



<https://doi.org/10.15407/scine19.01.020>

ISHCHUK, S. O.¹ (<https://orcid.org/0000-0002-3698-9039>),
SOZANSKYI, L. Yo.¹ (<https://orcid.org/0000-0001-7854-3310>),
and KNIAZIEV, S. I.² (<https://orcid.org/0000-0002-5308-4960>)

¹ SI "Institute of Regional Research named after M. I. Dolishniy of the NAS of Ukraine",
4, Kozelnytska St., Lviv, 79026, Ukraine,
+380 32 270 7093, irr_nas@ukr.net

² Scientific Secretary of the Department of Economics NAS of Ukraine,
54, Volodymyrska St., Kyiv, 01601, Ukraine,
+380 44 239 6646, ksi@nas.gov.ua

PROBLEMATIC ISSUES OF LOCALIZATION-BASED DEVELOPMENT OF MECHANICAL ENGINEERING IN UKRAINE

Introduction. *Mechanical engineering in synthesis with IT forms the economy sector with the highest potential for creating innovations, which in the postwar recovery should become major drivers of the socio-economic development of Ukraine and ensure its adequate competitive ability in the world market.*

Problem Statement. *The critical state of mechanical engineering in Ukraine requires the use of effective tools to stimulate the development of production, in particular on the basis of localization. The recovery plan of Ukraine foresees the localization of at least 60%.*

Purpose. *The purpose of this research is to substantiate proposals for stimulating the localization-based development of Ukraine's mechanical engineering in the context of strengthening the national economic security.*

Material and Methods. *Economic analysis; the method for the calculation of localization, the authors' method for determining the production localization level. The cost-output datasheets for Ukraine and the OECD have been used as information base of the study.*

Results. *The consequences of the negative effect of economic globalization on the domestic mechanical engineering enterprises in the absence of the state protectionism have been analytically established. A new methodological approach to determining the production localization level has been developed and tested. It is based on calculating the share of the domestic component in each basic segment of the sectoral cost structure. The authors' proposals on the non-tariff stimulation of the development of Ukraine's mechanical engineering corporations on the basis of localization, in order to defend the interests of domestic manufacturers in terms of the elimination of the consequences of the Russian aggression and the postwar recovery of Ukraine's economy, structural transformations and increased competition in world markets have been substantiated.*

Conclusions. *The authors' approach to calculating the production localization level allows determining the key elements (in terms of types of economic activity) of the production cost and the weight of the domestic component in them while forming the strategic nomenclature of mechanical engineering in Ukraine.*

Keywords: mechanical engineering, development, production, industry, innovation products, localization, and costs.

Citation: Ishchuk, S. O., Sozanskyi, L. Yo., and Kniaziev, S. I. (2023). Problematic Issues of Localization-Based Development of Mechanical Engineering in Ukraine. *Sci. innov.*, 19(1), 20–35. <https://doi.org/10.15407/scine19.01.020>

Mechanical engineering (or machine-building) was and remains a basic segment of the national economy and industry, because, in particular, it has sufficient production and resource potential and human capital for effective operation and provision of the economy with the necessary range of machine-building products, despite the fact that its share in the gross value added of the processing industry (in terms of production costs) decreased in 2020 to 15.82% (versus 27.03%, in 2013). Economic problems of the mechanical engineering development have been studied by many researchers. In particular, the advantages and cautions related to signing the FTA agreement between Ukraine and the EU have been outlined in [1]. The factors of the crisis phenomena in Ukraine's machine-building have been considered in [2]. The problems of the development of the automobile industry as one of the basic segments of mechanical engineering in the countries of Eastern Europe (Czech Republic, Slovakia, Poland, and Hungary) have been described in [3]. The trends and prospects, as well as internal and external factors of the operation of mechanical engineering in the transport sector of Poland have been analyzed in [4], where, in particular, the need to enhance product innovation and to take into account the structural changes in mechanical engineering and in the economy in general has been emphasized.

One of the most effective ways to stimulate the development of mechanical engineering is the localization of production. This has been confirmed by the studies at both the macro- and microeconomic levels in many countries, with the use of various methods and approaches. Thus, the external factors and the strategy of production localization by Swedish companies have been analyzed in [5]. The levels of localization of branches and productions of the processing industry in Belgium, France, Germany, Italy, Spain, and Great Britain have been comparatively assessed with the use of the Ellison and Glaeser index, Duranton and Overman index, in [6]. In the study of Japanese firms [7], the level of production localization in Japan's processing industry has been de-

termined, depending on the level of knowledge intensity of products. The factors that contribute to the growth of reshoring and localization of US companies have been outlined [8].

Localization of production, in particular in the field of mechanical engineering, is one of the most relevant topics of discussion in the scholarly research, political, and expert economic environment of Ukraine. In [9], the hypothesis of establishing a special regime for Ukraine for a certain period and introducing production localization regulations for public procurement has been substantiated. In some studies of domestic researchers, the localization of production is considered an economic category that is placed against dependence on import. In particular, in [10], the level of localization of economic activity has been calculated as the inverse share of imports in the sum of final consumer spending for the reporting period, gross capital accumulation, and net exports for this economic activity.

The review of scholarly research literature has confirmed the relevance and diversity of interpretations of "production localization" as economic category. Different interpretations and methodical approaches to determining the localization level, as well as the urgent need for the development of domestic machine-building industry have prompted the authors to conduct their own research in this direction. In addition, the interest in the discussed topic is explained by the fact that the production localization is one of the criteria for the structural transformation of the industrial sector of the economy, which are justified by the authors. Accordingly, this research to some extent continues and widens the author's previous studies [11] and [12]. Its relevance has increased under the conditions of the Russia-Ukraine war. The purpose of this research is to identify the problems of the development of Ukraine's mechanical engineering and to justify the proposals for its stimulation on the basis of production localization in the context of strengthening the national economic security and increasing the level of its competitiveness in world markets.

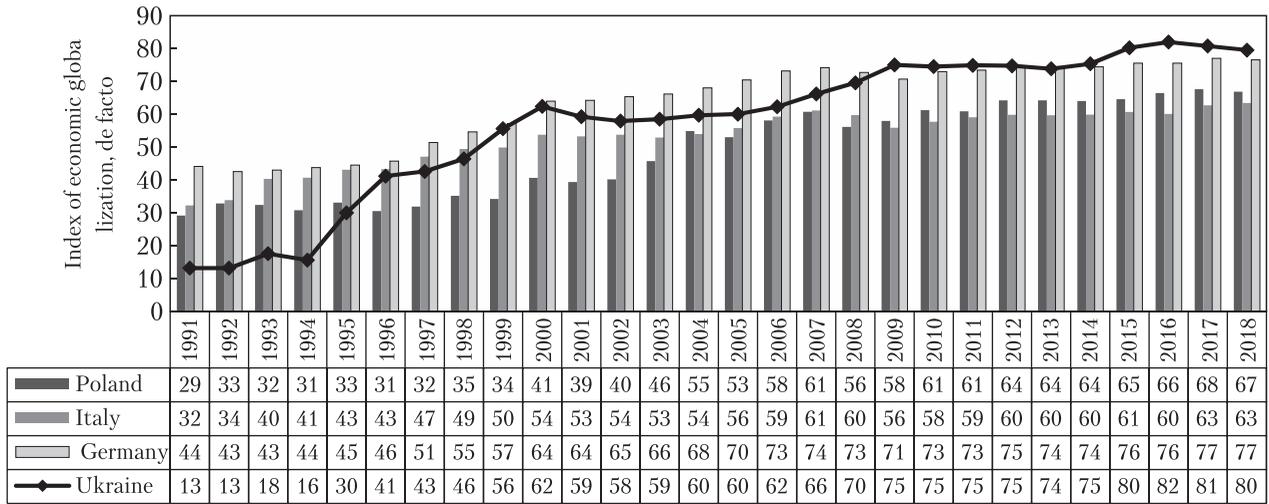


Fig. 1. Economic globalization de facto index
 Source: [13].

At the early 1990s, mechanical engineering accounted for a third of Ukraine’s industry, with a significant part of machine-building products almost entirely produced by domestic manufacturers. However, over the past thirty years (and especially, since 2008, with an intensified aggravation in 2014–2019), the domestic engineering industry has been suffering from destructive changes that have caused a drop in production and, accordingly, a loss of positions in the world market. As a result, the current state of mechanical engineering in Ukraine is from being satisfactory. In particular, in 2020, the share of mechanical engineering products in the structure of sold industrial products amounted to only 6.98% against 13.70%, in 2007 (the highest value for the period 2001–2020). Foreign economic factors dominate among many causes of this situation.

Ukraine belongs to the developing economies. In addition, it has been experiencing the consequences and resisting the military and hybrid aggression of the Russian Federation, and therefore needs special conditions (instead of equal to those of advanced economies) and provisions in the WTO and FTA agreements with the EU. Being part to these agreements (which by their definition should be anti-discriminatory) facilitates the

development of strategic sectors of the national economy (with mechanical engineering as the most important one), prevents its degradation into a raw material base for TNCs and a landfill for worn-out used goods (primarily industrial and household appliances), and levels the competitiveness of domestic (mainly machine-building) products in the domestic and foreign markets.

The advanced economies, in particular the USA, large EU member states, China, and others simultaneously openly or covertly use the tools of protectionism to protect their strategic (and not only) sectors. In almost all advanced economies, engineering as a whole system was formed by purposeful actions of government, in particular with the help of protectionist policy measures, rather than by the market. Accordingly, the application of libertarianism and liberalism (the utopian approaches about the “wisdom” of a truly non-existent free market) to mechanical engineering as a center of intersectoral relations is inappropriate and even dangerous from the standpoint of national interests. Instead, Ukraine has rapidly joined the processes of world economic globalization, in particular, through the expansion of free trade zones, i.e. the reduction (or abolition) of tariff and non-tariff barriers between

countries, the promotion of offshoring and the growth of tolling operations, and thus the geographical extension of value-added chains. According to the economic globalization de facto index¹, Ukraine has been significantly surpassing Poland and Italy, since 1996, and Germany, since 2008 (Fig. 1) in terms of the openness of the economy.

In 2018, among 200 world countries, Ukraine ranked 25th, surpassing most of the advanced economies of the EU and the world, in particular Germany, Italy, Poland, Great Britain, France, Canada, Japan, the USA and others in terms of economic globalization de facto index. The leaders in this ranking are mainly small countries with limited resources, whose economies are significantly dependent on other countries, specialize in one or more sectors, highly export-oriented and import-dependent (Cyprus, Malta, Switzerland, Luxembourg, Estonia, Georgia, Montenegro, Hungary, etc.). On the other hand, the advanced economies that have sufficient potential and resources for the comprehensive development of all types of economic activity, unlike the developing economies or small economies, mostly focus on the domestic market and relatively less integrated into global economic processes, although they are the ones that form the world financial and innovative capital framework. Ukraine, in terms of its area, population, natural resources and human potential, which are the basis for the integral development of all sectors of the economy, in particular engineering, as well as in terms of economic parameters, should have been equal to the advanced industrial economies of the EU, for example, Poland, Italy, and in the future, France and Germany. Accordingly, the government policy of Ukraine regarding openness (customs, investment) should

have been appropriate for balancing the economic interests of both the national economy and foreign companies.

In addition to the processes of economic globalization, fierce competition between key corporations and leading countries in the world market of machine-building products, primarily China, South Korea, the USA, Japan, Germany, and France, had a significant impact on domestic engineering in the last decade. The struggle for sales markets, the formation of new geopolitical, economic, and innovation centers, the loss of the Russian market and the gradual reorientation towards the EU market, the unstable situation on the raw materials and capital markets, the COVID-19 pandemic, and other macroeconomic factors have shaped the environment for the operation of machine-building industry in Ukraine and changed the qualitative and quantitative characteristics of the demand for its products. Therefore, under the influence of the mentioned external and other (internal) factors, as well as the cycles of the world economy development, Ukraine's mechanical engineering industry has been significantly transforming its dynamics, structure, functional purpose, and effectiveness over the past 10 years.

In 2015, as compared with 2011, the GVA of machine building decreased by 65.4%, the output dropped by 69.7%, and the exports and imports fell by 65.2%, and 48.9%, respectively. The growth in 2019, as compared with 2015, accounted for 67.7%, 77.9%, 12.5% and 145.3%, respectively, for the above mentioned indicators. However, despite the positive trends in 2016–2019, Ukraine's machine-building failed to reach the pre-crisis GVA, output, and exports in 2019. In particular, the output in 2019 made up only 68.1% of that in 2013; the GVA and exports accounted for 61.1% and 52.2% of those in 2013, respectively (Table 1). At the same time, it should be noted that since 2014, the import of mechanical engineering products to Ukraine has been significantly exceeding the output and exports. In 2019, it reached the highest value (EUR 19 billion) in the last ten years,

¹ Economic globalization de facto index is the indicator that shows the level of openness of country's economy in the field of foreign economic activities and includes trade globalization (trade in goods and services, diversification of trading partners) and financial globalization (foreign direct and portfolio investments, foreign debt, foreign exchange reserves). The higher the index, the more open and integrated the economy.

which was 2.3 times higher than the output and 5 times higher than the exports.

The structure of mechanical engineering in 2013–2019 (Table 2) changed significantly. In 2013, the manufacture of other vehicles had the largest share of the GVA and output of mechanical engineering (45.7% and 37.1%, respectively). It includes the manufacture of ships and boats, trains and locomotives, aircraft and spacecraft, as well as parts for these vehicles. These are the directions of mechanical engineering in which Ukraine still has had the most promising produc-

tion and resource potential for growth, and the products of which are extremely needed by the Ukrainian economy. However, over the analyzed period (2014–2019), the share of the manufacture of other vehicles in the structure of the GVA of mechanical engineering industry decreased by 15.8 percentage points; in the structure of the output, it dropped by 10.5 percentage points; and in the structure of the exports, it fell by 11.6 percentage points. On the other hand, the shares of other groups increased, especially, the manufacture of other machines and equipment (now it

Table 1. Growth Rates of the GVA, Output, Export, and Import of Mechanical Engineering Products in Ukraine, %

KVED code	Industry	GVA		Output		Export		Import	
		2019/2013	2019/2015	2019/2013	2019/2015	2019/2013	2019/2015	2019/2013	2019/2015
C26-30	Machine-building	61.1	167.7	68.1	177.9	52.2	112.5	122.9	245.3
C26	Manufacture of computers, electronic and optical products	101.6	209.2	98.0	205.1	62.6	109.5	142.5	243.7
C27	Manufacture of electrical equipment	76.2	152.5	78.0	157.9	72.7	141.8	133.9	282.8
C28	Manufacture of other machines and equipment	75.5	166.5	77.1	170.7	55.5	94.1	111.2	196.2
C29	Manufacture of motor vehicles, trailers and semi-trailers	81.3	169.4	78.8	165.9	54.0	120.2	120.5	307.3
C30	Manufacture of other vehicles	40.0	169.4	48.9	205.9	28.7	128.7	97.9	289.9

Source: [14].

Table 2. The Structure of GVA, Output, Exports, and Imports of Ukraine's Mechanical Engineering, %

Industry	GVA		Output		Export		Import	
	2013	2019	2013	2019	2013	2019	2013	2019
Manufacture of computers, electronic and optical products	5.0	8.3	5.8	8.4	6.9	8.3	21.1	24.5
Manufacture of electrical equipment	14.7	18.3	17.0	19.5	19.2	26.8	11.8	12.9
Manufacture of other machines and equipment	28.2	34.9	30.5	34.5	37.5	39.8	34.4	31.2
Manufacture of motor vehicles, trailers and semi-trailers	6.4	8.5	9.5	10.9	10.6	10.9	29.8	29.2
Manufacture of other vehicles	45.7	29.9	37.1	26.6	25.8	14.2	2.9	2.3
Machine-building	100.0							

Source: [14].

has the dominant share in the domestic machine-building): by 6.7 percentage points in the structure of the GVA and by 4.0 p.p. in the output structure. The share of the manufacture of computers, electronic, and optical products (the most high-tech and innovative), despite an increase of 3.3 pp. in the structure of the GVA, 2.56 p.p. in the structure of the output and 1.4 percentage points in the structure of exports, has remained critically small. At the same time, the products of this group have accounted for almost a quarter of Ukrainian imports of mechanical engineering.

The foreign trade deficit in this strategically important sector of the national economy is a consequence of the negative dynamics of the key performance indicators of domestic machine-building enterprises. In 2010–2019, the foreign trade (import/export) coverage ratio for machine-building products in Ukraine decreased by 63.9 percentage points and fell to 20%, while in Poland, it did not fall below 130%. In terms of machine-building groups, during 2013–2019 (with the exception of 2017 and 2018), the group of the manufacture of other vehicles was the only one for which the export of products prevailed over the import (Table 3). This means that this product is competitive in the domestic and foreign markets, and therefore may be considered the base (and prospects) for the development of mechanical engineering in Ukraine.

Machine-building products form the framework of high-tech exports from Ukraine, which have de-

creased by almost 50% since 2013. In addition, in Ukraine’s exports of mechanical engineering products, a large share belongs to the toll manufacturing products. In particular, in 2020, the share of these products in the export of machines, equipment and mechanisms, electro-technical equipment (commodity group 16) accounted for 42.6%, while that in the export of electric machines (commodity subgroup 85) made up 71.8%.

The key problem of domestic engineering is the urgent need to modernize production. The depreciation of tangible assets of machine-building enterprises in Ukraine has exceeded 70%, while in Poland it has been about 53%. In Ukraine, this indicator is critical for the manufacture of electrical equipment (92.5%, in 2020) and for the manufacture of other vehicles (87.3%). In turn, the high wear and tear of assets is a direct consequence of insufficient capital investments: the capital investments in machine-building in 2020 (EUR 220.9 million) accounted for as little as 36.4% of the level of 2012 (EUR 607.0 million). For comparison, in Poland, in 2019, the capital investments in mechanical engineering reached EUR 6,269.6 million that was 16.4 times higher than in Ukraine (EUR 381.9 million). The structure of the capital investments in domestic engineering is poorly diversified and irrational from the point of view of manufacturability. In 2020, 43.9% of the capital investments (against 41.4%, in 2012) were directed to the manufacture of motor vehicles, trailers and semi-trailers, and other vehicles;

Table 3. Foreign Trade Coverage Ratio for Ukraine’s Mechanical Engineering, %

Group	2013	2014	2015	2016	2017	2018	2019
Manufacture of computers, electronic and optical products	15.4	16.7	15.1	13.3	10.6	7.4	6.8
Manufacture of electrical equipment	76.4	72.2	82.8	61.1	61.1	53.8	41.5
Manufacture of other machines and equipment	51.1	58.9	53.2	32.3	29.3	26.2	25.5
Manufacture of motor vehicles, trailers and semi-trailers	16.7	19.0	19.1	12.8	9.7	10.1	7.5
Manufacture of other vehicles	422.1	188.3	279.0	197.7	99.6	79.1	123.8

Source: [14].

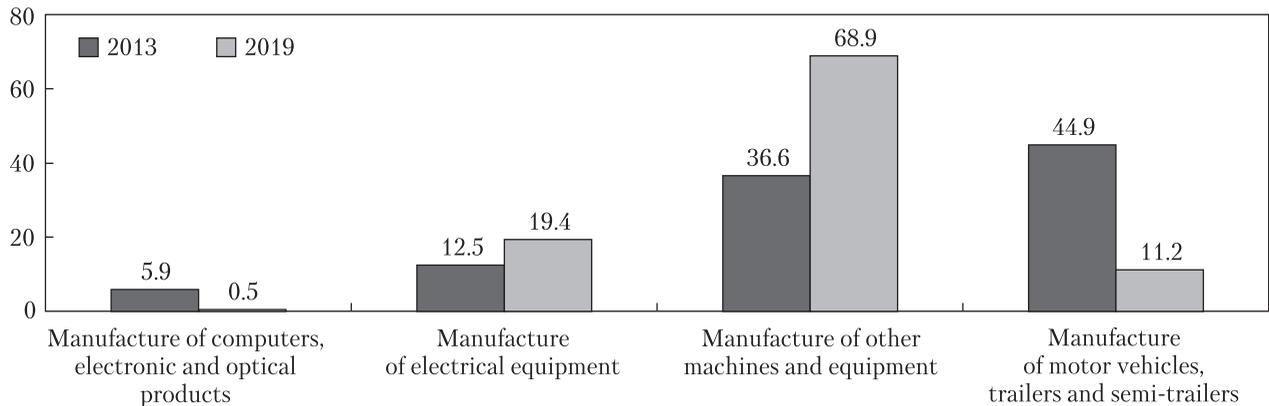


Fig. 2. Structure of Ukraine's export of machine-building innovations, %
Source: [14].

32.9% (against 42.9%, in 2012) to the manufacture of other machines and equipment; 17.1% (against 12.0%, in 2012) in the manufacture of electrical equipment and 6.2% (against 3.9%, in 2012) to the manufacture of computers, electronic and optical products. The last mentioned group is a high-tech and extremely important one for ensuring the activity of the rest of the machine-building industries, so the growth of its share in the structure of capital investments is a positive trend, however, the amount of capital investments has remained extremely small (EUR 13.6 million).

The reduction in investments in Ukraine's machine-building has caused a drop in innovation costs to EUR 84.77 million in 2020 (-27.3%, as compared with 2013), while in Germany, in 2019, the innovation costs amounted to EUR 93.4 billion (more than 70% of the total in the German industry). In 2014–2020, the number of innovating enterprises in mechanical engineering decreased more than twice, from 397 to 194. As a result, the innovation products sold by machine-building enterprises in Ukraine in 2009–2020 dropped by 84%, and its share in the total machine-building products sold decreased by 12.1 percentage points.

Proportionally to the output, there was a reduction in the export of commercialized engineering innovations, the amount of which, in 2019, decreased by 84.1%, as compared with 2013, and

by 87.7%, as compared with 2008. At the same time, the export of domestic machine-building innovations (or the share of exports in the sales) declined by 37.4 percentage points, in 2013–2019. To the greatest extent, this negative trend manifested itself in the manufacture of computers, electronic and optical products and in the manufacture of motor vehicles, trailers and semi-trailers and other vehicles. In recent years, both in the structure of the output and in the structure of the export of Ukraine's engineering innovations there has been dominating the manufacture of other machines and equipment, the share of which increased by 32.3 percentage points, in 2014–2019, while the share of the manufacture of motor vehicles, trailers and semi-trailers and other vehicles, on the contrary, decreased by 33.7 percentage points (Fig. 2).

In general, the low level (with a downward trend) of innovativeness of mechanical engineering products in Ukraine, in combination with a decrease in the production volumes and the level of manufacturability and a simultaneous increase in imports, is a consequence of the growing technological gaps between the national manufacturers and those of the leading economies [20], which means the gradual transformation of Ukraine's mechanical engineering from an integral strategic sector of the national economy into separate segments of the supply of intermediate consumption products and services to foreign markets.

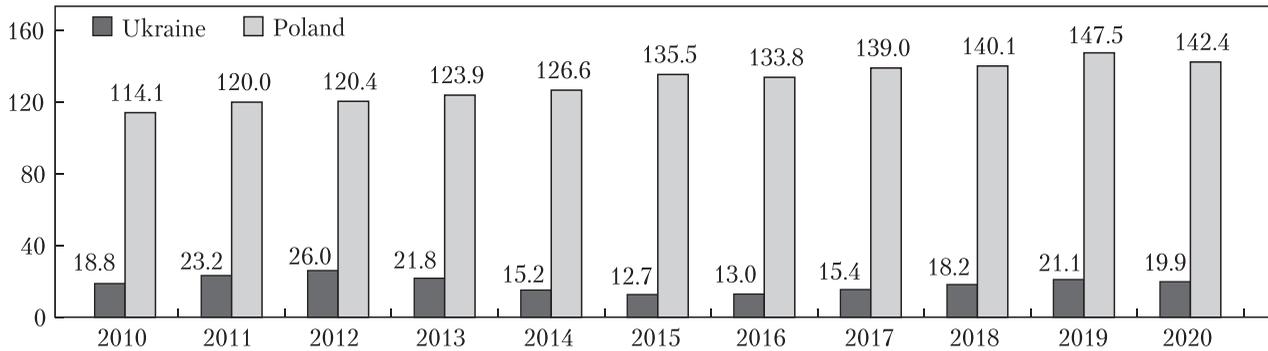


Fig. 3. Labor productivity in machine-building EUR thousand per capita
 Source: [14, 15].

The consequence of the described negative trends in the development of domestic mechanical engineering is the deterioration of socio-economic indicators, in particular, a reduction in the employment rate, a decrease in the labor productivity and wages. The number of people employed in mechanical engineering dropped simultaneously with the decline in production. In 2012–2020, this indicator decreased by 39.4% (or 207.1 thousand people), whereas in 2020, it amounted to 318.3 thousand people, which is almost 60% less than in Poland. Most workers were employed in the manufacture of other machines and equipment (37.3%, in 2020, against 35.9%, in 2012) and in the manufacture of other vehicles (22.1% against 30.4%). At the same time, in Poland, the leader in the employment is the manufacture of motor vehicles, trailers and semi-trailers (36.9%), while the manufacture of other vehicles accounts for as little as 9.4%. The given statistics have additionally confirmed the fact that the domestic automotive industry, unlike the Polish one, is more concentrated on the provision of assembly services and the manufacture of individual components for cars. The significantly higher employment in the manufacture of other vehicles in Ukraine (as compared with Poland) is a sign of the advantageous human capital and prospects for the development of this group.

In 2020, the labor productivity in Ukraine's machine-building amounted to EUR 19.86 thou-

sand that was by 23.8% (or by EUR 6.19 thousand) less than in 2012. At the same time, it was by 56.2% (or EUR 7.15 thousand) higher than in 2015 (Fig. 3). Through 2020, this indicator fell by 5.7% (or by EUR 1.2 thousand). As a result, the labor productivity in Ukraine's mechanical engineering, in 2020, was 7.2 times (versus 4.6 times, in 2012) lower than in Poland. At the same time, the average monthly wage of workers in Ukraine's mechanical engineering, in 2020, was equivalent to EUR 372.9 that was by 3.4% less than in 2019 and by 213% higher than in 2015. Despite the significant increase, this indicator is 3.5 times less than in Poland.

The given trends that have testified to a decline in the production and export of machine-building products with a simultaneous rapid growth of imports, low level (with a downward trend) of technology and innovation products, labor productivity, capital investments, employment, and the deterioration of the foreign trade balance are direct consequences of destructive systemic changes in the domestic mechanical engineering. The negative for the national economy dynamics of the key performance indicators in the machine-building sector coincided with the periods of increased economic globalization of Ukraine (Fig. 4). Therefore, this fact has empirically proven that one of the main causes for the crisis in the domestic engineering industry (in addition to the military and hybrid aggression of the Russian Federation

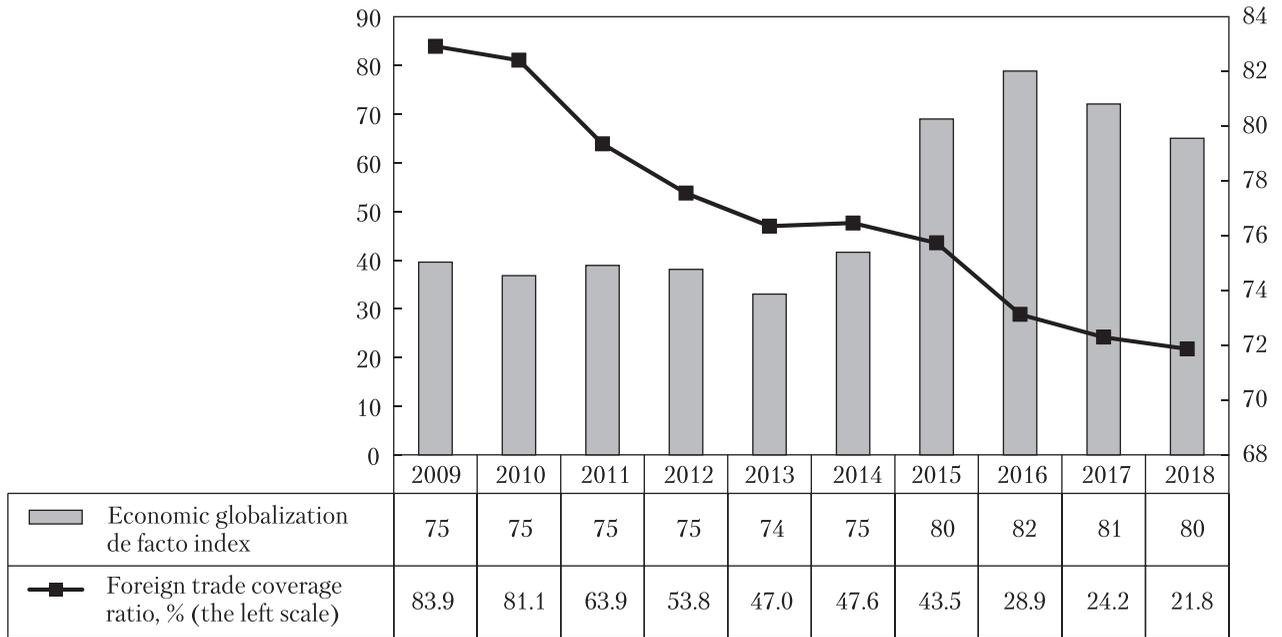


Fig. 4. Economic globalization de facto index and foreign trade coverage ratio for Ukraine's machine-building products
 Source: [14, 17].

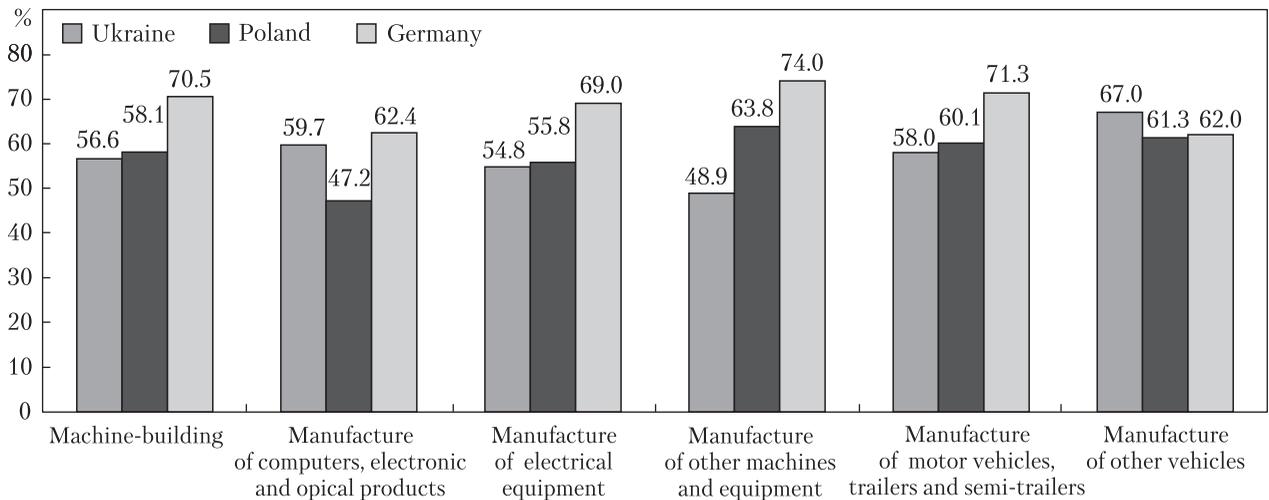


Fig. 5. The share of domestic production in the intermediate consumption costs of machine-building manufacturers, %
 Source: authors' estimates based on [14, 17].

against Ukraine with its consequences) was the neglect of national economic interests in the processes of foreign trade liberalization, in particular in the WTO and FTA agreements with the EU, as well as the absence of government pro-

tectionism aimed at the innovation-based modernization of production.

Under such conditions, the adoption of the Law of Ukraine on Amendments to the Law of Ukraine on Public Procurement in terms of the

creation of prerequisites for the sustainable development and modernization of domestic industry dated December 16, 2021 No. 1977-IX [16] maybe considered an important step towards stimulating import substitution and support of national producers. According to this Law, public procurement shall take into account the localization that reflects the specific weight of the cost of raw materials, materials, parts, component parts and components of products, works, services, and other elements of domestic production in the cost price of the subject of procurement.

As evidenced by the results of the authors' calculations made according to the methodology given in the mentioned Law, it is typical that for Ukraine's machine-building industry the localization of production (56.6%) is lower by 20 p.p. than that for the processing industry in general (72.6%). This is primarily due to the fact that medium- and high-tech productions (which include mechanical engineering) depend much more, as compared with other industrial productions, on the import of intermediate consumption products. In terms of the localization indicator in mechanical engineering, in general, Ukraine falls behind Poland by as little as 1.5 percentage points and Germany by 13.9 percentage points (Fig. 5). This largest gap has been reported for the manufacture of other machines and equipment (code 28): 14.9 and 25.1 percentage points, respectively. At the same time, in the manufacture of other vehicles (code 30), the localization in Ukraine is higher than in Poland and Germany. In addition, there has been reported an upward trend in this indicator, in particular during 2017–2019, it increased by 9.9 percentage points.

Nevertheless, the level of localization, calculated as the share of the domestic component in the sum of machine-building costs (according to the formula given in the Law of Ukraine on Public Procurement) is a rather generalized indicator, since it does not reflect the products of those foreign enterprises that have the highest share in the structure of intermediate consumption by the machine-building manufacturers. Therefore, the

assessment of the localization of mechanical engineering is more reliable when it is made segment by segment in terms of the most significant and important (in terms of functionality, strategy) elements of costs or technological operations.

In order to objectively assess the localization of production, and therefore, of strategically important mechanical engineering products, the authors have developed a new methodical approach that can be generalized by the following formula:

$$\frac{E_d}{C} = \frac{e_{d1} + e_{d2} + e_{d3} \dots + e_{dn}}{c_1 + c_2 + c_3 \dots + c_n}, \quad (1)$$

$\frac{E_d}{C}$ is the share of domestic components in the cost of product, %; $e_{d1} + e_{d2} + e_{d3} \dots + e_{dn}$ is the domestic component in the elements of the cost of the studied product, UAH; $c_1 + c_2 + c_3 \dots + c_n$ is the value of the product cost elements, UAH; n is the number of the elements.

The advantage of the authors' approach is the possibility of determining the share of the domestic component in each element of the production cost, for example, in materials, assemblies, units, engines, gearboxes, wheels, etc. The results of calculations by formula (1) have shown that in the sectoral structure of machine-building expenses in Ukraine, Poland, and Germany, machine-building (C26-30) and metallurgy have the highest share among the economic activities (industries) (Table 4).

It should be emphasized that in Ukraine, in 2019, in the structure of expenses of machine-building manufacturers (in general), the machine-building products accounted for 33.4% that was by 10.2 percentage points less than in Poland and by 14.0 percentage points less than in Germany. In addition, as few as 23.8% of these costs were covered by domestic products, while in Poland and Germany this indicator made up 38.6% and 65.0%, respectively. It follows from this that *the key problems of the development of mechanical engineering in Ukraine are, on the one hand, a relatively low technological efficiency and, at the same time, a high resource intensity of production (the presence*

of only the initial links of the value added chain) and, on the other hand (as a consequence), a low level of localization or, in other words, excessively high dependence on imported intermediate consumption products of **specifically machine-building rather than the aggregate of all industries**.

It is also necessary to pay special attention to the meager share (12.5%) of the domestic component of the metallurgy products and finished metal products used in Ukraine's machine-building. This situation is economically irrational and generally impracticable in terms of the use of national industrial and natural resource potential. In Poland, this indicator accounts for 69.9%, in Germany, it makes up 80.9%. Ukraine has a huge potential for the development of metallurgy whose products have the largest share in domestic commodity exports. However, despite this, 87.5% of the intermediate consumption products of the manufacture of finished metal products, which are used in Ukraine's mechanical engineering, are

covered by imports. In other words, Ukraine exports iron ore and products of primary metal processing, and imports finished metal products for the production needs of the machine-building industry. The causes of this situation become clear when we consider the corporate structure of metallurgical companies operating in Ukraine. Having a complete vertically integrated structure that includes mining, beneficiation of raw materials, and manufacture of metallurgical products, in order to increase the proceeds from resource rent, to minimize taxes, to reduce the need to invest in the fixed capital, and to avoid restrictions (quotas) on the supply of metallurgical products to the EU, these corporations in recent decades have "increased" production capacity within the EU and concentrated their efforts on the extraction of raw materials in Ukraine and the export of iron ore raw materials and products of primary metal processing to their own metallurgical enterprises in Europe [21]. From the standpoint of rational

Table 4. The Shares of the Weighty Economic Activities (Industries) and the Domestic Component in the Machine-Building Expenses, %

Industry	Ukraine		Poland		Germany	
	Share in the expenses	Share of the domestic component in the expenses	Share in the expenses	Share of the domestic component in the expenses	Share in the expenses	Share of the domestic component in the expenses
Machine-building	33.4	23.8	43.6	38.6	47.4	65.0
Metallurgy	22.2	58.0	8.4	40.2	7.0	58.5
Manufacture of finished metal products, except for machines and equipment	5.2	12.5	11.1	69.9	7.0	80.9
Manufacture of rubber and plastic products	2.5	51.1	5.4	54.8	3.6	65.2
Manufacture of chemicals and chemical products	1.1	66.8	2.5	29.2	1.7	55.7
Supply of electricity, gas, steam and conditioned air	4.7	100.0	1.4	97.7	1.4	94.8
Transport, warehousing (including transport markup)	4.2	91.8	3.4	90.6	3.0	78.5
Business sector services*	2.0	93.3	5.1	89.6	6.4	80.3

* Business sector services are the total of industries coded under M69–M82

Source: authors' estimates based on [14, 17].

management of resources and protection of the country's economic interests, in particular the machine-building, such a practice is extremely inefficient and even harmful to the national economy. At the same time, it should be noted that the share of the domestic component in the products of the chemical industry, which are used in the intermediate consumption of machine-building manufacturers, in Ukraine is significantly higher than in Poland and Germany, by 37.6 and 11.1 percentage points, respectively.

In the present-day conditions of globalization and the strengthening of the role of TNCs, the business sector services that include the total of eco-

nomical activities M69–82, have been becoming more important for mechanical engineering. Such services, primarily scholarly research, engineering, testing, advertising, and so on form an innovation framework for the development of high-tech manufacture, and therefore determine the competitiveness of machine-building products. Business sector services account for as little as 2% of Ukraine's mechanical engineering expenses (of which 93.3% are covered by domestic resources), which is three times less than in Poland and Germany.

In Ukraine, the domestic component has a relatively insignificant share in the expenses of machine-building manufacturers on the products of similar

Table 5. The Shares of the Weighty Economic Activities (Industries) and Domestic Component in the Expenses (Intermediate Consumption) of Machine-Building Manufacturers, %

Industry	Share of industry in the machine-building expenses						Share of the domestic component in the expenses					
	C26	C27	C28	C29	C30	C26–C30	C26	C27	C28	C29	C30	C26–C30
Machine-building, including:	43.5	27.3	25.9	46.5	39.1	33.4	17.3	12.3	7.8	44.8	35.1	23.8
Manufacture of computers, electronic and optical products	41.2	8.6	3.4	2.6	2.4	7.3	15.6	6.7	8.1	23.3	22.2	13.2
Manufacture of electrical equipment	0.7	7.5	1.2	0.6	0.2	2.1	1.9	7.8	26.6	65.0	2.9	13.3
Manufacture of other machines and equipment	1.2	10.9	20.6	14.3	25.6	17.5	58.5	18.0	5.9	31.1	12.0	12.4
Manufacture of motor vehicles, trailers and semi-trailers	0.2	0.2	0.4	13.7	0.8	2.0	100.0	98.5	13.9	0.8	34.9	8.0
Manufacture of other vehicles	0.2	0.2	0.1	15.3	10.1	4.4	100.0	100.0	100.0	100.0	97.3	98.4
Metallurgy	3.9	32.2	27.8	16.3	15.7	22.2	97.7	52.5	51.8	50.7	82.5	58.0
Manufacture of finished metal products, except for machines and equipment	2.1	2.7	8.9	6.4	2.4	5.2	3.7	17.2	4.7	18.9	42.7	12.5
Manufacture of rubber and plastic products	0.6	1.5	1.4	0.4	0.7	1.1	67.4	67.2	67.2	58.8	67.3	66.8
Manufacture of chemicals and chemical products	1.1	4.3	2.3	3.5	1.4	2.5	68.1	67.9	15.3	67.8	67.9	51.1
Supply of electricity, gas, steam and conditioned air	1.9	3.8	7.3	2.2	4.0	4.7	100.0	100.0	100.0	100.0	100.0	100.0
Transport, warehousing (including transport markup)	38.2	10.0	9.5	7.9	16.3	13.5	98.8	99.8	99.5	99.7	99.1	99.3
Business sector services	0.9	1.3	1.9	4.5	1.9	2.0	93.9	92.6	93.0	94.1	93.4	93.3
Other industries	7.8	16.8	15.2	12.3	18.5	15.5	x	x	x	x	x	x
Total expenses	100	100	100	100	100	100	59.7	54.8	48.9	58.0	67.0	56.6

Source: authors' estimates based on [14].

industries (Table 5). For example, in the expenses of manufacture of computers, electronic and optical products, 43.5% falls on the machine-building products, of which only 17.3% is covered by domestic products. The extremely low share of the domestic component in machine-building products is typical for the rest of the groups (except for C30).

The given sectoral structure of expenses has shown that all machine-building groups are interconnected by the use of each other's intermediate consumption products in their production activities. However, the longest intra-sectoral chain has been reported for the manufacture of motor vehicles, trailers, and semi-trailers (C29). In particular, in the structure of costs of this group, 46.5% falls on mechanical engineering in general (C26–30), including: 14.3% on the manufacture of other machines and equipment (C28); 13.7% on the manufacture of motor vehicles, trailers, and semi-trailers (C29); and 15.3% on the manufacture of other vehicles (C30). At the same time, the domestic component of products used in the manufacture of motor vehicles, trailers, and semi-trailers accounts for 31.1% for C28, 0.8% for C29, and 100% for C30. Thus, only 0.8% of the manufacture of motor vehicles, trailers, and semi-trailers in Ukraine is provided by domestic products. At the same time, the share of the domestic component in the expenses (total for all economic activities) of the manufacture of motor vehicles, trailers, and semi-trailers made up 58%, in 2019. It is also appropriate to note that in the structure of Ukraine's mechanical engineering, the share of this group accounts for 10.9%, while in Poland and Germany it makes up 44%.

The low localization of Ukraine's machine-building in the key expenses, along with the reduction of production volumes and a narrow range of products, high resource intensity and, at the same time, low technology level, are direct consequences of the critical scarcity of capital investments in machine-building production for upgrading fixed assets. This problem has been exacerbated by global instability and the lack of effective and efficient government incentives for

Ukrainian producers. As a result, the supply of the national economy with domestically produced machine-building products has rapidly decreased. In particular, the share of the domestic component in the total consumption of mechanical engineering products in Ukraine was 30.9%, in 2019, against 56.6% in 2009 (–25.7 pp), while, for example, in Poland this indicator accounted for 67.3%, in 2019, and decreased by as little as 1.8 percentage points during the period under review.

It should be noted that since 2002, separate instruments of the government protectionist policy have been introduced in Ukraine in order to stimulate the development of domestic engineering, but only for the agro-industrial complex [18, 19]. However, despite these actions, in 2011–2020, there was reported a sharp decrease in the production of all types of machine-building products for agro-industrial purposes (except for sprayers for liquid and powder substances), which was mostly caused with the Ukraine's exit from the markets of the Russian Federation and other CIS countries. The manufacture of tractors, combine harvesters, and machines for preparing animal fodder, which belong to the more technological products and which Ukrainian farmers are provided with for 70%, has declined the most (by more than 80%).

In addition, a significant problem for Ukraine is the high import dependence of domestic machine-building for the agro-industrial complex, especially, in terms of the most important components, i.e. engines and gearboxes. Thus, all tractors included in the program of partial government compensation for the cost of agricultural machinery were equipped with imported engines. The vast majority of tractor models manufactured by Kharkiv Tractor-Building Plant PJSC, TDV BRATSLAV, and Slobozhanska Industrial Company LLC had engines manufactured in the Russian Federation and Belarus. According to the authors' estimates, the engine accounts for about 40% of the tractor's cost price. After the introduction of the trade embargo for the Russian Federation (which should be extended to Belarus as well), the mentioned enterprises (and

not only them) have to find a substitution for the corresponding components. Under these conditions, Ukraine has a real chance to lay the foundation for a large-scale program of import substitution in the segments of high- and medium-high-tech engineering products.

The authors' proposals regarding the improvement of the current regulatory and legal instruments for stimulating the development of domestic engineering for the agro-industrial complex provide for:

1. The revision of the government program for lowering the price of domestically manufactured agricultural machinery and equipment [19] in terms of its expediency and effect on the development of domestic engineering for the agro-industrial complex and (if necessary) to cancel it or to apply only to tractors, self-propelled energy vehicles for agricultural purposes, special agricultural vehicles, self-propelled and trailed combines. At the same time, it is necessary to comply with the following conditions: a) the specified equipment shall be used in micro- and small agricultural enterprises; b) basic elements (engines, gearboxes, electronics, etc.) of such equipment shall be of domestic origin.

2. The finalization of the Law on Amendments to the Law of Ukraine on Public Procurement in terms of the creation of prerequisites for the sustainable development and modernization of domestic industry [16] in the following areas:

- ◆ the localization should be estimated based on the costs of the basic innovation high-tech elements (engines, gearboxes, electronics, etc.) rather than on the total cost of the products used for the manufacture of machine-building products. Therefore, only those products in which the basic components meet the localization requirements that should be reasonably established by the draft law shall be eligible for public procurement. In addition, it is necessary to apply differentiated, instead of general for all types of products, localization norms;
- ◆ it is necessary to determine criteria for the selection of products subject to the draft law and to justify the value of the indicators of localiza-

tion. It is mandatory to specify the actual (at the time of adoption of the Law) value of the localization for such products. During the validity of the draft law, at the beginning of each year, the authorized body shall publish the actual localization for the products (or their basic elements) included in the relevant list;

- ◆ the draft law should not cover those types of products in which the basic cost elements are imported from countries that are aggressive or unfriendly to Ukraine.

The above proposals contribute to the implementation of the plan for the post-war recovery of the economy of Ukraine, which has been announced by the team of the President's Office and representatives of the government. One of the key principles of this plan is to reach at least 60% localization. This means that in the process of restructuring the national economy, priority is given to Ukrainian companies and manufacturers, which leads to enhancing business activity, creating new jobs, and ultimately boosting the socio-economic development.

To summarize the above said, we can consider that the critical state of domestic engineering requires the use of not only motivational or stimulating tools, but also the purposeful restoration of the key links of the value chain by the industrial sector of the national economy in general, including the use of direct government management. In order to secure and further strengthen its position as a traditionally important player in the world engineering market, Ukraine needs to move away from passively following the liberal conditions and rules of foreign trade towards being involved in the formation of these rules, based on the priority of defending the national interests. The losses incurred in the war against the Russian Federation have proven the urgent need for active government actions to ensure the development of machine-building as a strategic segment, in order to counteract the further agrarization of Ukraine and to transform the national economy based on the principles of neo-industrialization and technological self-sufficiency.

REFERENCES

1. Heyets, V. M., Ostashko, T. O. (Eds.) (2016). Implementation of the Association Agreement between Ukraine and the EU: economic challenges and new opportunities Scientific Report. 184 p. Kyiv: Institute for economics and forecasting National Academy of Sciences of Ukraine [in Ukrainian].
2. Smerichevskiy, S. F., Kryvoviazuk, I. V. (2017). Research on the development of the machine-building industry of Ukraine: state and prospects – multi-authored monograph. Latvia: “Izdevnieciba “Baltija Publishing”. 200 p. URL: https://www.researchgate.net/profile/Sergii-Sardak/publication/322052953_Research_on_the_development_of_the_machine-building_industry_of_Ukraine_state_and_prospects/links/5a40f90b458515f6b04a3775/Research-on-the-development-of-the-machine-building-industry-of-Ukraine-state-and-prospects.pdf (Last accessed: 01.09.2022) [in Ukrainian].
3. Hlušková, T. (2019). Competitiveness Outlook of the Automotive Industry in the V4 Countries. *Studia Commercialia Bratislavensia (SCB)*. *Sciendo*, 12, 41(1), 24–33. <https://doi.org/10.2478/stcb-2019-0003>.
4. Tkaczyk, S., Brzozowski, M., Dymitrowski, A., Staszaków, M. (Review). (2016). Współczesne koncepcje trendy w branży motoryzacyjnej. (Eds. Łuczak, M., Małys, L.). Poznań: Advertiva. URL: <https://docplayer.pl/40177645-Wspolczesne-koncepcje-i-trendy-w-branzy-motoryzacyjnej.html> (Last accessed: 01.09.2022) [in Poland].
5. Andersson, M., Segerdahl R. (2012). Supply Chain Localization Strategies for the Future. A study of Swedish AIE companies. Master of Science Thesis in the Master Degree Program Supply Chain Management. Department of Technology Management and Economics. Chalmers university of technology. *Report No. E2012:041*. P. 162. Göteborg, Sweden. URL: <https://publications.lib.chalmers.se/records/fulltext/159975.pdf> (Last accessed: 01.09.2022).
6. Vitali, S., Napoletano, M., Fagiolo, G. (Preprint submitted on 21 May 2014). Spatial Localization in Manufacturing: A Cross-Country Analysis, *Regional Studies*. P. 37. URL: <https://hal-sciencespo.archives-ouvertes.fr/hal-00972830/document> (Last accessed: 01.09.2022).
7. Nakajima, K., Saito, Yu., Uesugi, I. (2012). Measuring Economic Localization: Evidence from Japanese firm-level data. *Journal of the Japanese and International Economies*, 26, 2, 201–220. <https://doi.org/10.1016/j.jjie.2012.02.002>
8. Burke, R., Mahto, M., Bowman, G., Cotteleer, M. (2021). Reshoring or localization on your mind? *Deloitte*. URL: <https://www2.deloitte.com/us/en/insights/topics/operations/reshoring-supply-chain.html>.
9. Bul'yeyev, I. P., Bryukhovetska, N. Yu., Chorna, O. A. (2021). Modernization of Industry through Import Substitution and Localization of Production in Mechanical Engineering. *Economic Herald of the Donbas*, 1(63), 37–51. [https://doi.org/10.12958/1817-3772-2021-1\(63\)-37-51](https://doi.org/10.12958/1817-3772-2021-1(63)-37-51) [in Ukrainian].
10. Gurochkina, V. V., Menchynska, O. M. (2018). Assessment of the degree of localization of production and import dependence of enterprises of the industry. *ECONOMICS: time realities. Scientific journal*, 5(39), 21–29. <https://doi.org/10.5281/zenodo.2565330> [in Ukrainian].
11. Ishchuk, S., Sozanskyi, L., Pukala, R. (2020). Optimisation of the relationship between structural parameters of the processing industry as a way to increase its efficiency. *Engineering Management in Production and Services*, 12(2), 7–20. <https://doi.org/10.2478/emj-2020-0008>.
12. Ishchuk, S., Sozanskyi, L., Pukala, R. (2021). Optimisation of structural parameters of the industry by the criterion of product innovation. *Engineering Management in Production and Services*, 13(3), 7–24. <https://doi.org/10.2478/emj-2021-0018>.
13. KOF. (2022). Economic Globalisation, de facto index. Swiss Economic Institute. URL: <https://kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html> (Last accessed: 01.09.2022).
14. UkrStat. (2021). Official Web-site of the State Statistics Service of Ukraine. URL: <http://www.ukrstat.gov.ua>. (Last accessed: 01.09.2022) [in Ukrainian].
15. Statistics Poland. (2021). Official Web-site of the Statistics Poland. URL: <http://stat.gov.pl>. (Last accessed: 01.09.2022) [in Poland].
16. Law of Ukraine of On the introduction of amendments to the Law of Ukraine “On Public Procurement” regarding the creation of prerequisites for the sustainable development and modernization of domestic industry. (2021). Law of Ukraine, adopted on December 16, 1977-IX. Legislation of Ukraine: Website. URL: <https://zakon.rada.gov.ua/laws/show/1977-20#Text>. (Last accessed: 14.07.2022). [in Ukrainian].
17. UNIDO (United Nations Industrial Development Organization). (2021). Database. URL: <https://stat.unido.org/database/CIP%202020>.
18. Law of Ukraine of On stimulating the development of domestic engineering for the agro-industrial complex (2020). Law of Ukraine, adopted on Oktober 16, 3023-III. Legislation of Ukraine: Website. URL: <https://zakon.rada.gov.ua/laws/show/3023-14#Text>. (Last accessed: 16.10.2020). [in Ukrainian].
19. Decree of On the approval of the Procedure for determining the degree of localization of production by domestic engineering enterprises for the agro-industrial complex of domestic machinery and equipment for the agro-industrial com-

- plex and establishing indicators of the degree of localization of the production of tractors and other self-propelled power tools for agricultural purposes, special agricultural vehicles, self-propelled and trailed combines (2013). Decree of Ukraine, adopted on 2013 May 27, 369-2013-p. Legislation of Ukraine: Website. URL: <https://zakon.rada.gov.ua/laws/show/369-2013-%D0%BF#Text>. (Last accessed: 26.10.2021). [in Ukrainian].
20. Vishnevsky, V. P., Harkushenko, O. M., Kniaziev, S. I. (2020). Technology Gaps: the Concept, Models, and Ways of Overcoming. *Science and Innovation, Academic and Research journal of the NAS of Ukraine*, 16(2), 3–17. <https://doi.org/10.15407/scine16.02.003>
21. Danylenko, A. (2021). Specifics of investment policy in the Ukraine real sector. *Finance of Ukraine. Scientifically theoretical, informatically practical journal*, 4, 24–47. <https://orcid.org/0000-0002-9753-5831> [in Ukrainian].

Received 10.05.2022

Revised 18.08.2022

Accepted 21.09.2022

С. О. Іщук¹ (<https://orcid.org/0000-0002-3698-9039>),
Л. Й. Созанський¹ (<https://orcid.org/0000-0001-7854-3310>),
С. І. Князев² (<https://orcid.org/0000-0002-5308-4960>)

¹ ДУ «Інститут регіональних досліджень імені М. І. Долішнього НАН України»,
вул. Козельницька, 4, Львів, 79026, Україна,
+380 32 270 7093, irr_nas@ukr.net

² Відділення економіки НАН України,
вул. Володимирська, 54, Київ, 01601, Україна,
+380 44 239 6646, ksi@nas.gov.ua

ПРОБЛЕМНІ ПИТАННЯ РОЗВИТКУ МАШИНОБУДУВАННЯ В УКРАЇНІ НА ЗАСАДАХ ЛОКАЛІЗАЦІЇ

Вступ. Машинобудування у синтезі з ІТ-сферою формує сектор економіки з найвищим потенціалом для створення інновацій, які в умовах повоєнного відновлення мають стати головними рушіями соціально-економічного розвитку України та забезпечити гідний рівень її конкурентоспроможності на світовому ринку.

Проблематика. Критичний стан українського машинобудування вимагає застосування ефективних інструментів стимулювання розвитку виробництва, зокрема на засадах локалізації. Планом відновлення України передбачено локалізацію не менше 60%.

Мета. Обґрунтування пропозицій щодо стимулювання розвитку українського машинобудування на засадах локалізації виробництва у контексті посилення національної економічної безпеки.

Матеріали й методи. Методи економічного аналізу, методика розрахунку локалізації, авторський метод визначення ступеня локалізації виробництва. Інформаційною базою дослідження слугували дані таблиць «витрати-випуск» України і OECD.

Результати. Аналітично доведено наслідки негативного впливу економічної глобалізації на результати діяльності вітчизняних машинобудівних підприємств за відсутності державного протекціонізму. Розроблено й апробовано новий методичний підхід до визначення ступеня локалізації виробництва, який базується на розрахунку частки вітчизняної складової у кожному з базових сегментів секторальної структури витрат. Обґрунтовано авторські пропозиції щодо нетарифного стимулювання розвитку українських машинобудівних компаній на засадах локалізації з метою відстоювання інтересів національного виробника в умовах ліквідації наслідків російської агресії та повоєнного відновлення економіки, структурних трансформацій і посилення конкуренції на світових ринках.

Висновки. Застосування авторського підходу до розрахунку ступеня локалізації виробництва дозволить визначити ключові елементи (у розрізі видів економічної діяльності) собівартості продукції та вагомість вітчизняної складової у них при формуванні стратегічної номенклатури машинобудування в Україні.

Ключові слова: машинобудування, розвиток, виробництво, промисловість, інноваційна продукція, локалізація, витрати.