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PROBLEMS OF MECHANICAL ENGINEERING DEVELOPMENT IN UKRAINE

Svitlana Ishchuk[1], Luybomyr Sozanskyy [2]*

[1,2] Department of Problems of the Real Sector of the Economy of the Regions,
M.I. Dolishniy Institute of Regional Research of NAS , Ukraine

Abstract: Mechanical engineering is the most innovative segment of the world economy, and especially the economy of industrial European countries. The purpose of this article is to analytically identify the problems and outline the prospects for the development of mechanical engineering in Ukraine. According to the results of the authors' research, the dynamics and features of production and foreign economic activity of mechanical engineering enterprises in Ukraine within the regional context are determined. The dependence of the Ukrainian economy on imports of mechanical engineering products is calculated, and the share of imports in the costs of Ukrainian mechanical engineering productions is determined. The key trends in the development of mechanical engineering in Ukraine during 2010-2020 are substantiated. The measures of the state industrial policy directed at overcoming the challenges and threats in the development of Ukrainian mechanical engineering in the conditions of globalization are offered.

Keywords: export, import, mechanical engineering, production, products

JEL classification: L60, L62, L69

Introduction

Mechanical engineering is a key driver of scientific and technological progress; it accumulates the highest potential for innovation and spreads the greatest multiplier effect on the economy as it has the widest range of intersectoral links. The share of

[1] Svitlana Ishchuk, DSc in Economics, Professor, 79026 Lviv, 4 Kozelnytska, St., Ukraine, iso.ird@ukr.net, https://orcid.org/0000-0002-3698-9039
[2] Luybomyr Sozanskyy, PhD in Economics, 79026 Lviv, 4 Kozelnytska, St., Ukraine, ls.ird2@ukr.net, https://orcid.org/0000-0001-7854-3310
* Corresponding author: Luybomyr Sozanskyy – ls.ird2@ukr.net

mechanical engineering in the GDP of Germany exceeds 10%, and the GDP of Slovakia exceeds 7%, while in Ukraine the value of this indicator is less than 2%. In terms of value added, Ukrainian mechanical engineering is 136 times smaller than that of Germany, 7 times smaller than that of Poland and is almost comparable (1.1 times smaller) with the analogical segment of such a small country as Slovenia. The share of mechanical engineering in industrial products sold in Ukraine is less than 7%, and in the value added it is about 3%.

The economic problems of mechanical engineering development constitute the subject of studies of many researchers. In particular, the benefits and concerns of signing the FTA between Ukraine and the EU are outlined in Geyets and Ostashko (2016). The advantages include creating opportunities to accelerate the modernization of domestic mechanical engineering by using the scientific and technical achievements of European countries; the adaptation of domestic production to the technological, sanitary and environmental standards of the EU; and the establishment of zero rates of import duty on investment types of mechanical engineering products. The concerns are focused on the following: an increase in competitive imports in the domestic market of Ukraine, in particular cars, tractors, combine harvesters; high barriers for Ukrainian manufacturers to enter the European market due to the relatively lower technological level of domestic mechanical engineering; growing dependence on the imports of high-tech products, both of final consumption as well as components used in the assembly of machines of well-known foreign brands. In Amosha and Bulyeyev (2017), the main problems of the development of the mechanical engineering enterprises of Ukraine include: obsolete fixed assets, a lack of working capital of enterprises, a low level of innovation activity of Ukrainian enterprises, the low competitiveness of many product types of domestic enterprises; an insufficient number of skilled workers; and a low geographical diversification of exports of mechanical engineering products. The factors of the occurrences of crises in the mechanical engineering enterprises of Ukraine are considered in Smerichevskyi et al. (2017). Such factors include a decline in the pace of development, reduced product competitiveness due to certain political and internal governmental factors, the inefficient training of human resources, reduced capital investment, the depreciation of fixed assets, in addition to the reduced innovation activity of enterprises.

Similar problems in automotive development, as one of the basic segments of mechanical engineering, are typical for Eastern European countries. Thus, in Hlušková (2019) it was noted that a shortage of skilled and relatively cheap labor is the main problem of automotive industry competitiveness in the Czech Republic, Slovakia, Poland and Hungary. In addition, a high export orientation with growth of a protectionist policy and trade tensions pose a significant threat to the functioning of this industrial sector. The spread of Industry 4.0, the development of the production of electric vehicles and self-driving cars constitute an important factor of the changes in the automotive industry.

A detailed evaluation of the trends and prospects, as well as internal and external factors of the functioning of mechanical engineering in the transport equipment production sector in Poland is presented in Łuczak and Małys (2016). In particular, emphasis is placed on the need to increase product innovation and take into account structural changes in mechanical engineering and the economy in general.

In Włodarczyk and Janczewski (2014) it was noted that the rising costs of materials, a fall in demand, and hence a drop in car prices, the overproduction of cars, as well as competition constitute the key factors in reducing efficiency, the need to optimize the costs of the automotive industry, distributors of automotive components and parts, in addition to car service companies in Poland.

The scientific-analytical report by Deyneko (2018b) diagnoses the situation in key industrial markets, including engineering, and identifies the most vulnerable segments in terms of a critical decline in production, excessive dependence on imports, and the gap between the production of certain goods and domestic demand. The ways to increase the technological and resource bases for industrial modernization, which are due to innovative development and a transition to the digitalization of industrial production, access to financial resources and capital markets, as well as opportunities for human resources development, were proposed in the study by Deyneko (2018a). The theoretical, methodological and practical aspects of assessing the competitiveness of industry in the context of globalization, internationalization and international competition are considered in research reports by Shynkaruk et al. (2015) and Heyets et al. (2015).

The main problems of machine building development in Ukraine in Sokolova and Stoyka (2019) include outdated logistics, the high level of depreciation of fixed assets, significant costs of production, high dependence of the national market of machine building products on imports, low level of effective domestic demand - low competitiveness of products, in addition to an unstable financial, economic and political situation in the country.

In Gurochkina and Menchynska (2020) the integration of the business processes of Ukrainian production in the context of its inclusion in the world economy are investigated, and the strengthening of the level of dependence of domestic engineering on imported raw materials and components is revealed. The dynamics of the degree of industry localization by the main types of activity, in particular in the processing industry, is assessed, and additionally the advantages and disadvantages of the functioning of integrated corporate structures are revealed.

The effectiveness of a localization policy to ensure economic development on the examples of its successful implementation in different countries is discussed in Shovkun (2017) In particular, the world practice of harmonizing localization requirements with WTO rules is analyzed. Furthermore, the specifics of localization requirements in certain sectors of the economy are generalized, while the necessity to carry out systematic measures on the localization of production in Ukraine is substantiated.

Methods

The purpose of the study is to analytically identify problems and outline the prospects for the development of mechanical engineering in Ukraine.

The specific objectives of the study are:

- to analyze the dynamics and peculiarities of production and foreign economic activity of the mechanical engineering enterprises in Ukraine in the regional context;
- to determine the dependence of the Ukrainian economy on imports of mechanical engineering products;
- to substantiate the key trends in the development of mechanical engineering in Ukraine 2010-2020;
- to outline the main challenges and threats to the development of Ukrainian mechanical engineering in the context of globalization, and suggest ways to overcome them.

To achieve the set aims and objectives of the study, economic-logical and structural-dynamic methods of economic analysis were used.

The analytical part of the study used statistical data of the State Statistics Service of Ukraine (SSSU, 2021). The years 2010-2020 were chosen for the research period. During this period, the Ukrainian economy and mechanical engineering in particular underwent significant structural and dynamic changes due to the consequences of the global financial crisis of 2008, the aggression of the Russian Federation, as well as the signing of the FTA between Ukraine and the EU. Therefore, the authors became interested in researching how mechanical engineering functioned in the regions of Ukraine in this difficult period. In the analytical part, the methods of desk research of the mesolevel were used. During the review of publications on the problems discussed in the article, the most thorough scientific studies of highly qualified researchers, specializing in the study of problems in mechanical engineering of Ukraine, were considered.

Results

The development of mechanical engineering in Ukraine is characterized by unstable dynamics; after the decline in production during 2012-2015 there was an increase in the values of this indicator in 2016-2018, which from 2019 again changed to a decline with a deepening of this negative trend (−17.6 % in 2020) (Table 1).

In 2020, only four regions (compared to 23 in 2010) achieved an increase in mechanical engineering production, namely the Kyiv (+37.8%), Kirovohrad (+25.8%), Ivano-Frankivsk (+11.7%) and Rivne (+11.4%) oblasts (regions). The last of the above-mentioned regions has consistently demonstrated positive dynamics of mechanical engineering development since 2016. As opposed to the latter, the decline in production of mechanical engineering was more than 30% in 4 regions (Poltava, Cherkasy, Chernivtsi and Chernihiv) in 2020.

Table 1. Indices of mechanical engineering production in Ukraine (%)

Production	Code NACE	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mechanical engineering	***26-30***	***142.4***	***115.4***	***96.7***	***86.8***	***79.4***	***85.2***	***101.8***	***111.7***	***112.4***	***97.8***	***82.4***
Manufacture of computer, electronic and optical products	26	105.7	102.4	89.7	86.4	77.9	71.0	109.3	119.6	122.8	91.6	75.2
Manufacture of electrical equipment	27	163.6	125.8	88.6	91.1	100.9	83.0	107.7	113.0	105.2	94.7	99.1
Manufacture of machinery and equipment n.e.c.	28	133.9	109.9	97.3	95.0	88.7	91.1	100.0	104.4	110.7	102.5	84.0
Manufacture of motor vehicles, trailers, semi-trailers	29	125.6	122.0	87.7	89.3	90.3	94.4	94.8	111.6	101.8	74.3	85.6
Manufacture of other transport equipment	30	161.2	118.6	102.6	78.2	59.9	81.5	100.4	118.2	119.3	102.5	72.5

Source: (SSSU, 2021)

The mechanical engineering industries in Ukraine are concentrated mainly in the eastern regions – the Dnipropetrovsk, Donetsk, Zaporizhzhia and Kharkiv regions, which in 2020 accounted for a total of 46.34% of the products in this industry segment against 53.81% in 2010 (Table 2). Over the last 10 years, the following regions lost a significant part of the potential of mechanical engineering: Donetsk (its share in the regional structure of the corresponding products decreased by 12.17 percentage points) and Poltava (−6.73 percentage points since 2013). At the same time, during this period the shares of the Kyiv (+3.84 percentage points) and Kharkiv (+2.99 percentage points) regions increased in this structure, as well as in all 7 regions of Western Ukraine without exception, most of all in the Lviv region (+3.72 percentage points).

Table 2. Regional structure of sold mechanical engineering production (%)

Oblast (region)	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
Vinnytsia	0.72	0.57	0.62	0.74	0.80	1.01	1.27	1.18	1.64	1.89	1.58
Volyn	1.08	1.21	1.23	1.56	2.59	3.29	3.42	3.40	2.92	3.11	3.45
Dnipropetrovsk	10.01	11.96	12.22	9.45	8.71	8.46	8.92	9.74	11.47	13.56	11.86
Donetsk	20.98	19.14	18.91	17.52	10.32	7.80	7.59	6.92	7.96	8.09	8.81
Zhytomyr	0.79	0.81	0.82	0.89	1.13	1.32	1.45	1.42	1.81	1.49	2.03
Zakarpattia	3.13	2.48	3.30	4.25	4.87	4.53	5.01	4.95	5.07	4.80	5.02
Zaporizhzhia	13.79	13.08	12.37	14.20	16.59	18.98	15.54	17.37	15.11	12.18	13.65
Ivano-Frankivsk	0.26	0.53	0.46	0.57	0.84	1.90	1.63	1.49	1.74	1.89	2.43
Kyiv	2.25	2.39	2.18	2.81	3.27	3.68	4.41	4.61	4.42	4.75	6.09
Kirovohrad	1.52	1.16	1.28	1.26	1.79	1.87	2.39	2.53	2.44	2.49	2.70

Luhansk	7.02	8.40	7.52	7.45	4.84	1.67	1.32	1.55	1.85	1.54	1.08
Lviv	2.12	2.17	2.07	2.56	2.99	4.01	4.11	4.31	4.94	6.14	5.84
Mykolaiv	2.92	2.75	2.79	3.14	3.37	4.70	5.24	2.76	1.92	2.87	2.92
Odessa	2.65	2.17	2.10	2.05	3.25	3.38	4.07	3.83	3.02	3.25	3.47
Poltava	11.68	12.38	13.20	8.80	8.68	6.56	6.10	6.92	7.17	7.64	4.95
Rivne	0.57	0.54	0.45	0.52	0.48	0.63	0.66	0.83	0.68	0.79	0.98
Sumy	3.60	4.16	4.33	4.52	4.57	5.07	4.57	3.84	3.61	3.22	3.12
Ternopil	0.59	0.54	0.51	0.70	0.88	1.09	1.18	1.38	1.48	1.83	2.19
Kharkiv	9.03	8.77	9.20	11.64	14.32	14.09	13.98	13.79	13.69	12.22	12.02
Kherson	1.18	0.96	0.86	1.23	0.94	0.91	1.27	1.12	0.91	0.83	0.92
Khmel-nytskyi	1.00	0.98	0.98	1.49	2.13	2.26	2.14	2.21	2.21	1.52	1.82
Cherkasy	2.08	1.89	1.67	1.50	1.41	1.23	1.70	1.71	1.87	2.04	1.29
Chernivtsi	0.29	0.32	0.28	0.42	0.36	0.39	0.45	0.39	0.43	0.43	0.46
Chernihiv	0.72	0.65	0.64	0.73	0.87	1.18	1.54	1.78	1.62	1.45	1.32
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Authors' calculations based on: (SSSU, 2021)

Among the regions of Ukraine, mechanical engineering occupies the largest share in the structure of sold industrial products of the Zakarpattia region – 35.1% in 2019 (against 45.0% in 2013). The value of this indicator is significant (> 10%) in the Volyn, Zaporizhzhia, Kirovohrad, Luhansk, Lviv, Sumy, Ternopil and Kharkiv regions. However, in some of these regions, in particular the Zaporizhzhia, Sumy and Kharkiv regions, the share of mechanical engineering in the structure of industry during 2011-2019 decreased by more than 5.0 percentage points. A similar negative trend is also characteristic of the Donetsk (−4.3 percentage points), Mykolaiv (−5.9 percentage points), Poltava (−10.7 percentage points), Kherson (−5.8 percentage points). n.) and Cherkasy (−4.1 percentage points) regions.

Five segments or complex production groups (NACE codes 26-30) uniting about 70 types of specialized industries constitute the structure of domestic mechanical engineering (Table 3).

Table 3a. Structure of sold mechanical engineering production in Ukraine (breakdown by production) (%)

Production in industry	***NACE code***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***
1	2	3	4	5	6	7	8	9	10	11	12	13
	26–30	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***
Manufacture of computer, electronic and optical products	*26*	*6.89*	*8.98*	*5.70*	*6.70*	*7.71*	*6.80*	*8.28*	*7.09*	*7.16*	*6.86*	*7.11*
Manufacture of electronic components and boards	26.1	...	4.02	0.41	0.40	0.41	0.42	0.53	0.50	0.44	0.50	0.53
Manufacture of communication equipment	26.3	...	0.55	0.89	0.48	...	...	...	...	...	1.27	1.35
Manufacture of consumer electronics	26.4	...	0.92	0.97	1.52	1.94	0.67	0.41	0.16	0.17	0.20	0.22

Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks	26.5	...	1.93	2.16	2.56	3.41	3.47	4.35	3.43	3.44	3.23	3.23
Manufacture of irradiation, electromedical and electrotherapeutic equipment	26.6	...	0.34	0.36	0.21	0.15	0.33	0.45	0.31	0.21	0.26	0.37
Manufacture of electrical equipment	*27*	*16.23*	*13.25*	*16.22*	*19.62*	*20.52*	*20.61*	*20.84*	*19.30*	*20.15*	*18.22*	*18.17*
Manufacture of electric motors, generators, transformers, electricity distribution and control apparatus	27.1	...	4.34	8.28	9.76	8.44	6.96	7.39	6.73	6.35	6.76	6.04
Manufacture of electric motors, generators and transformers	27.11	...	2.30	5.75	6.57	5.80	4.65	5.02	4.15	3.64	2.87	2.13
Manufacture of electricity distribution and control apparatus	27.12	...	2.04	2.53	3.19	2.64	2.32	2.36	2.58	2.71	3.89	3.91
Manufacture of batteries and accumulators	27.2	...	1.93	1.39	1.59	1.61	1.90	1.68	1.60	1.56	0.91	1.14
Manufacture of wiring and wiring devices	27.3	...	3.19	2.87	3.58	4.83	5.62	5.64	5.36	4.78	4.65	4.80
Manufacture of electric lighting equipmen	27.4	...	0.71	0.66	0.89	0.98	1.08	1.06	0.95	0.99	0.90	1.01
Manufacture of domestic appliances	27.5	...	2.18	1.85	1.99	2.91	3.26	3.41	3.06	2.92	2.76	3.62
Manufacture of other electrical equipment	27.9	...	0.89	1.17	1.81	1.75	1.78	1.66	1.59	3.55	2.25	1.56
Manufacture of machinery and equipment n.e.c.	*28*	*31.54*	*29.40*	*27.52*	*31.71*	*31.58*	*36.17*	*38.13*	*33.99*	*32.04*	*33.13*	*34.84*
Manufacture of general-purpose machinery	28.1	...	9.53	9.36	11.46	12.10	15.14	13.99	10.03	9.00	8.66	9.71
Manufacture of other general-purpose machinery	28.2	...	5.50	6.06	6.95	6.12	7.20	7.66	7.74	7.82	8.03	8.92
Manufacture of agricultural and forestry machinery	28.3	...	3.69	3.24	3.22	3.98	5.34	6.60	6.16	4.88	4.59	4.98
Manufacture of metal forming machinery and machine tools	28.4	...	0.69	0.53	0.53	0.44	0.50	0.43	0.41	0.35	0.41	0.32
Manufacture of other special-purpose machinery	28.9	...	10.00	8.34	9.56	8.94	7.99	9.45	9.65	9.98	11.44	10.92
Manufacture of machinery for metallurgy	28.91	...	1.76	1.72	2.18	2.65	2.39	2.91	2.92	3.17	3.24	3.50
Manufacture of machinery for mining, quarrying and construction	28.92	...	5.18	4.13	4.38	3.76	2.94	3.41	3.81	3.78	5.18	4.42
Manufacture of machinery for food, beverage and tobacco processing	28.93	...	0.70	0.56	0.95	1.10	1.28	1.50	1.58	1.47	1.38	1.45
Manufacture of motor vehicles, trailers, semi-trailers and of other transport equipment	*29.30*	*45.34*	*50.38*	*52.68*	*44.92*	*40.19*	*36.42*	*32.75*	*39.62*	*40.65*	*41.79*	*39.88*
Manufacture of motor vehicles, trailers and semi-trailers	*29*	...	*8.64*	*9.22*	*9.61*	*12.05*	*12.61*	*13.18*	*13.88*	*14.66*	*16.05*	*15.84*
Manufacture of motor vehicles	29.1	...	5.49	5.95	5.39	4.92	3.65	4.19	4.53	4.37	4.82	4.50
Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	29.2	...	0.49	0.53	0.58	1.42	1.14	...	...	...	0.72	0.77
Manufacture of parts and accessories for motor vehicles	29.3	...	2.66	2.74	3.63	5.76	7.86	7.77	8.43	9.31	10.51	10.57
Manufacture of other transport equipment	*30*	...	*41.74*	*43.46*	*35.32*	*28.15*	*23.81*	*19.57*	*25.74*	*25.99*	*25.74*	*24.03*
Building of ships and boats	30.1	...	0.84	0.97	1.91	0.51	0.79	...	...	...	0.73	1.28
Manufacture of railway locomotives and rolling stock	30.2	...	33.67	33.59	22.25	11.76	5.63	6.44	9.23	12.38	16.11	9.78
Manufacture of air, spacecraft and related machinery	30.3	...	6.98	8.13	9.78	13.79	15.56	...	...	...	7.48	8.47
Manufacture of military fighting vehicles	30.4	...	0.18	0.61	1.17	2.36	2.51	...	...	...	1.11	4.17
Manufacture of transport equipment n.e.c.	30.9	...	0.08	0.16	0.20	0.21	0.28	...	...	...	0.31	0.33

Source: Authors' calculations based on: (SSSU, 2021)

The manufacture of machinery and equipment n.e.c. (NACE code 28) invariably occupies the largest share in this structure – 34.84% in 2020 against 31.54% in 2010. 43.61% of this production volume sold in 2019 was concentrated in the Donetsk, Kharkiv and Dnipropetrovsk regions. These regions were characterized by generally positive trends in the development of this segment of mechanical engineering. Nonetheless, the highest growth rates in Ukraine for the manufacture of machinery and equipment n.e.c. during 2015-2019 were exhibited by the Vinnytsia (3.88 times), Lviv (3.88 times) and Ternopil (4.36 times) regions, which is explained by the opening of new enterprises in their territories operating according to tolling schemes, namely: LLC "Fujikura Automotive Ukraine Lviv" (+ Vinnytsia branch) and LLC "SE Bordnetze – Ukraine" (Ternopil).

Almost a quarter (24.03% in 2020) of the sold mechanical engineering production in Ukraine accounts for the *manufacture of other transport equipment* (code 30), although its share decreased by 17.71 percentage points during 2011-2020. Instead, steadily increasing dynamics of development of the *manufacture of motor vehicles, trailers and semi-trailers* (code 29) (+7.2 percentage points in the structure of sold engineering products) were observed. Nevertheless, a key element of this segment of mechanical engineering – the production of components, parts and accessories for transport equipment - operates mainly with the involvement of toll raw materials. These enterprises include: LLC "Kromberg and Schubert Ukraina" (Volyn and Zhytomyr regions), LLC "Yazaki Ukraine" and PrJSC "Eurocar" (Zakarpattia region), "Elertrokontakt Ukraine" i LLC "LEONI Wiring Systems UA GmbH" (Lviv region), LLC "PRETTL-Kabel Ukraina" (Khmelnytskyi region), LLC "Automotive Electric Ukraine" (Chernivtsi region).

The main production of motor vehicles, trailers and semi-trailers and other transport equipment (codes 29, 30) is concentrated in the Dnipropetrovsk (18.84%), Zaporizhzhia (12.25%) and Poltava (13.39%) regions, where powerful domestic mechanical engineering enterprises are concentrated, namely the State-owned enterprise (SE) "A.M. Makarov Production Association Yuzhny Machine-Building Plant", PrJSC "Zaporizhia automobile building plant", JST "Motor Sich", SC "Kremenchuk Steel Works", PJSC "Kryukiv Railway Car Building Works" etc.). At the same time, the shares of Lviv (by 6.48 percentage points), Ivano-Frankivsk (by 1.69 percentage points) and Zakarpattia (by 1.59 percentage points) increased significantly in the structure of sold products of the studied industries during 2015-2019, which is explained by the increase in their production during this period of 4.9 times, 9.5 times and 2.7 times respectively.

The share of the *manufacture of electrical equipment* (code 27) in the structure of mechanical engineering of Ukraine during 2012-2016 increased by 7.59 percentage points. (up to 20.84%), but subsequently decreased to 18.17 % (in 2020). The main capacities of this production are concentrated in the Zaporizhzhia (21.18% in 2019) and Kharkiv (15.69%) regions. Among the largest enterprises in this segment there are PRJSC "Zaporizhzhia Plant Preobrazovatel", PRJSC "Zaporizhzhia Superpower Transformer Plant", PRJSC "Factory for production of small-size transformers", SE "Plant Electrovazhmash", PRJSC "Yuzhcable Works", PRJSC "Kharkiv Electrical Engineering plant Ukrelectromash", SE "Zavod Radiorele". In 2019 there

was a decline in the production of electrical equipment by 25.02% in the Zaporizhia region, and a slight growth of only 1.72% was in the Kharkiv region.

The manufacture of computer, electronic and optical products (code 26) occupies the smallest share (≈7%) in the structure of domestic mechanical engineering. The Kharkiv region became the undisputed leader among the regions of Ukraine in this production; its share in the relevant structure in 2019 was 23.72% against 13.26% in 2014, and the increase in production during the above-mentioned period amounted to 244.03%. The Rivne (+3461.82%), Sumy (+765.32%), Lviv (+278.68%), Mykolaiv (+245.27%) and Odessa (+231.03%) regions also demonstrated high dynamics of the production of computer, electronic and optical products.

One of the key problems of the national economy is its high dependence on imports of mechanical engineering products. This mostly applies to the products of codes 26, 27 and 29 (Table 4). At the same time, a positive fact is the significant reduction during 2014-2019 in import dependence in the segment of the final consumption of *other transport equipment* (code 30) and *machinery and equipment n.e.c.* (code 28), which indicates an increase in the production of relevant products in Ukraine. Nonetheless, the costs of most mechanical engineering industries (especially the production of machinery and equipment) are dominated by imported components.

Table 4. Dependence of Ukrainian economy on imports of mechanical engineering products (%)

Production	Share of imports in consumption of mechanical engineering products						Share of imports in costs of mechanical engineering industries	
	internal		intermediate		final			
	2013	*2019*	*2013*	*2019*	*2013*	*2019*	*2013*	*2019*
Manufacture of computer, electronic and optical products ***(code 26)***	93.57	92.12	87.67	80.06	91.02	97.90	55.50	40.33
Manufacture of electrical equipment ***(code 27)***	71.61	79.28	69.86	66.95	53.10	83.40	40.90	44.78
Manufacture of machinery and equipment n.e.c. ***(code 28)***	83.18	80.70	72.04	64.93	19.07	10.60	44.30	50.55
Manufacture of motor vehicles, trailers and semi-trailers ***(code 29)***	91.84	91.54	85.27	84.15	95.33	90.50	60.10	41.05
Manufacture of other transport equipment ***(code 30)***	13.92	20.18	6.36	2.09	96.60	29.40	27.50	32.40

Source: Authors' calculations based on: (SSSU, 2021)

During 2011-2020, mechanical engineering in Ukraine showed extremely negative trends in the foreign economic activity of enterprises; the decline in exports during this period amounted to 39.58% with an increase in imports by 47.14%. As a result, the share of the production of mechanical engineering enterprises

(groups XVI-XVIII) in the commodity structure of Ukrainian exports over the last 10 years decreased by 6.8 percentage points. (down to 10.9% in 2020), while the share of this production in the commodity structure of imports, by contrast, increased by 13.3 percentage points. and reached 34.2%. In addition, the import component of domestic mechanical engineering exports is ≈45%, and the ratio of import coverage of export in 2020 decreased to a critical level – 0.29 (against 0.71 in 2010). Only four regions – Donetsk, Zakarpattia, Zaporizhzhia and Ternopil consistently provide a dominance of exports over imports. The Ternopil region is actively increasing its export potential and since 2019 has occupied the 8th position among the regions of Ukraine in terms of share in the export of mechanical engineering production. This region was the third among 11 regions that increased exports in this industry segment in 2020.

Almost 38% of mechanical engineering exports in 2020 was provided by the Zakarpattia (17.79%), Lviv (10.08%) and Zaporizhzhia (10.04%) regions. However, while the Zaporizhzhia region exports mainly nuclear reactors, boilers, and machinery (78.17% in the structure of exports of mechanical engineering in the region), the Zakarpattia and Lviv regions export electrical machinery and equipment (93.54% and 86.89%, respectively).

During 2015-2020, the highest growth in exports of mechanical engineering products was achieved by the Vinnytsia (239.83%), Zhytomyr (106.73%), Ivano-Frankivsk (59.62%), Lviv (29.45%), Odessa (164.48%), Ternopil (28.05%) and Chernivtsi (140.66%) regions. Only the Odessa region does not export products made from toll raw materials from the above-mentioned list due to the lack of enterprises engaged in tolling operations on its territory. Mechanical engineering exports in the other 6 mentioned regions are formed mainly from such products. For instance, the share of toll raw materials in mechanical engineering exports is over 85% in the Lviv region, and in the Ivano-Frankivsk region – it is over 75%. In general, the value of this indicator in Ukraine was 37.97% in 2019, in the export of commodity subgroup 85 (electric machines) in particular – 64.42%.

The exports of "insulated wires, cables and other insulated electrical conductors; fiber-optic cables" (code 8544 according to the Ukrainian classification of goods of foreign economic activity) form the basis of Ukrainian mechanical engineering exports, reaching the share of 24.93% in 2019 against 15.92% in 2014. This means that Ukraine exports mainly goods for intermediate consumption. Moreover, products made from toll raw materials dominate in this key position of the domestic exports of mechanical engineering industries. Instead, finished final consumption products "cars and other motor vehicles intended primarily for transportation of people" (code 8703 according to the Ukrainian classification of goods of foreign economic activity) constitute the main item of Ukrainian imports of mechanical engineering – 16.01% in 2019 (against 10.07% in 2014).

Eastern European countries (Poland, Romania, Hungary, the Czech Republic) dominate in the geographical structure of domestic mechanical engineering exports. On the territory of these countries there are car assembly plants, whose components (or their individual elements) are made from toll raw materials from Ukraine. At the same time, imports to Ukraine come mainly from developed industrial countries,

primarily Germany, Japan and the United States (cars) and China (diodes, semiconductors, telephones, etc.).

Conclusions and recommendations

Summarizing the results of the conducted evaluations, we can state generally negative trends in the development of domestic mechanical engineering, especially over the past 5 years, namely:

- *a decline in production* since 2012 (which dropped significantly in 2020), and especially in the production of high-tech computers, electronic and optical products. The loss of economic ties and traditional markets for the supply of finished products and components became the reasons for this decline owing to changes in the geopolitical course of Ukraine and the narrowing of business activity in general;
- *deterioration of the output structure of mechanical engineering products* in the direction of reducing the share of high-tech industries, including electronic components and boards (by 3.49 percentage points during 2012-2020), and instead, increasing the share of medium-tech industries, and the most – parts and accessories for motor vehicles (by 7.91 percentage points). The problem is aggravated by the fact that the production of the latter (as well as the production of most types of electrical equipment) operates with the involvement of toll raw materials, i.e. its development was initiated by the opening of enterprises-branches of MNC (in the Vinnytsia, Volyn, Zhytomyr, Zakarpattia, Ivano-Frankivsk, Lviv, Ternopil, Khmelnytsky and Chernivtsi regions) that carry out tolling operations;
- *increasing dependence on imports, in particular on toll raw materials* – in 2019 the share of mechanical engineering in the structure of imports of toll raw materials was the largest among all the sectors of processing manufacturing – 37.4%, 35.7% of which belonged to the production of electric machines;
- *the rising dominance of imports over exports*, as evidenced by the decrease in the values of the coverage ratio in mechanical engineering over the past 10 years by 42 percentage points. (up to 29% in 2020). This problem is mostly related to "land transport, except rail" (code 87 according to the Ukrainian classification of goods of foreign economic activity) – the coverage ratio in this product subgroup for the period decreased from 385% to 2%, and imports during 2015-2020 increased 2.25 times;
- *export structure deterioration* – an increase in the share of intermediate consumption products (mostly insulated wires, cables and other insulated electrical conductors; fiber-optic cables), among which products made from toll raw materials predominate (≈65%), and at the same time, *import structure deterioration* – an increase in the share of finished products (primarily cars and other motor vehicles intended mainly for human transportation), the production of which is curtailed in Ukraine due to low competitiveness (both in terms of quality and price).

Given the existence of systemic problems in the development of mechanical engineering, Ukraine faces a number of challenges and threats that may exacerbate in conditions of global instability:

1. destruction of the formed chains of high-tech industrial production, reduction in domestic demand for domestic mechanical engineering products, deepening of disparities in the reproductive structure of fixed capital;
2. deterioration of price market conditions for imported components and equipment on world markets, while exhausting the possibilities of supplies to the markets of countries – traditional consumers of domestic products;
3. a reduction in the international competitiveness of Ukrainian goods, and as a result, a decrease in the efficiency of mechanical engineering exports (while maintaining a high level of resource and material consumption of the vast majority of industries and an absence of breakthrough innovative solutions and developments).

To overcome the negative trends in the development of mechanical engineering in Ukraine, it is necessary to pursue a purposeful state industrial policy focused on:

- forming a reliable system of scientific, technical and industrial cooperation between powerful domestic companies, research institutions in addition to small and medium-sized businesses (SMEs) in order to manufacture finished products, parts and components that meet international technical regulations and generally accepted international standards;
- encouraging the development of SMEs and domestic investment, the priority areas of which should be investment in equipment upgrades and modernization, as well as the introduction of resource-saving technologies to increase the competitiveness of domestic products in domestic and foreign markets; introducing SME lending programs in cooperation with international organizations;
- strengthening the motivation of foreign companies to transfer production to the territory of Ukraine; attracting investments of international companies by creating a favorable regulatory framework and implementing joint investment projects, especially in the direction of innovation;
- developing an institutional system for promoting export – from marketing strategies to measures to mitigate financial risks for exporters; promoting domestic goods and brands in order to strengthen positions in the markets of certain niche segments for mass, but technically complex mechanical engineering products, including cable and wire;
- introducing incentive and compensation mechanisms (including fiscal) at the state, regional and local levels aimed at supporting the key sectors of mechanical engineering, whose products are suitable (and promising) for export;
- directing the policy of import substitution to strengthen the orientation of certain categories of industrial production (competitive primarily in price parameters) to meet the needs of the domestic market in both consumer goods for the population and industrial products (intermediate consumption goods). The latter, in particular, provides import substitution in the segment of parts and assemblies required for the manufacture of final products of mechanical engineering.

According to world practice (in particular, the experience of developed industrial countries such as Germany and France), one of the most effective tools for implementing an import substitution policy is a public procurement system. The use of this tool will allow the purposeful development of strategically important mechanical engineering productions in the segment of intermediate consumption and the accumulation of gross fixed capital.

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PROBLEMY ROZWOJU INŻYNIERII MECHANICZNEJ NA UKRAINIE

Streszczenie: Inżynieria mechaniczna jest najbardziej innowacyjnym segmentem gospodarki światowej, a zwłaszcza gospodarki przemysłowych krajów europejskich. Celem niniejszego artykułu jest analityczna identyfikacja problemów i zarysowanie perspektyw rozwoju inżynierii mechanicznej na Ukrainie. Zgodnie z wynikami badań autora określono dynamikę i cechy produkcji oraz zagranicznej działalności gospodarczej przedsiębiorstw inżynierii mechanicznej na Ukrainie w kontekście regionalnym. Obliczono zależność ukraińskiej gospodarki od importu wyrobów inżynierii mechanicznej oraz określono udział importu w kosztach produkcji ukraińskiej inżynierii mechanicznej. Uzasadnione są kluczowe trendy rozwoju inżynierii mechanicznej na Ukrainie w latach 2010-2020. Zaproponowano działania państwowej polityki przemysłowej ukierunkowane na przezwyciężenie wyzwań i zagrożeń w rozwoju ukraińskiej inżynierii mechanicznej w warunkach globalizacji.

Słowa kluczowe: eksport, import, inżynieria mechaniczna, produkcja, produkty, konstrukcja