. This additional profit is intellectual or technological rent.

Thus, many researchers associate the high technological level of the processing industry with significant and systematic investments in R&D. In our opinion, this approach limits the
understanding of the factors that determine the technological level of industries, because in addition to significant expenditures on R&D, it is typical for high-tech companies (Denisyuk V.A., 2004, 2005):

- availability of modern high-performance equipment, technologies and intangible assets that allow creating a high-tech product.
- availability of highly qualified personnel capable of developing and applying high technologies. Even if the company only uses high technologies for production, and does not develop them itself, its employees must still be able to work on high-tech equipment, apply new work methods, and therefore, high-tech companies need highly qualified personnel. In addition, due to the constant appearance of innovations, regular work is required to improve the qualifications of personnel, the level of their knowledge and skills;
- development and implementation of new effective methods of management and organization of production, promotion of goods on the market;
- orientation of the business to the global market: having created a new product or technology, it is often difficult for the company to find a sufficient number of consumers in the local or even national market. Only presenting the product to consumers in the world can ensure a sufficient level of financial income for business development;
- the use of methods of accelerated depreciation of new technologies and technological equipment, which ensures a high rate of reproduction of fixed assets and allows companies to be on the crest of the wave of scientific and technological progress;
- financial capabilities of the business: the availability of financial resources is one of the most important factors for the development of any business, however, since the high-tech business is more risky, this factor becomes of paramount importance for it. When creating a new product or technology, the company cannot rely on the experience of financial decisions that has developed, so the cost of financial resources is higher than for a traditional business, and therefore, public and private financial support is more important.

Thus, the technological level of industries depends on a number of factors, and not only on the amount of R&D expenditures.

An important characteristic of high-tech companies is the consumption of innovations. In modern management practice, four types of innovations are defined, covering a wide range of changes inherent in the activities of enterprises: product, process, organizational and marketing.

When defining the high-tech sector, the processing industry is mainly considered, although it cannot be denied the presence of enterprises with a high level of knowledge in the extractive industry, in the supply of electricity, gas, steam and air conditioning, as well as in the field of water supply, sewage, waste management (groups B, D, E of the international ISIC classification and the domestic KVED harmonized with it). It should also be noted the presence of high-tech business entities in the service sector (software development, telecommunications, scientific research and development, etc.) (State Consumer Standard of Ukraine, 2005).

Summarizing the above conceptual provisions, regarding the definition of the technological core (high-tech sector) of the processing industry, the following definition is proposed, as well as its general formula.

The technological core (high-tech sector) of the processing industry is the industries that are based on significant investments in R&D, the presence of significant amounts of intellectual property, intangible assets, modern equipment and technologies, the presence of highly qualified human capital, modern methods of management and production organization. This ensures the creation of high-tech goods with a high level of added value and a high level of labor productivity, which is higher than in other branches of the processing industry.

The general formula of the technological core (high-tech sector) is industries that have a high level of availability of various types of capital and a high level of efficiency in their use.

2. Methodical approaches to assessing the technological level of processing industries in the context of capitalization

Today, when assessing the technological level of the manufacturing industries, they mainly use the indicator of scientific intensity (the level of R&D expenditures compared to the amount of gross added value). But a high level of scientific capacity is a necessary but not sufficient condition for a high technological level of industries. Since the level of scientific capacity is one of the factors that determine the technological level of the industry. In addition, this factor has certain disadvantages compared to the “intangible assets” indicator. Scientific capacity reflects the level of R&D expenditures for the year, and intangible assets reflect the total R&D expenditures for the entire previous period. Accordingly, the last indicator to a greater extent determines the
technological level of the branches of the processing industry.

The technological level of industries also depends on capital intensity (the level of use of fixed assets), labor intensity (the level of qualification and experience of employees), the level of organizational capital, the level of use of intangible assets, etc. An important indicator of the technological level of industries is the level of added value and labor productivity.

Two methodical approaches to assessing the technological level of processing industry branches can be distinguished: resource-based and result-oriented.

According to the first approach, the assessment of the technological level of branches of the processing industry is carried out on the basis of the availability of resources: knowledge-intensive (intangible assets), fixed assets, human capital (level of education and qualification of employees), organizational capital. The number of factors can be expanded, the main thing is the presence of functional dependence of the factor and the result.

The assessment of the technological level of processing industry branches, according to the second approach, is based on evaluation of their effectiveness in performing functions (goals, missions) that determined by the interests of the enterprise, society and the state, business including processes of creation of high-tech products with a high level of added value and high labor productivity.

The relationship of resource-result approaches can be displayed within the framework of the production function

\[ Y = f (x_1, x_2, \ldots, x_n), \]

where: \( x_1, x_2, \ldots, x_n \) – resource factors (research and development costs, intangible assets, fixed assets, human and organizational capital, etc.; \( Y \) – productive factors – gross added value per 1 employee, the level of added value in the products sold.

Assessment of the technological level of industries on the basis of performance indicators is more adequate, but assessment on the basis of resource factors, especially in terms of scientific intensity, can serve as an additional "filter" when identifying high-tech industries. For example, the tobacco products industry (KVED 12) in Germany and Ukraine has the highest level of labor productivity (gross added value per 1 employee). But according to the OECD classification, this industry belongs to low technology. Or the industry of production of coke and oil refining products (KVED 19) in terms of labor productivity, it ranks second in Germany and Ukraine, and even first in Poland. But according to the OECD classification, it belongs to the medium-low technological industries, and according to the indicator of scientific intensity (the share of R&D expenditures in the added value is 1.17%), it should be classified as a low-tech industry. Moreover, according to this indicator, it is inferior to most low-tech industries (Appendix 1).

2.1. Methodological principles of assessing the technological level of processing industries based on the resource approach

Based on the indicator "ratio of R&D expenditures to the volume of product sales." This approach was first used in 1933 by the US National Research Council when analyzing the effects of the Great Depression, when companies were classified according to the amount of R&D spending: more than 10% of sales revenue, 5-10%, 1-5% and less than 1%. According to a second survey initiated in 1941 by the National Resources Planning Board, it was found that the average expenditure of companies on industrial research was 2% of gross sales. In 1947, the National Association of Manufacturers reported that the average amount of spending by companies on industrial R&D was 1.6% of sales. In the early 1950s, the US Bureau of Labor Statistics identified industries in which R&D spending in American industry exceeded the 2% level. They included the production of airplanes, electric machines, professional and scientific instruments, chemicals, etc. (Bulkin I.O., Denisyuk V.A., 2010).

The disadvantage of this approach is the use of the "sales volume" indicator when compared with R&D losses. The "sales volume" indicator consists of gross value added and intermediate consumption. The latter is the cost of material resources and services that were purchased from other enterprises and fully consumed in the production process. That is, the "sales volume" indicator reflects not only the results of the enterprise itself, but also the results of the enterprises of suppliers of goods and services. For example, an automobile assembly enterprise that assembles passenger cars based on large blocks. It buys the engine, fuel system, electrical equipment, transmission, cooling system, body, suspension, steering, braking system, wheels, tires and more from other companies. In this case, the main contribution to the production of the car and its cost belongs to the supplier enterprises. That is, the increase in output may not be the result of the enterprise's activity, but
the result of an increase in the volume of consumed goods and services. Thus, the "sales volume" indicator does not give an adequate idea of the results of the enterprises.

Based on the indicator "ratio of R&D expenditures to the volume of added value." In the late 1970s, Canada's Science and Technology Department divided industries based on the ratio of R&D expenditure to value added. Unlike the "sales volume" indicator, the "added value" indicator is purely a result of the company's activity. It does not include the results of the activities of other enterprises, and therefore reflects the real contribution of the enterprise to the creation of specific goods and services that it produces. Industries were divided into four groups (Bulkin I.O., Denisyuk V.A., 2010):
- high technological intensity (the share of R&D in added value is more than 3%);
- medium technological intensity (1-3%);
- low technological intensity (less than 1%);

On the border of the 1980s and 1990s, the OECD conducted a detailed analysis of direct and indirect R&D expenditures in various industries in 10 developed countries (Australia, Great Britain, Germany, Denmark, Italy, Canada, the Netherlands, the United States, France, and Japan). As a result, based on the indicator "specific weight of R&D expenditures in the volume of added value", four groups of industries were distinguished by the level of technological intensity (Table 1):
- high-tech (high-technology);
- medium-high technology (medium-high technology);
- medium-low technology (medium-low technology);

<table>
<thead>
<tr>
<th>KVED</th>
<th>Name of VED</th>
<th>Percentage of R&amp;D expenditures to added value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>21</td>
<td>Production of basic pharmaceutical products and pharmaceutical preparations</td>
<td>27.98</td>
</tr>
<tr>
<td>26</td>
<td>Production of computers, electronic and optical products</td>
<td>24.05</td>
</tr>
<tr>
<td>30.3</td>
<td>Production of air and space aircraft and related equipment</td>
<td>31.69</td>
</tr>
<tr>
<td>20</td>
<td>Production of chemicals and chemical products</td>
<td>6.52</td>
</tr>
<tr>
<td>25.4</td>
<td>Production of weapons and ammunition</td>
<td>18.87</td>
</tr>
<tr>
<td>27</td>
<td>Production of electrical equipment</td>
<td>6.22</td>
</tr>
<tr>
<td>28</td>
<td>Production of machines and equipment, n.v.i.u.</td>
<td>7.89</td>
</tr>
<tr>
<td>29</td>
<td>Production of motor vehicles, trailers and semi-trailers</td>
<td>15.36</td>
</tr>
<tr>
<td>30.1</td>
<td>Production of other vehicles (excluding the production of air and space aircraft, related equipment and the construction of ships and boats)</td>
<td></td>
</tr>
<tr>
<td>32.5</td>
<td>Production of medical and dental instruments and materials</td>
<td>9.29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>KVED</th>
<th>Name of VED</th>
<th>Percentage of R&amp;D expenditures to added value</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.2</td>
<td>Duplication of sound, video recordings and software</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Production of coke and oil refining products</td>
<td>1.17</td>
</tr>
<tr>
<td>22</td>
<td>Production of rubber and plastic products</td>
<td>3.58</td>
</tr>
<tr>
<td>23</td>
<td>Production of other non-metallic mineral products</td>
<td>2.24</td>
</tr>
<tr>
<td>24</td>
<td>Metallurgical production</td>
<td>2.07</td>
</tr>
<tr>
<td>25</td>
<td>Manufacture of finished metal products, except for machinery and equipment (excluding manufacture of weapons and ammunition)</td>
<td></td>
</tr>
<tr>
<td>30.1</td>
<td>Construction of ships and boats</td>
<td>2.99</td>
</tr>
<tr>
<td>33</td>
<td>Repair and installation of machines and equipment</td>
<td>1.93</td>
</tr>
</tbody>
</table>

Table 1. Distribution of types of economic activity (FDI) by technological sectors according to the OECD methodology
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Production of food products</td>
<td>1,44</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Production of beverages</td>
<td>1,44</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Production of tobacco products</td>
<td>1,44</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Textile production</td>
<td>1,73</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Production of clothes</td>
<td>1,40</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Production of leather, leather products and other materials</td>
<td>1,65</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Wood processing and manufacture of wood and cork products, except furniture; production of products from straw and plant materials for weaving</td>
<td>0,70</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Production of paper and paper products</td>
<td>1,58</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Printing activities, duplication of recorded information (without duplication of sound, video recordings and software)</td>
<td>0,67</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Production of furniture</td>
<td>1,17</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Production of other products</td>
<td>2,85</td>
<td></td>
</tr>
</tbody>
</table>


In 2016, the OECD proposed a new option for dividing types of economic activity depending on the intensity of research costs. In contrast to the previous version, in addition to types of economic activity, processing industrial types of economic activity related to services were added. All of them were divided into five technological groups (OECD, 2016):
- high-tech with a share of R&D spending of more than 20% of gross added value (GVA);
- medium high-tech (5% - 20%);
- medium-tech (1.8% - 5%);
- medium low-tech (0.5% - 1.8%);
- low-tech (less than 0.5%).

Public administration and defense, education, health care are regulated by the state, less controlled by the market, so the OECD excluded them from the distribution.

Today, when evaluating the technological core (high-tech sector), the first classification is used to a greater extent. One of the reasons for this is the availability of statistical data on R&D spending.

Experts define the high-tech sector as a combination of high-tech and medium-high-tech industries. This definition largely overlaps with the definition of mechanical engineering. According to the classification adopted by UN statistics and many countries of the world (especially in Ukraine), all machine-building industries are grouped into five groups. Each group consists of several narrower ones that can unite dozens of others. Such groups have productions:
- computers, electronic and optical products (KVED 26);
- electrical equipment (KVED 27);
- machines and equipment, n.v.i.u. (general and special purpose) (KVED 28);
- motor vehicles, trailers and semi-trailers (KVED 29);
- other vehicles (KVED 30).

In turn, the high-tech sector includes the same industries, as well as:
- production of chemicals and chemical products (KVED 20);
- production of basic pharmaceutical products and pharmaceutical preparations (KVED 21);
- production of weapons and ammunition (KVED 25.4);
- production of medical and dental instruments and materials (KVED 32.5).

But excluding the construction of ships and boats (KVED 30.1) (Fig. 1).

*Based on the indicators of "funding" and "employee qualification level". An important condition for the creation of high-tech production is the presence of highly qualified and experienced managers, organizational and administrative potential. No matter how good the idea, technology and plant, corruption and/or incompetent management can destroy everything. This is especially relevant for Ukraine. Later, it was proposed to take into account such criteria as the number of scientific and technical personnel, the level of qualification of employees, for the selection of these industries.*
In our opinion, the hypothesis about the correlation (relationship) between the level of capital and the level of qualification of employees, on the one hand, and the technological level of industries, on the other hand, is justified. Its verification is associated with the difficulties of obtaining statistical data on the amount of fixed assets by industry and assessing the level of qualification of employees by industry.

2.2. Methodological principles for assessing the technological level of processing industry branches based on the effective approach

As the main indicator for assessing the technological level of processing industries, it is proposed to use the gross added value, which in its essence is an integral indicator of the effectiveness of the industries and reflects the influence of such factors as scientific capacity, capital resources, the level of human and organizational capital, etc. The assessment of the technological level of industries based on this indicator is based on the following hypotheses:

Hypothesis 1. The higher the technological level of the industry, the higher the level of added value.

Hypothesis 2. The higher the technological level of the industry, the higher the labor productivity (gross added value per 1 employee).

Labor productivity (Pp) is proposed to be evaluated as the volume of gross added value per employee, namely:

\[ Pp = \frac{VDV}{N}, \]

where VDV is the gross added value of the industry; 
N is the average annual number of employees in the industry.

The level of added value (Rdv) is proposed to be estimated as the ratio of the gross added value of the industry to the volume of products sold, namely:

\[ Rdv = \frac{VDV}{V}, \]

where VDV is the gross added value of the industry; 
V – volume of sold products.

2.3 Methodological principles for assessing the technological level of processing industry branches based on the indicator "number of technological redistributions"

Many specialists believe that the technological level of production is determined by the number of technological redistributions. They note that redistribution is a certain number of production operations and technological cycles. The production of any relatively complex product involves dozens, hundreds, and often thousands of technological operations that may require many repetitions within one operation. Chemical, mechanical, thermal and other types of impact occur during the technological operations of products.

It is also noted that the level of technological redistribution depends on the complexity of production, production capacity - the spectrum (quantity) of components and types of raw materials included in finished products. Transportation and heavy machinery involves thousands of different components, each of which typically has its own supplier/manufacturer. Therefore, mechanical engineering belongs to high-tech products. The higher the technological redistribution, the more contractors are involved in the production of finished products, and the higher the multiplier effect in the economy. To grow grain or potatoes, a small number of contractors and contractors are needed, and for the production of space vehicles, entire industries are created that lock in a large number of contractors. When the USA and the USSR implemented atomic and space projects, virtually the entire economy worked on them, developing adjacent, related industries. That is, high-tech production increases the complexity and depth of interaction of counterparties in the economy, thereby leading to the development of the country.

Another important characteristic that determines the level of technological redistribution is the scientific intensity of products.
Technological production requires technologies created by universities, research institutes, design bureaus, and basic science. And these are hundreds of thousands of high-paying jobs. The difficulty of applying this approach lies in the lack of a clear definition of the concept of "technological redistribution" and quantitative criteria for the selection of technological redistributions in the chain of numerous operations on the way to the creation of final products. It should be added that the number of redistributions does not always determine the technological level of products. R&D is often considered in the context of microelectronics, semiconductors, and complex mechanical engineering, but the largest share of R&D spending occurs in the modern pharmaceutical industry, where drug production costs do not exceed 1%. Other costs go to numerous and lengthy chemical-biological studies that can last for years. However, the pharmaceutical industry is considered a high-tech industry.

Usually, but not always, the higher the technological redistribution, the higher the value added per employee or unit of resources expended. For example, the oil and gas industry, which has super-profits, based on zero and low redistribution. But this is rather an exception that proves the rule.

Conclusions and perspectives of further research. There are no examples in the world of a developed, rich, successful and relatively large country not having high-tech production, because there is a relationship between the level of technological development and the wealth of society. The development of the high-tech sector of the economy is a determining factor of economic growth, since the transition of the economy to the production of high-tech products is accompanied by a drastic decrease in the level of material and energy intensity of production, an increase in labor productivity and an increase in the competitiveness of the country's economy.

Mechanical engineering is traditionally considered the technological core of the processing industry. This is the most complex and differentiated part of the processing industry, which produces machines and machines, devices and aggregates, various mechanisms for industrial, household and military purposes, and for scientific research. Mechanical engineering determines the development of other branches of industry. In addition, it is an important factor in creating new jobs, raising people's living standards and ensuring the economic development of countries.

Many researchers associate the high technological level of the processing industry with significant and systematic investments in R&D, but this approach limits the understanding of the factors that determine the technological level of the industries, because in addition to significant expenditures on R&D, high-tech companies are characterized by the presence of modern high-performance equipment, technologies and intangible assets, availability of highly qualified personnel, development and implementation of new effective methods of management and organization of production, orientation of business to the global market, availability of financial resources.

The proposed definition of the technological core (high-tech sector) is the processing industry, which is based on significant investments in research and development, the presence of significant amounts of intellectual property, intangible assets, modern equipment and technologies, the presence of highly qualified human capital, modern methods of management and production organization. This ensures the creation of high-tech goods with a high level of added value and a high level of labor productivity, which is higher than in other branches of the processing industry.

The general formula of the technological core (high-tech sector) of the processing industry is proposed - these are industries that have a high level of availability of various types of capital and a high level of efficiency in their use.

Two methodical approaches to the assessment of the technological level of processing industry branches are distinguished: resource-based and result-oriented. According to the first approach, the assessment of the technological level of branches of the processing industry is carried out on the basis of the availability of resources: knowledge-intensive (intangible assets), fixed assets, human capital (level of education and qualification of employees), organizational capital. According to the second approach, the assessment of the technological level of the branches of the processing industry is carried out on the basis of their effectiveness in terms of the performance of their functions (purposes, missions), which are determined by the interests of the population, business and the state, including the creation of high-tech products with a high level of added value and high labor productivity.

As the main indicator for assessing the technological level of processing industries, it is proposed to use the gross added value, which in its essence is an integral indicator of the effectiveness of the industries and reflects the influence of such factors as scientific capacity, capital resources, the
level of human and organizational capital, etc. The assessment of the technological level of industries based on these indicators is based on the hypothesis - the higher the technological level of the industry, the higher the labor productivity (gross added value per 1 employee).

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