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Key trends in the development of mechanical engineering in Ukraine

Abstract. *The article presents an analysis of the state of and trends in the Ukrainian mechanical engineering industry based on selected key economic indicators. The industry is characterised by unstable, negative dynamics and falling production volumes, a rapid decrease in the volume and share of implemented innovative products, a significant reduction in the number of manufactured motor vehicles, an insignificant volume of high-tech products, a reduction in capital investments and a high level of depreciation of fixed tangible assets, extremely low labour productivity, a rapid decline in the number of employed workers, relatively low wages, a deterioration of the external balance. The authors view the current economic trends as destructive systemic changes that can significantly affect not only the activity of the machine-building industry but of the country as a whole. They highlight the critical state of the domestic mechanical engineering industry caused by a long period of inaction on the part of the state as regards the development of this industrial sector, which is only exacerbated by the military and hybrid aggression of the Russian Federation against Ukraine. The authors propose ways of overcoming these negative tendencies.*

Keywords: *machine-building, industrial products, labour productivity, capital investments*

1. Formulation of the problem

Machine-building, combined with IT, is the industry sector with the highest potential for creating and implementing commodity, technical and technological innovations, on which the future of economic, social and financial development of any country depends.

This industrial sector is the most important center of inter-sectoral relations and the economic basis of advanced economies. This results from the fact that on

the one hand machine-building creates basic means and products of intermediate consumption (raw materials, materials, etc.) for all sectors of economy (agriculture, types, production of industry, its spheres, trade, transport, construction, medicine, defense, etc.), and final consumption goods (household items and tools, means of transportation). On the other hand, machine-building is interconnected with almost all types of economic activity through the use of their products in their production activities. Close relations with all and the most important, strategic sectors of the economy – are the basis for defining machine-building as a system-building sector of the real sector of economy and indirectly, of financial and social sectors as well. In addition, the importance of machine-building for industry and economy is confirmed by its high and growing share in secondary industries of the majority of the large advanced economies of the EU. In particular, in 2019 machine-building in GVA of secondary industry reached 48,4% in Germany; 29.8% in France; 28.9% in Italy; 25.5% in Poland. In Ukraine, however, the GVA share of machine-building in the secondary industry decreased from 26% in 2013 to 17% in 2019. The share of this industrial sector in the export of the secondary industry decreased to 14.2% against of 20.8%, respectively. At the same time, the share of machine-building in the import of secondary industry in 2019 reached 38.9% against 32.1% in 2013. Taking into account the high multiplier impact of machine-building on the economy, the trends and features of the industrial sector need to be studied more thoroughly.

2. Literature review

Economic problems of machine-building development are the subject of scientific research. The scientific and analytical report [Deyneko, 2018] diagnoses the situation on key industrial markets, including machine-building, and identifies the most vulnerable segments in terms of critical drop in production and excessive import dependence. The ways to increase the technological and resource base of industrial modernization, which are conditioned by innovation development and transition to digitalization of industrial production, access to financial resources and capital markets, human resources development possibilities are proposed in the study [Deyneko, 2019]. Theoretical, methodological and practical aspects of industrial competitiveness assessment in conditions of globalization, internationalization and international competition are considered in scientific reports [Shynkaruk, Bevz, Baranovska, Bobukh, Vdovichen, Herasimova et al., 2015; Heyets, Danylenko, Ostashko, 2015].

According to Sokolova and Stoyka [2019] the main problems of machine-building development in Ukraine include: outdated logistics, high level of depreciation of fixed assets, high production cost, high import dependency of the

national machine-building market, low level of solvent domestic demand; low competitiveness of products, unstable financial, economic and political situation in the country.

In Viktoriya Hurochkina and Olena Menchynska [2020] the integration business processes of Ukrainian production in the context of its inclusion in the world economy were investigated, the dependence of domestic machine-building on imported raw materials and components was strengthened. The dynamics of industrial localization by main activities, in particular in the processing industry, were assessed, and the advantages and disadvantages of integrated corporate structures were highlighted.

The effectiveness of the localization policy to ensure economic development on the basis of its successful implementation in different countries is considered in Shovkun [2017]. In particular, the world practice of WTO rules harmonization of localization requirements has been analyzed. The specificity of localization requirements in certain sectors of economy is summarized. The necessity of systematic measures on localization of production in Ukraine has been substantiated.

3. Main results of the study

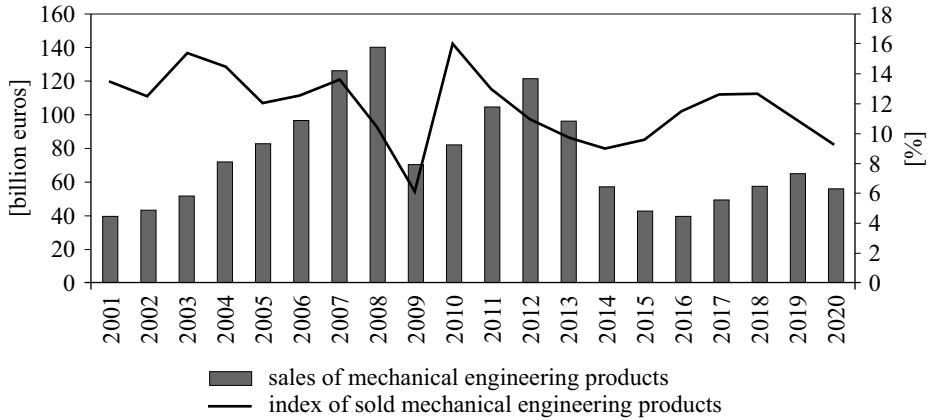
The purpose of the research is to analyze problems and outline prospects of machine-building development in Ukraine.

Machine-building of Ukraine possesses sufficient production and resource potential and human capital for effective functioning and meeting the demands of the economy with all necessary assortment of machine-building products. Domestic machine-building has considerable experience in aircraft, carriages, buses, sea vessels, passenger and cargo cars, tractors, agricultural equipment and techniques, household appliances, rocket-space and defense-industrial products. In the early 90-ies, the machine-building industry accounted for a third of the industrial production of Ukraine, a large part of the machine-building production was almost completely provided by domestic producers.

However, over the last thirty years, and significantly since 2008 and 2014 years, domestic machine-building has undergone a number of destructive systemic changes, which have caused a fundamental negative impact on its economic results, organization and forms of activity, competitiveness, technological and innovation of products. The following economic trends and indicators are identified as the basis of complex, systemic destructive changes of the domestic machine-building.

Unstable and negative dynamics and decreasing of production volumes. In 2000-2007, according to the industrial production index, machine-building production was unstable but increased, but since 2008 (except for 2010, 2011,

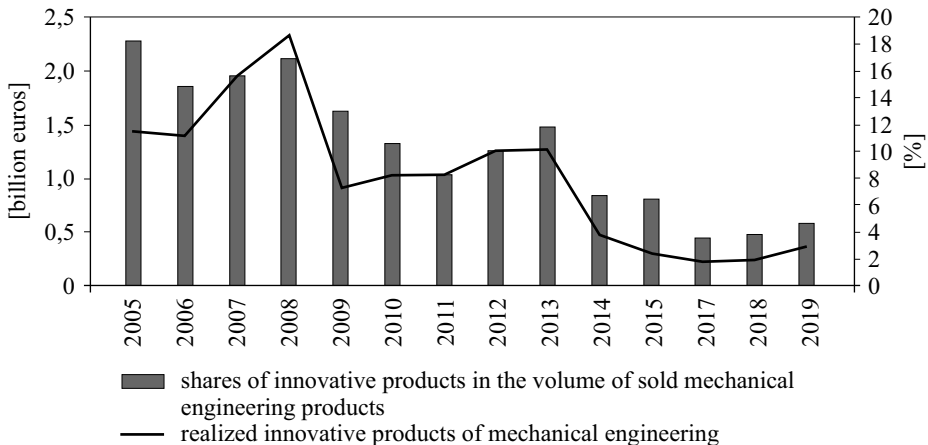
Chart 1. Index of mechanical engineering industrial production and volume of sold industrial production of mechanical engineering in Ukraine



Source: own elaboration based on SSSU, 2021.

2016-2018 years) – it has kept a steady downward trend, which in 2020 reached (-17,6%) (Chart 1). In 2020, the volume of sold industrial products of machine-building made 6,32 billion euros, which is more by 36% in 2016, but by 60% in 2008 (the highest value of the investigated period) and by 41.1% in the pre-crisis in 2013 (caused by military aggression of the Russian Federation). In addition, the volume of sold industrial products of machine-building outside the coun-

Chart 2. Indicators of innovation of Ukrainian machine-building products*



* 2016 data is not available.

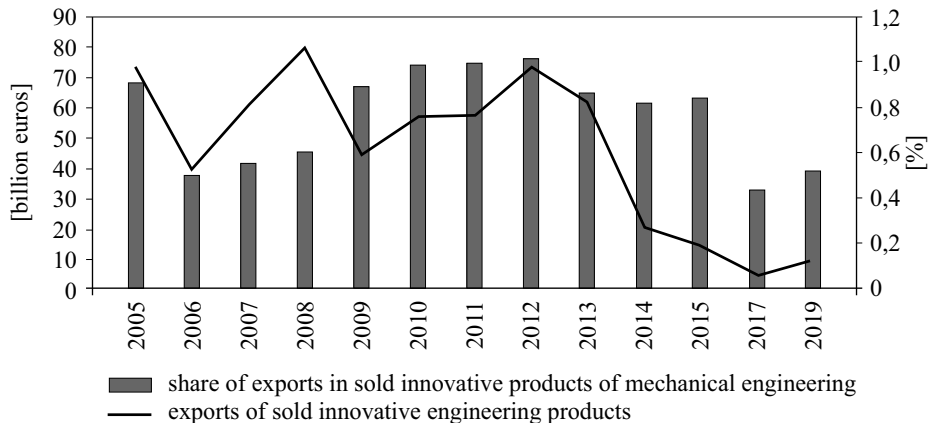
Source: own elaboration based on SSSU, 2021.

try (exports) decreased from 11,97 billion euros in 2014 to 2,62 billion euros in 2020 (–78.15%). The share of products sold outside the country in the volume of sold industrial products of machine-building (export orientation) decreased from 54.1% in 2014 to 46.5% in 2020 (–7.5 points).

Reduction of product innovation. In 2019, compared to 2013, the volume of innovative products of machine-building decreased by 73.3% and in 2008 (the highest indicator since 2005-year) –85,5% (Chart 2).

As a result, the innovation of machine-building products decreased to 4.6% in 2019, compared to 11.7% in 2013 and 18.2% in 2005. The volume of export of realized innovative products of machine-building has decreased by 84.1% in 2019 compared to 2013, and in 2008 by –87,7% (Chart 3).

Chart 3. Export of realized innovative products of machine-building and share of export in realized innovative products of machine-building of Ukraine*



* no data for 2016 and 2018.

Source: own elaboration based on SSSU, 2021.

The share of innovative products outside the country in the volume of realized innovative products (export orientation) of machine-building decreased to 38.9% in 2019 against 76.3% in 2012 (–37.4 percentage points).

Reduction of the complete collection and insignificant volume of high-tech products. During 2011–2016, the volume of production of the majority of Ukrainian machine-building products in quantitative terms decreased significantly and rapidly (Table 1). The most significant drop occurred in the number of manufactured motor vehicles and high-tech components to them, agricultural machinery and tractors, as well as industrial equipment. For example, the number of motor vehicles for transportation of 10 and more persons in 2016 has decreased by 6.7

Table 1. Volume of machine-building products production in Ukraine

Product name by Industry Product Nomenclature (NIP)	Unit of measurement	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Vehicles for transportation of 10 and more persons thousand pieces	thousands of pieces	4,0	3,7	2,6	1,0	1,0	0,6	0,9	1,0	1,1	1,0
Electric motors and direct current generators with a power of more than 37,5 W, but not more than 750 W (except starter motors for starting of internal combustion engines)	thousands of pieces	65,4	47,4	34,0	24,8	10,5	7,8	11,6	10,4	0,6	6,1
Tractors with engine power greater than 59 kW (except for tractors, driver-driven tractors for semi-trailer, track-type tractors) thousand units	thousands of pieces	5,4	4,0	2,9	2,7	2,8	3,3	3,3	2,4	1,4	0,9
Plows	thousands of pieces	6,1	15,4	6,2	4,4	3,7	3,6	2,9	3,0	2,5	2,7
Screwdrivers and field cultivators	thousands of pieces	7,4	4,7	4,4	3,7	3,4	3,8	4,0	2,9	3,9	2,5
Screwdrivers and field cultivators	thousands of pieces	7,4	1,6	2,0	2,0	2,3	2,8	3,3	2,2	2,1	2,3
Harrow (except disc), press	thousands of pieces	11,1	7,5	7,8	7,9	5,8	8,7	9,3	10,4	5,1	5,6
Harrow (except disc), press	pieces	823	1939	3803	402	163	219	295	334	308	517
Industrial equipment for sugar production of pieces	pieces	829	931	1100	429	727	1085	540	291	250	148
Industrial equipment for processing of meat or poultry with a pressure of pieces	thousands of pieces	11,0	33,6	18,9	10,3	11,1	11,4	11,8	10,1	10,9	8,0

Source: own elaboration based on SSSU, 2021.

times compared to 2011; electric motors and generators of DC power with capacity of more than 37.5 W, but not more than 750 W in 8.3 times; the equipment is industrial for production or preparation of confectionery, cocoa or chocolate in 3.8 times. In 2017-2020, some products managed to restore a slight positive dynamic, but still a significant number of important types of machine-building products with a declining trend remains. In particular, they are tractors with engine power more than 59 kW; industrial equipment for sugar production, processing of meat or poultry and other types of machine-building products.

At the same time, the number of specific types of electrical products (wires, electrical equipment) has increased: Tools for measuring electric values without a recording device; transformers other, n.o.s.l., with capacity not more than 1 kVA; equipment for switching electric kilovolts electric voltage not more than 1 kV (including switches of buttons, rotary; except relays); Lamps of electric and equipment lighting, plastic and other materials used with lamps and tube lamps (including sets of equipment lighting for Christmas and LED); electrical appliances for heating of premises, etc.

In the structure of machine-building, the dominant share (more than 83% in 2020, compared to 92% in 2014) is occupied by medium-high-tech production. Among them in 2020, 34.8% was on the production of machines and equip-

Table 2. Structure of the machine-building industrial production in Ukraine (by groups of adaptability to streamlined manufacture, %)*

Group of adaptability to streamlined manufacture	Manufacturing	Code	2014	2015	2019	2020
	Machine-building	26–30	100,0	100,0	100,0	100,0
High-tech	Production of computers, electronic and optical products	26	7,7	6,8	6,9	7,1
	Production of air and space aircraft, satellite equipment	30,3	7,5	8,5
	Total		7,7	6,8	14,3	15,6
Medium high-tech	Production of electrical equipment	27	20,5	20,6	18	18,2
	Production of machines and equipment not assigned to other groups	28	31,6	36,2	33	34,8
	Production of motor vehicles, trailers and semi-trailers	29	12,0	12,6	16	15,8
	Production of other vehicles	30-3.1-30,3	28,1	23,8	18	14,3
	Total		92,3	93,2	84,9	83,1
Medium low-tech	Building of vessels and boats	30,1	0,7	1,3
	Total		0,0	0,0	0,7	1,3

* Grouped according to the methodology of Eurostat.

Source: own elaboration based on SSSU, 2021.

ment not assigned to other groups. At the other hand, the share of high-tech production was within the range of 7-15%.

Reduction of capital investments and high level of material assets' bearing. In 2020, compared to 2012 the share of capital investments in machine-building decreased by 63.6% (220 million euros versus 607 million euros). In 2019, capital investments in machine-building in Poland reached EUR 6269,6 million (14.7 times more than in Ukraine). In 2020, the level of material assets in the machine-building industry of Ukraine was 70.7%, whereas in Poland it was 52.7%.

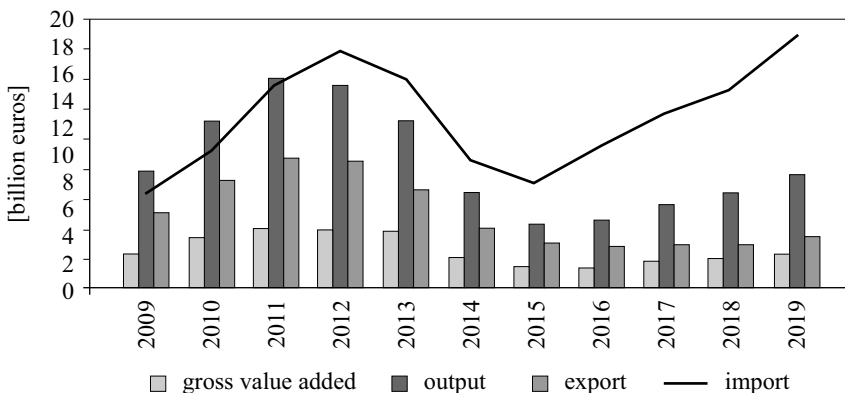
Reduction of employment, labor productivity and average monthly wages. During 2012-2019 the number of people employed in machine-building decreased by 33.8% (177,8 thousand) and in 2019 made up 347,7 thousand people, which is 57.7% less than in Poland (548,4 thousand).

In 2020 workforce productivity of machine-building in Ukraine was 19,86 thousand euros, which is 23.8% or 6,19 thousand euros less than in 2012, but by 56.2% (7,15 thousand euros) more than in 2015. In 2020, this indicator decreased by 5.7% (1,2 thousand euros). In 2020 workforce productivity of machine-building of Ukraine was 7.2 times (against 4.6 times in 2012) lower than in Poland.

The average monthly wage of employees in machine-building in Ukraine in 2020 amounted to 372 euros, which is 3.4% less in 2019, but more in 25% in 2013, and 113% in 2015. Despite a significant increase, the average monthly wage of machine-building workers in Ukraine is 3.5 times higher than that of Poland, which in 2020 reached 1292,6 euros.

Rapid growth of imports, worsening of the balance of foreign economic balance. In Ukraine, during 2012-2019 years, imports of machine-building products exceeded their respective output, exports and imports (Chart 4). In 2019, imports

Chart 4. GVA, manufacture, export and import of machine-building in Ukraine

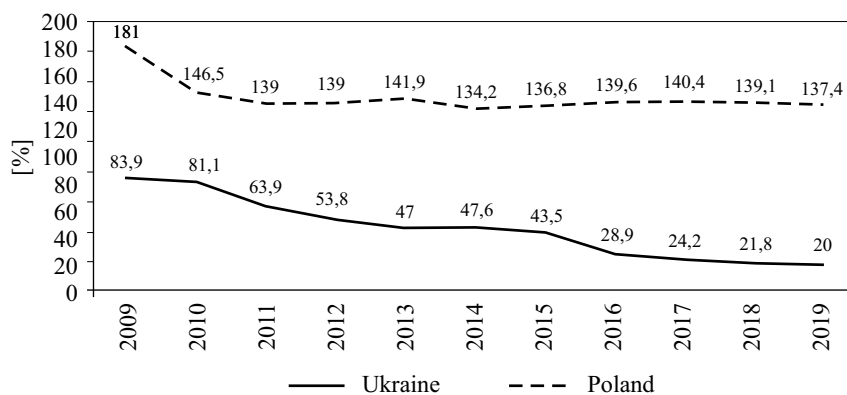


Source: own elaboration based on SSSU, 2021.

of machine-building products amounted to 19 billion euros, which is 2.3 times more than for the output and 5 times more than exports. In 2019, the volume of machine-building products imports was 22.9% higher than in 2013 and 145.3% higher than in 2015.

The significant increase in imports, along with the decrease in technological innovation, labor productivity and production drop, resulted in a sharp decrease in import coverage of exports of machine-building products, which in Ukraine in 2019 decreased to 20% against 83,9% in 2009 (Chart 5). Another side of this trend is the sign of a rapid decline in competitiveness or demand for domestic machine-building products as in domestic and foreign markets.

Chart 5. Coverage of imports by exports of engineering products of Ukraine



Source: own elaboration based on SSSU, 2021.

By comparison, in Poland, import coverage of machine-building products has also been reduced for ten years. However, in contrast to Ukraine, in Poland exports of machine-building products exceeded imports in 2009-2019, in particular in 2019 – by 37,4% (against –80% in Ukraine).

4. Conclusion

Trends and current state of domestic machine-building are considered, caused by military and hybrid aggression of the Russian Federation against Ukraine with corresponding consequences, as well as by long-term passivity of the state in development and preservation and maintenance of national interests of this industrial sector.

At the same time it is necessary to take into account the following:

– after the collapse of the USSR, Ukrainian machine-building still requires significant capital investments in modernization, modernization and modernization of production to increase competitiveness of products in the domestic and foreign markets, which makes and substantiates the necessity of purposeful actions of the state to attract investments, stimulation, tax and financial assistance to the development of this sector of industry;

– advanced economies, the USA, the EU, China in particular, openly and by convert means use protectionist tools to protect strategic and not only economic sectors;

– in almost all developed economies of machine-building as a whole system of economy was formed not by the market, but by purposeful actions of the state, in particular by protectionism policy, therefore, liberalization and liberalization, utopian approaches on “wisdom” of the really unexistent free market to forming machine-building as a center of intersectoral relations is not appropriate and even dangerous.

Taking into account the given analysis, renewal of competitiveness, innovation of products, inflow of capital investments, increase of labor productivity, the development of domestic machine-building as an integral economic system and center of inter-sectoral requires the development and implementation of a law or a complex of interrelated and coordinated and mutually contradictory normative documents aimed at development, restoration of domestic machine-building in general and in all manufactures particularly (passenger and cargo cars, buses, buses, city, railway transport, communal special equipment, means and equipment for agro-industrial and power complex, household appliances, space and defense-industrial production, ships, etc.). The main purpose of this task is to satisfy consumer demand and production needs of the national economy and machine-building, in particular, produce final and intermediate consumption of domestic origin. Under the products of domestic origin we understand the products made at enterprises which actually operate in Ukraine, regardless of the form of ownership and the countries of origin of capital (except for countries which are hostile to the Ukrainian state). In other words, it is necessary to develop laws that would promote, stimulate the development of existing machine-building and related industries and sectors of the economy and concentrate on the domestic market. On the other hand, foreign TNCs were motivated to work on the Ukrainian consumer market of machine-building goods (primarily cars, household, computer equipment, communication means) and to create full-cycle production in Ukraine. In addition, the existing domestic export-oriented machine-building enterprises, especially those working under the schemes, were encouraged to direct at least 60% of the sales products to the domestic market. And one of the key criteria of effectiveness of such measures is re-orientation of domestic machine-building on products of final, rather than intermediate consumption.

At the same time, the choice of the state policy tools must go beyond the observance of the percentage of localization at the state purchases of products of individual machine-building production or compensation of the value of the produced or purchased agricultural machinery, state orders, preferential credits, compensation of interest on credits, which is necessary, but perhaps not always sufficient, rational and effective in ukrainian realities. As an example, instead of partial compensation of 25% of agricultural machinery value produced by domestic producers, perhaps more economically rational, from the position of national interests, is to organize, finance, order production of key components (strategic products) imported. Therefore, the production of such products in Ukraine can significantly reduce cost and improve the technical characteristics of end products and thus increase their price and technical competitiveness on the domestic market. This requires the preparation of a corresponding range of strategic products of intermediate consumption, for each machine-building production. At the same time it is important to focus attention on products that can have multi-vector application (in several machine-building industries), for example, electrical engineering products.

One way to increase product innovation and competitiveness is to state funding of research and development to be implemented in machine-building. With the help of such researches it is possible to form strategically necessary assortment of products of intermediate consumption of machine-building and to carry out its production and implementation. Financing can be carried out through special grant projects, funds of scientific research development, orders of scientific and technical products. Besides, participants of the following scientific researches can be domestic and foreign scientists, engineers of corresponding establishments. In addition to the state, machine-building enterprises can also be involved in co-financing. Thus, financing for the attraction of intellectual capital may be cheaper, but much more effective, compared to the methods of stimulating machine-building in Ukraine. At the same time, it is important to emphasize that the current state of domestic machine-building cannot be limited to motivational or stimulating instruments, but requires purposeful restoration of key chains of the entire industrial sector with application and direct state administration. In addition, there is a need for a constant information-stimulating campaign on popularization and support of the Ukrainian producer, primarily in the domestic market. A striking example is Poland's goal-based open policy of buying Polish goods, which is being populated with the start of the COVID-19 pandemic. In Ukraine there are much more important arguments in favor of the use of aggressive and motivational policy of import substitution, in particular – the armed and hybrid aggression of the Russian Federation. Further research in this direction will be based on the improvement of the protectionist tools of the development of domestic machine-building.

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Główne tendencje rozwojowe przemysłu maszynowego na Ukrainie

Streszczenie. W artykule przedstawiono analizę stanu i tendencji w ukraińskim przemyśle maszynowym w oparciu o wybrane wskaźniki ekonomiczne. Branża ta charakteryzuje się niestabilną, ujemną dynamiką produkcji, szybkim spadkiem ilości i odsetka wdrożonych produktów innowacyjnych, znaczącym spadkiem liczby produkowanych pojazdów samochodowych, niewielką liczbą produktów wysokiej technologii, spadkiem inwestycji kapitałowych i wysokim poziomem amortyzacji środków trwałych, skrajnie niską wydajnością pracy, szybkim spadkiem liczby zatrudnionych, relatywnie niskimi płacami oraz pogorszającym się stanem bilansu zewnętrznego. Autorzy postrzegają obecne trendy gospodarcze jako destrukcyjne zmiany systemowe, które mogą znacząco wpłynąć nie tylko na działalność przemysłu maszynowego, ale i całego kraju. Zwracają uwagę na krytyczny stan krajowego przemysłu maszynowego wywołany długim okresem bezczynności państwa w zakresie rozwoju tego sektora przemysłu, który tylko pogłębia militarna i hybrydowa agresja Federacji Rosyjskiej na Ukrainę. Autorzy proponują sposoby przewyżyczenia tych negatywnych tendencji.

Słowa kluczowe: budowa maszyn, wyroby przemysłowe, wydajność pracy, inwestycje kapitałowe