

# The systematic development of mechanical engineering is a key link in increasing the competitiveness of the Russian economy

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**Abstract.** The competitiveness of the economy is its ability to develop steadily under the conditions of the modern intensification of the world redistribution struggle. The material basis of economic competitiveness is the developed machine-building. It forms the technical equipment of the whole machine-building industry, creates the labour means for all branches of the economy and determines the level of their efficiency. The study of Russian machine-building indicators for 2005-2022 reveals a number of negative trends and factors generating these trends. At the same time, the analysis shows an objective possibility for a significant acceleration of the machine-building development existed in the country. They consist primarily in the use of the trade balance surplus for the import of equipment and components, aimed at the technical renewal and expansion of machine-tool construction industry and further - of other machine-building industries. Using the construction and analysis of the annual inter-branch production and distribution balances of gross social product for the period 2005-2019, we reveal the interrelations in the development of the main industries. Also we found the dependence of the material and labour intensity indicators on the technical armament of labour in the industries. The calculations performed provide a basis for the conclusion stating as follows: if the current account surplus materiality were used for purchasing imported equipment and re-equipping machine-building, then within 10-15 years Russia could achieve a significant approach to technological sovereignty and overcome its dependence on imported equipment by increasing its exports. We provide the calculations for the period 2016-2020 as an illustration. In accordance with these data, the main internal factor preventing the revival of domestic machine-building is the relationship of private ownership of the means of production, and the external factor is the anti-Russian sanctions. In this regard, we propose a variant to mitigate the effect of negative factors, based on increasing the role of the state in the economy and the use of state planning.

**Keywords:** role of machine tool industry; indicators and trends in mechanical engineering; factors hindering the development of mechanical engineering; the relationship of the main sectors of the economy; effect of foreign trade; reserves for accelerating the development of mechanical engineering; directions of their use; the role of the state in accelerating the development of engineering.

**JEL codes:** E60, E61, E65, E66, E69

**For citation:** Nikolay K. Vodomerov. (2023). The systematic development of mechanical engineering is a key link in increasing the competitiveness of the Russian economy. JOURNAL OF REGIONAL AND INTERNATIONAL COMPETITIVENESS, 4(1), 12. Retrieved from [https://doi.org/10.52957/27821927\\_2023\\_1\\_12](https://doi.org/10.52957/27821927_2023_1_12)

**DOI:** 10.52957/27821927\_2023\_1\_12

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## Introduction

Nowadays, as the struggle of the imperialist powers led by the United States to expand their spheres of influence escalated to the adoption of the most severe anti-Russian sanctions and the instigation of a proxy war in Ukraine, the problem of Russia's economic competitiveness is more relevant as never before.

In our opinion, the competitiveness of the economy is its ability to develop steadily at a high pace and improve the quality of life of the entire population of the country in the long term, successfully overcoming external negative impacts. Ultimately, the Russian economy will be able to withstand the confrontation with the collective West in the long term only if there is a developed technical base and technological independence. It can be ensured only through the accelerated revival of domestic machine building. Indeed, machine tool construction, which «is the basic fund-forming industry». Also, the level of development «largely characterizing the level of development of machine building in the country as a whole», its competitiveness. Therefore, the Chairman of the Government of Russia M.V. Mishustin speaking to the deputies of the State Duma, pointed out the development of machine tool construction as one of the four most important points

of economic growth .

The purpose of the study is to identify reserves for accelerating the development of Russian mechanical engineering, identify factors preventing their use, and possible ways to overcome these factors.

The main hypothesis of the study is that the development of mechanical engineering is possible only in cooperation with other sectors of the economy, including foreign trade.

The object of the study is the economic system of Russia, the subject of the study are indicators of the economic activities development in their interrelation and influence on the mechanical engineering development. The analysis performed for the period 2005-2023. We use data of the official websites of Rosstat; the Ministry of Finance the Federal Customs Service, and the Bank of Russia.

### **Main Part**

#### *1. Advanced mechanical engineering is the basis of technological sovereignty*

Any technology is, first of all, knowledge about the objects and means of labour, the ways of their use are required to obtain a certain result. If there is only knowledge, then the technology can be sold or provided for use as an object of intellectual property, but not applied.

Technological sovereignty means the use of the most important technologies in production on domestic territory. This requires certain items and means of labour, which are produced on the appropriate equipment. Nowadays, the idea appeared in the 1990s that all the equipment needed by the country could be purchased in exchange of the natural resources is not supported by the facts. Indeed, after the Crimea integration, and especially after the beginning of the Special Military Operation in Ukraine (SMO), it became obvious the revival of domestic engineering is of particular importance to achieve technological sovereignty.

During the 1990s, the Russian machine-building industry was in a deep crisis. It has not completely emerged even today. The main cause of the crisis was the transition to a market capitalist economy.

The reforms had a great negative impact on the domestic machine tool industry, which occupied leading positions in the world previously. For instance, the world's first CNC machine was created in the USSR in 1958. Their serial production was established in the 1970s. In 1991, the country produced more than half of all the necessary equipment for the mass production of CNCs. At the time of the USSR break up thousands of Soviet machines were working abroad: in Germany, Switzerland, France, Japan, etc. In 1991, there were presented about 50 units of Soviet equipment at the Paris Machine Tool Exhibition.

As a result of privatization, «the output of metal-cutting machines has decreased by several times, and CNC machines in general by dozens of times. In 2009, the production of machine tools reached the lowest level in the history of the country. By this time, many machine-tool factories were stopped, the remaining ones worked very poorly» .

The consequences of the negative trends in the Russian machine tool industry are: the dependence of the economy on the equipment and components import, the loss of the country technological sovereignty, a decrease in the competitiveness of the enterprises products, etc.

The measures of the Russian government to support the domestic machine tool industry, including the adopted ones in 2020-2022, were not insufficiently effective. Indeed, they relied mainly on methods of indirect regulation and did not create conditions for solving the entire complex of tasks for the rise of the industry. The most machine tool enterprises were unable to cope with this problem on their own.

The losses incurred have not yet been compensated. it has affected the development of mechanical engineering as a whole, although recently there has been some growth in the industry (see Table 1).

The investment decreased in all branches of mechanical engineering in the period 2014 - 2019. Since 2020, despite the pandemic, they began to increase. In 2022, the growth of investments continued, except for the production of electrical equipment and vehicles: this branch has an investment reducing up to the level of 2014.

The level of investment in mechanical engineering remained generally poor, on average about 1.7 times lower than investment in trade and repair of vehicles (see Table 2).

**Table 1** – Growth rates of production in machine–building industries for the period 2015–2022, %

Period	2015	2016	2017	2018	2019	2020	2021	2022	Average annual growth for 2015–2022
Manufacture of computers, electronic and optical products	105.8	102.8	100.2	103	110.6	103.4	107.9	101.7	104.4
Production of electrical equipment	90.7	107	102.7	105.4	101.3	99.2	106.3	96.3	101.1
Production of machinery and equipment not included in other groups	98	97.9	108.3	102.4	113.5	110	113.8	101.9	105.7
Production of motor vehicles, trailers, and semi-trailers	77	97.9	120.1	111.5	96.3	87.8	113.8	55.3	95.0
Manufacture of other vehicles and equipment	97.3	110.8	115.6	107.7	99	106.6	107.9	95.8	105.1

Source: Russian Statistical Yearbook, 2005–2022

**Table 2** – The share of industries in the investments volume, %

Period	2017	2018	2019	2020	2021
Manufacture of computers, electronic and optical products	0.4	0.4	0.3	0.3	0.4
Production of electrical equipment	0.3	0.2	0.2	0.2	0.2
Production of machinery and equipment not included in other groups	0.4	0.4	0.4	0.3	0.4
Production of motor vehicles, trailers, and semi-trailers	0.5	0.6	0.5	0.4	0.6
Manufacture of other vehicles and equipment	0.8	0.9	0.8	0.8	0.9
<b>Total in mechanical engineering</b>	<b>2.4</b>	<b>2.5</b>	<b>2.2</b>	<b>2</b>	<b>2.5</b>
Wholesale and retail trade; repair of motor vehicles and motorcycles	4	4.4	3.7	3.4	4.1

Source: Russian Statistical Yearbook, 2005–2022

Capacity utilization for a number of main types of machinery production on average for 2018–2021 ranged from 12.1% (forging machines) to 62.1% (household refrigerators and freezers), averaging about 29%. It indicates significant opportunities for production growth in mechanical engineering without additional investments. However, the investments level is quite low.

The main reasons of it are:

- Insufficient financing of the industry, lack of working capital and investment resources, own funds for R&D, high cost of credit (Mehanik, 2022).

- Depreciation of fixed assets at the level of 63–65%. First of all, technological equipment requires replacement. More than half of equipment has been in operation for 25–30 years. Shortage of modern equipment to replace depreciated ones.

– Dependence on the import of components and materials, the component base of electronics. Almost all microchips and chips in machines assembled in Russia are made abroad. It is necessary to import CNC systems from abroad. 1.5-2 years ago there were no problems with supplies, but in 2022, anti-Russian sanctions destroyed almost all logistics chains (Mehanik, 2022).

– There are practically no research institutes in Russia working in the interests of machine tool construction, although in 1991 there were about 30 of them. Today there are only 4 that barely survive. The ties of the industry with fundamental science are broken (Mehanik, 2022).

– The loss of qualified personnel, the training of engineers and workers has sharply decreased.

– Loss of the key technologies.

– The cheapness of labour, motivating entrepreneurs to use labour instead of using expensive machines (Fomin, 2022).

– The lack of investment resources in Russia as a whole for modernization and creation of modern production facilities (Fomin, 2022).

After the start of the SMO in Ukraine, the situation was exacerbated by new sanctions. If «before February 2022 nothing prevented the renewal of the machine tool fleet, now only China, Turkey and India are open to us» (Rezvanova, 2023). At the same time, certain achievements have taken place in the work of machine builders in recent years. For example, it applies to the most important sub-branch of machine tool construction – the production of metalworking equipment (see Table 3).

**Table 3** – Some indicators of the metalworking equipment production in Russia

Period	2013	2014	2015	2016	2017	2018	2019	2020	2021
The volume of sales in the domestic market, total, pcs.	16713	17962	14677	14382	18192	21108	23102	16378	19489
Including imports, pcs.	13015	13556	10635	8566	11789	13387	15192	7732	11433
Share of imports in sales volume, %	78	75	72	60	65	63	66	47	59
Product output, pcs.	4273	4670	4690	6280	6969	8317	9129	9394	9279
Export, pcs.	575	534	648	464	565	596	1219	712	1223
Export share in output, %	13	11	14	7	8	7	13	8	13
Import to export, times	22.6	25.4	16.4	18.5	20.9	22.5	12.5	10.9	9.3

Source: *Mehanik*, 2022

Russian weapons are also competitive, and their exports have grown noticeably. There are other types of equipment that can compete with foreign analogues, for example, an agricultural machinery.

According to experts, with an increase in investment in the industry and the creation of other necessary conditions, Russian engineering can dramatically increase the output of competitive products and strengthen the technological sovereignty of the country. However, as already mentioned, investments in mechanical engineering remain at a low level, lower than in trade and repair of motor vehicles.

At the same time, the rise of mechanical engineering is necessary not only for the industry itself, but also for the entire economy as a whole. This is evidenced by data on the state of fixed assets of Russian enterprises in the most important sectors of production (see Table 4).

**Table 4** – Indicators of machinery and equipment in Russian commercial organizations in 2013 and 2021 (excluding small businesses)

Period	Wear rate, %		The proportion of completely worn out, %	
	2013	2021	2013	2021
All industries	54.6	63.4	22.1	30.2
Agriculture, hunting, and forestry	48.5	56.9	10.3	18.5

Period	Wear rate, %		The proportion of completely worn out, %	
	2013	2021	2013	2021
Mining	62.1	66.5	32.0	35.9
Manufacturing industries	53.4	61.9	18.8	25.6
Construction	58.1	60.5	19.5	25.7

Source: Russian Statistical Yearbook, 2005-2022

In 2013 the introduced funds investments covered about 32% of the completely worn-out equipment. It was not completely enough. In 2021 investments figures dropped up to 16.8% . Mechanical engineering uses an increasing proportion of obsolete equipment, the life circle of which has expired. Significant acceleration of the domestic machine building development is relevant not only for upgrading the technical base of the industries, but also for the timely and sufficient army supplying.

### 2. Assessment of mechanical engineering accelerated growth reserves

Accelerated development of mechanical engineering is possible only in close cooperation with related industries. To study the relationship of mechanical engineering in terms of the other activities, we divide all industries into nine main sectors (see Table 5). Also we classified the enlarged annual intersectional balances of GPP production and distribution of Gross Public Product for the period 2005-2019 on the basis of Rosstat data. We considered mechanical engineering products in the balance as part of the final products of manufacturing industries. The period under study was determined by the availability of relevant statistical data.

**Table 5** – Sector numbers in the analysis of the interindustry balances

Sector number	Type of economic activity
1.	Agriculture, forestry, hunting, fishing, and fish farming
2.	Mining
3.	Manufacturing industries
4.	Production and distribution of electricity, gas, and water
5.	Construction
6.	Trade and repair
7.	Hotels and restaurants
8.	Transport and communications
9.	Services (all remaining activities)

Source: composed by author

All comparable calculations were in the basic prices of 2005. We studied these models in terms of mathematical statistics methods and the interrelations between sectors due to production technology, while levelling the influence of price dynamics and natural rent.

During the study we calculated and analysed the aggregated coefficients and dynamics of direct material costs and labour costs. According to the study, the vast majority of these coefficients tend to decrease, which with a high degree of correlation (R from 0.89 to 0.99) is due to an increase in the stock of labour in the relevant industry.

This result convincingly confirms the position of the theory that the increase in the technical equipment of labour is the main factor in the production process development, the growth of social labour productivity.

We calculated the matrices of total material costs and total labour intensity, based on the matrices of direct material costs (see Tables 6 and 7).

We also assess the indices of output elasticity of number of industries to fixed assets, the indices of substitution of factors of production necessary for calculations by the methods of mathematical statistics (see



tables 7 and 8).

**Table 6a** – Assessment of direct labour intensity indices (people. years / mln, RUB)

Direct labour intensity indices									
Sector No.	2005	2006	2007	2008	2009	2010	2011	2012	2013
1.	4.10	3.96	3.83	3.69	3.56	3.42	3.29	3.15	3.02
2.	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.34	0.34
3.	1.00	0.98	0.95	0.92	0.90	0.87	0.84	0.82	0.79
4.	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
5.	1.83	1.84	1.85	1.86	1.88	1.89	1.90	1.91	1.93
6.	1.67	1.66	1.65	1.64	1.62	1.61	1.60	1.59	1.58
7.	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16
8.	1.34	1.33	1.32	1.30	1.29	1.28	1.26	1.25	1.24
9.	2.30	2.31	2.33	2.35	2.37	2.38	2.40	2.42	2.44

Source: composed by author

**Table 6b** – Assessment of direct labour intensity indices (people. years / mln, RUB)

Direct labour intensity indices						
Sector No.	2014	2015	2016	2017	2018	2019
1.	2.88	2.75	2.61	2.47	2.34	2.20
2.	0.34	0.34	0.34	0.34	0.34	0.34
3.	0.77	0.74	0.71	0.69	0.66	0.63
4.	1.06	1.06	1.06	1.06	1.06	1.06
5.	1.94	1.95	1.96	1.97	1.99	2.00
6.	1.56	1.55	1.54	1.53	1.52	1.50
7.	3.16	3.16	3.16	3.16	3.16	3.16
8.	1.23	1.21	1.20	1.19	1.17	1.16
9.	2.45	2.47	2.49	2.51	2.52	2.54

Source: composed by author

**Table 7a** – Assessment of total labour intensity indices (people. years / mln, RUB)

Total labour intensity indices

Total labour intensity indices									
Sector No.	2005	2006	2007	2008	2009	2010	2011	2012	2013
1.	4.74	4.59	4.44	4.29	0.59	3.99	3.85	3.69	3.55
2.	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.54	0.54
3.	1.64	1.62	1.58	1.54	1.51	1.47	1.43	1.4	1.36
4.	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47
5.	2.3	2.3	2.3	2.31	2.32	2.32	2.33	2.33	2.34
6.	2.07	2.06	2.04	2.03	2.01	1.99	1.98	1.98	1.95
7.	3.45	3.45	3.44	3.43	3.42	3.41	3.41	3.4	3.39
8.	1.58	1.58	1.58	1.56	1.56	1.56	1.54	1.54	1.54
9.	2.54	2.55	2.56	2.57	2.59	2.59	2.61	2.62	2.63

Source: composed by author

**Table 7b** – Assessment of total labour intensity indices (people. years / mln, RUB)

Total labour intensity indices						
Sector No.	2014	2015	2016	2017	2018	2019
1.	3.39	3.24	3.09	2.93	2.79	2.63
2.	0.53	0.53	0.53	0.52	0.52	0.52
3.	1.33	1.28	1.24	1.21	1.16	1.12
4.	1.47	1.47	1.47	1.47	1.47	1.47
5.	2.35	2.35	2.35	2.36	2.37	2.37
6.	1.92	1.9	1.89	1.87	1.85	1.83
7.	3.38	3.37	3.37	3.36	3.35	3.34
8.	1.54	1.52	1.52	1.51	1.5	1.5
9.	2.64	2.65	2.67	2.68	2.69	2.7

Source: composed by author

**Table 8** – Assessment of average output elasticity coefficients for fixed assets by sector ( bn, RUB / bn, RUB)

Sector	1	2	3	4	8
Index	1.385	0.19	0.485	0.025	0.160

Source: composed by author

**Table 9** – Assessment of average labour replacement indices by fixed assets by sector (thousand people / bn, RUB)

Sector	1	2	3	4	8
Index	2.09	0.23	0.942	0.090	0.097

Source: composed by author

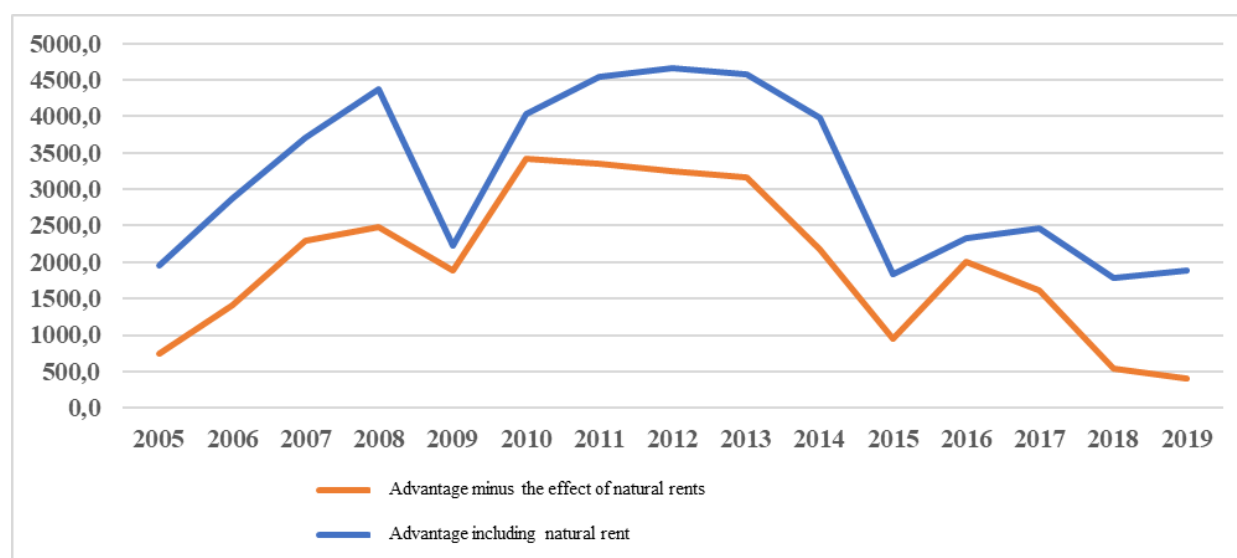
The positive impact of the increase in the stock ratio on the results of production is explained not only by an increase in the physical volume of funds, but also by their renewal with more efficient means of labour with the same and even decreasing number of employees. Hence the positive effect of the capital stock growth, despite the existing underutilization of production capacities.

Indeed, there is no absolute accuracy of the results given, since they depend on the accuracy of Rosstat data (which are often, repeatedly and significantly adjusted retroactively). In terms of this issue, it was necessary to neutralize the effect of many factors, primarily price dynamics and other monetary indicators. Nevertheless, they can be used to understand the trends of the processes taking place in the Russian economy, and for assessment of the certain actions results.

Thus, an assessment of foreign goods trade effect was calculated as the difference between the labour required for the production of imported goods and the labour spent on the manufacture of exported goods. The dynamics of the effect is shown in Figure 1.

As can be seen from the graph, foreign trade gave the economy a tangible effect, saving the labour of hundreds of thousands and even millions of workers. At the same time, after 2014, under the influence of anti-Russian sanctions, this effect began to decrease and now, apparently, continues to decrease due to the reduction of the volume of import. In addition, despite the significant magnitude of the foreign trade effect in the period up to 2014, the opportunities of foreign trade for the development of the Russian economy were largely underutilized.

During this period there was a significant outflow of the economic value in three main forms: world net lending based on a significant excess of exports of goods over their imports; an increase in the reserves of the Central Bank; transfer of funds to sovereign funds. The scale of this outflow is shown in Table 10.



**Figure 1.** The effect of foreign goods trade (thousand people. years)

Source: composed by author

If the outflow of value, although in part of the current account surplus implemented for imports, the effect of foreign trade would be much higher, as shown in Figure 2. An increase in imports by 1 bn, RUB in the basic prices of 2005 gives labour savings equal to the unit total labour costs for production in the relevant sectors of the economy. This issue takes into account the fact of purchasing the labour tools by import. It would led to the additional tangible effect both for the development of production and for the service sector.

**Table 10a** – Outflow of value from the Russian economy, bn, RUB, in 2005 prices (the «-» sign means inflow of value)

Period	2005	2019	2007	2008	2009	2010	2011
<b>Total outflow</b>	<b>4261.1</b>	<b>3790</b>	<b>6566.8</b>	<b>6453.1</b>	<b>3280.2</b>	<b>-485.9</b>	<b>1350.4</b>
Current account	2071.8	2753.3	2569	1732	1996.3	883.1	1357.9
Increase in gold and external reserves	1562.4	927.1	2897.2	3385.9	-883.1	77.3	740.8
Contributions to the sovereign wealth fund	626.8	109.6	1100.8	1335.2	2167	-1446.1	-748.3
Manufacture of other vehicles and equipment	97.3	110.8	115.6	107.7	99	106.6	107.9

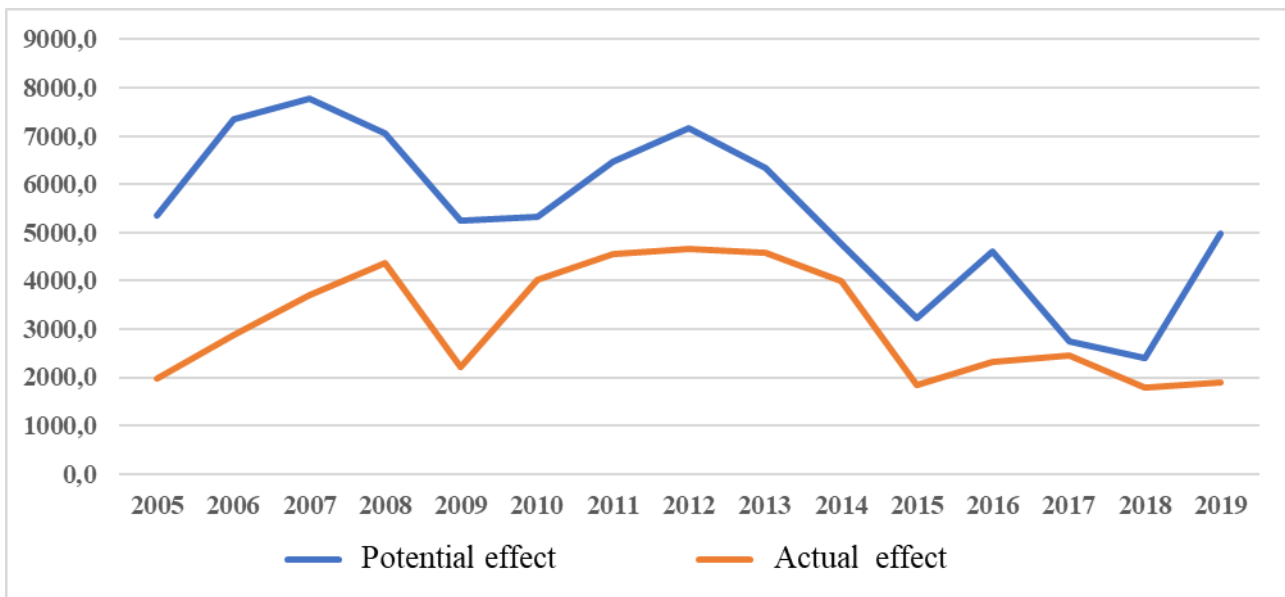
Source: calculated based on Russian Statistical Yearbook, 2005-2022; Federal Customs Service; Ministry of Finance of the Russian Federation; Statistical Bulletin of the Bank of Russia

**Table 10b** – Outflow of value from the Russian economy, bn, RUB, in 2005 prices (the «-» sign means inflow of value)

Period	2012	2013	2014	2015	2016	2017	2018	2019
<b>Total outflow</b>	<b>2103</b>	<b>2410.3</b>	<b>846.5</b>	<b>815</b>	<b>1687.7</b>	<b>-1006.2</b>	<b>820.8</b>	<b>3790</b>
Current account	1786.9	1296.6	583.3	1092.5	1845.5	228	532.4	2753.3
Increase in gold and external reserves	231.5	545.6	-385.7	-2042	45.5	229.2	533.3	927.1
Contributions to the sovereign wealth fund	84.5	568.1	648.8	1764.6	-203.3	-1463.4	-244.9	109.6
Manufacture of other vehicles and equipment	97.3	110.8	115.6	107.7	99	106.6	107.9	

Source: calculated based on Russian Statistical Yearbook, 2005-2022; Federal Customs Service; Ministry of Finance of the Russian Federation; Statistical Bulletin of the Bank of Russia





**Figure 2.** Assessment of the potential and actual effect of foreign trade in goods (thousand people. years)  
 Source: composed by author

The exports funds can be used to significantly increase the fixed assets of machine–building, primarily machine-tool construction, technological equipment modernization, through imports. It allows them to switch to import substitution of machine-building products and re-equip all sectors of the economy with domestic equipment. This particular policy allowed the Soviet Union to carry out a technical reconstruction of the national economy in the pre-war years and achieve technological sovereignty in a short period.

According to our assessment, if by 2005-2019, all or a substantial part of the current account surplus were spent on purchases of equipment abroad, then by 2017-2019, depending on the development of economic policy, domestic mechanical engineering volumes could increase to an extent enable further expanded social reproduction without the import of capital goods or enable substantial expansion of their export, reducing the use of imports. In other words, Russia, if not achieving technological sovereignty, would make a major step towards it.

In order to ensure the coordination of economic sectors, the development of mechanical engineering would be accompanied by an increase in the technical armament of labour in all other sectors of the economy. The increase in the technical equipment of labour would reduce the number of people employed in material production at a rate dependent on investment policy, and labour would be reallocated to the service sector (science, education, health care, etc.).

But, unfortunately, these purposes were not achieved. Moreover, as already mentioned, imports crowded out domestic engineering, preventing it from reviving during the period under study.

The described policy could be started lately. Assume the expected policy model of the mechanical engineering development in 2016. For instance, the trade surplus established the great opportunities for equipment imports those year: the entire current account balance of 1,845.5 bn, RUB was spent on purchase equipment in order to develop domestic engineering (Note, that here and after all monetary indices are in basic prices of 2005. Those based on the system of inter-branch balances for 2005-2019, calculated this way. Transition to the other years prices is possible using benchmark indices of intersectoral price growth. But it does not change the essence of the conclusions obtained. All calculations based on the total material costs indices assessments and output elasticity for fixed assets).

Since mechanical engineering develops only in cooperation with related industries (mining, energy, transport and communications, etc.), the additional fixed assets also required for their development.

There are two main options assuming the actual number of people employed in all industries:

- 1) with an increase in the volume of mining while maintaining the volume of their exports;
- 2) with the same volume of production, but a reduction in the export of raw materials in the amount

necessary for the social production growth.

By the implementation of option 1) in 2017, fixed assets in manufacturing industries would increase by 529.3 bn, RUB, and for adjacent companies – by 1293.5 bn, RUB. It made it possible to ensure a balanced growth of social reproduction in 2017 with an additional 5.9% increase in output in mechanical engineering with the same number of employees in all industries. In general, the total output in the economy would have increased by an additional 1.8%, and the productivity of public labour would have increased accordingly. In addition, the services sector would additionally receive equipment worth 22.7 bn, RUB.

By the implementation of option 2), the labour tools in manufacturing industries would have increased by 628 bn, RUB, and for adjacent companies – by 954.7 bn, RUB; the service sector would have received additional equipment by 262.8 bn, RUB. Production in mechanical engineering would be increased by an additional 7%, the entire output in the economy – by 2.2% to the level already achieved. But at the same time, the export of raw materials in the amount of 71 bn, RUB would have been replaced by exports of manufacturing products in the amount of 103.7 bn, RUB. Therefore, since the coefficient of raw materials replacement with processed products in exports in 2016 was 1: 1.46. It is due to the ratio of domestic prices and foreign trade prices. Reducing the export of raw materials when choosing option 2) it is necessary to increase the production of processing and related industries.

Other options are also possible. For instance, the release of employed from some industries to others ones. In this case, assessment of labour replacement indices in terms of fixed assets by sector would be used (see Table 9). It would also be possible to change the structure of imports in favour of purchasing equipment for mechanical engineering by reducing imports of luxury goods, alcohol, etc.(note, these kinds of products do not develop the economy); increase the volume of equipment of the service sector, primarily for the development of R&D, etc.

Consider the similar calculations for 2017. The possibilities of importing equipment due to the trade surplus were significantly limited to 228 bn, RUB. But even in these conditions, it would be possible to increase production in mechanical engineering. Thus, for an additional increase in the volume of mechanical engineering output in 2018 by 6.4%, taking into account the increase in equipment availability in 2017, it would require an increase in the technical base in all industries by 774.3 bn, RUB; 569.7 bn, RUB would be provided by an increase in mechanical engineering output in 2017 and 204.6 bn, RUB due to the excess of exports over imports. In addition, the services sector would additionally receive 23.4 bn, RUB for equip the sector. Therefore, the greater effect would be obtained by changing the import structure.

Continuing the same policy, it would be possible to increase the production of mechanical engineering in 2019 by an additional 8% due to the acquisition in 2018 of equipment imports in the amount of 532.4 bn, RUB. For instance, increasing the technical equipment of the industries ensures the development of mechanical engineering by 1095 bn, RUB, including the growth of domestic machinery production by 578.1 bn, RUB in 2018. At the same time, the volume of output in construction could be increased by an additional 0.5%; 15.5 bn, RUB would be sent for financing of service sector additional equipment.

Similarly using a significant trade surplus in 2019 for the import purchases of equipment, it was possible to achieve an additional increase in output in mechanical engineering total by 15% in 2020, in construction by 2.6%, etc.

A similar effect could be obtained by partially using part of the Central Bank and the sovereign funds reserves (currently the National Wealth Fund) for technology imports.

As a result, there would be an accelerated growth of mechanical engineering. On the basis of it there could be the labour productivity growth in all sectors of the economy. It would lead to a decrease in dependence on equipment imports, reduction its role in the investment process, and the equipment exports increasing. The reduction of specific material costs and labour for output would be accelerated, and its competitiveness would increase.

Of course, the assessment provided is very approximate, but the conclusions remain the same.

Russia had a huge underutilized potential to achieve technological sovereignty. The attempts to achieve the technological sovereignty at the initial stage, paradoxically, would be made by increasing imports of

equipment. It would subsequently lead to a weakening of the country's technological dependence on foreign manufacturers. Indeed, it seems to be the most desirable for our country at the moment. It is no coincidence that Western sanctions are aimed at depriving Russia of the opportunity to acquire technologies, equipment, and components.

### *3. Internal and external factors constraining the development of mechanical engineering*

Nowadays, private ownership of the means of production is the main internal factor that does not allow the country to achieve technological sovereignty.. According to the USSR experience, in the conditions of the public ownership of the means of production predominance and a planned economy this issue was not very urgent. Moreover, the predominance of private property destroyed the technological sovereignty of our country and became the main reason for its transformation, in fact, into a raw material appendage of the West.

As known, private capital is invested primarily into the industries providing the highest rate of return – extraction of natural resources, metallurgy, and chemical industry. The products of these industries are exported in significant volumes and provide the largest part of treasury revenues. Therefore, until now, the state has provided priority primarily to the interests of capital employed in these industries, contributing to the increase in exports of primary processing products containing natural rent.

As a result, there is a significant excess of exports over imports, a current account surplus, and net lending by Russia to the rest of the world. The value exported from the country was invested in huge amounts in foreign companies and branches, but not in the domestic economy. Hence, it causes the reduction of domestic investment, the slowdown in economic growth.

Even during the SMO, outflow of value has not decreased. Thus, according to the Central Bank for 2022, the current account surplus exceeded the level of 2021 by 1.8 times and amounted to \$ 227.4 bn, USD. It was achieved primarily due to a record trade surplus. It grew 1.7 times in 2022 and reached \$ 332.377 bn, USD for the first time. Exports increased by 19.9% to 591.5 bn, USD, imports decreased by 11.7% to 259.1 bn, USD . But it was neutralized with the lost effect from foreign trade, which also reached record values. Exports exist in order to buy the necessary goods abroad, and not to leave foreign exchange earnings there or in reserves. According to the forecast for 2023, the current account surplus may also amount to \$66 bn, USD .

As for mechanical engineering, it mainly competes with imports, except for the production of weapons and some other types of exported equipment. Investments in mechanical engineering are much more risky and give a much lower rate of return than investments in mining, metallurgy, and chemistry. Moreover, they require significant capital expenditures on R&D, personnel training, technological renewal, production of components, etc. Notice, their payback period is rather uncertain.

For an individual private owner in this industry it is difficult to solve the full range of issues necessary to establish competitive production. It is also difficult to take a loan for updating the technical base of production, increase working capital. Therefore, as an object of capital investment, mechanical engineering is less attractive than, for instance, investments in trade or restaurant business. Many technological innovations are not implemented in the domestic engineering industry, but are transferred abroad. The similar challenges are for the creators of these innovations.

Mechanical engineering is developing mainly due to orders and other types of the governmental support, as well as through the creation and development of state corporations designed to establish cooperation and coordination in the industry and at least partially overcome the existing difficulties.

Not only imports are used to supply the country with machinery and equipment, but also foreign capital is attracted to the mechanical engineering sector. However, in many cases the degree of localisation is insufficient and creates a dependence on imported components. As a result of sanctions and the withdrawal of foreign capital during the SMO period, the problem of component shortages has sharply increased.

Trade organisations, for private gain, buy abroad not only the products the country needs to develop its economy and win the SMO, but also luxury goods for affluent (alcohol, tobacco, products, knickknacks, etc.). As a result, the foreign currency proceeds from the export of natural resources are used inefficiently.

Banks – including those with state participation – use the funds raised to a large extent not to develop

the economy but to enrich themselves through stock exchange and foreign exchange transactions, serving as one of the main channels for exporting capital from the country. A large part of the real sector of the economy is cut off from the provision of loans, which excludes their reproduction. Targeted preferential lending to specific projects through the issuance of fiat money is not used. Despite of the SMO, large companies and banks, including banks with state participation, accrue huge dividends to foreign shareholders, including those from unfriendly countries.

The main external factor hindering the development of domestic engineering is obviously the sanctions imposed by the United States and its allies aimed at depriving Russia of advanced technologies and sales markets.

Even if Russia wins the SMO, confrontation with the West will not disappear. It will continue in other forms. There will be huge costs involved into restoring the previous provision. It will increase the challenging the country's technological sovereignty.

#### *4. Ways to overcome the factors hindering the development of mechanical engineering*

In our view, in order to achieve the goals of engineering development, the main issue is to increase the volume of equipment (technology) imports primarily for the development of domestic engineering same way as described above. Of course, at present it has become much more difficult to implement, but there are options to circumvent the anti-Russian sanctions: parallel and illegal imports, copying of technologies, etc. For instance, equipment imports are already on the list of goods for parallel imports.

In order to revive Russian machine-building, it is necessary to shift from indirect influence measures (credit rates, taxes, customs duties, etc.) to state planning. State planning is designed to solve the whole range of tasks to create a competitive machine-building industry in Russia, from R&D and personnel training to finished products, and hence to ensure Russia's technological independence.

To organize this kind of planning, it is required to establish appropriate planning authorities, scientifically based forecasts of market conditions, the preparation and approval of plans containing specific tasks for performers, the responsibility of performers for the implementation of planned tasks. It should include not only the establishment of work and technical re-equipment of existing enterprises, but also the construction of new ones; not only a certain reduction in the rights of private owners in the common interest, but, if necessary, the nationalization of enterprises; planning of personnel training and R&D, export and import of engineering products, the use of foreign technologies and specialists, foreign exchange earnings, financing, lending, etc.

Also, «a systematic and complete revision of conceptual approaches to the management of international reserve assets is to be carried out» in order to increase the investment potential of the economy (Ershov, 2022).

It is necessary further and significantly increasing the governmental role in the economy. But it requires a radical restructuring of the state apparatus itself. First of all, it is necessary to establish strict personal responsibility for making forecasts and development programs, for the validity of decisions made and for their implementation. The achievement of technological sovereignty would be significantly facilitated by the nationalization of the «heights of the economy», but only if the composition of the state apparatus is updated and its work is radically restructured in the interests of the people.

One option for using the trade surplus for machinery and parts imports could be, for example, as follows. Exporting enterprises would be obliged to sell on the domestic market all or most of the foreign exchange proceeds remaining after their import purchases. These funds as the projected trade surplus are purchased by the state leasing company, which implements the state policy on import purchases of machinery according to a set plan. It is also possible for exporters to transfer these funds to the state leasing company on a long-term loan basis. Funds to finance the leasing company could be generated from

- targeted long-term government loans, participation in which would be more profitable for the population in comparison with bank deposits;
- taxes raise on the purchase of luxury goods and on excess income;
- parts of the Central Bank and sovereign funds reserves.

By purchasing machinery abroad, the state-owned leasing company leases it to companies challenged



with fulfilling government orders to produce equipment with certain technical and economic parameters and within certain timeframes. R&D should design competitive machinery proceeding to those challenges. The essential R&Ds is financed by the state in cooperation with business, and the costs are multiplied compared with the current ones. State orders, if fulfilled, should be profitable for the companies performing them. There is a policy of concessional lending to such enterprises, and where necessary, targeted financing.

State orders are formed on the basis of demand for new equipment from enterprises – consumers of equipment aimed at import substitution. In case of non-fulfilment of the state order, the heads of enterprises have personal responsibility, and enterprises are responsible for their property. In addition, the state implements a stimulating monetary and fiscal policy uses protectionist measures to support mechanical engineering.

It is also important to refuse the neoclassical economics theory, which today is the basis for teaching macroeconomics in universities and to a certain extent adopted by the government.

We try to pay attention to its incorrect statements dwells on the growth of net exports as a crucial factor of economic development (it does not matter what is exported and what is imported); or, positive effect of current account balance; or «full employment» economical investments lead only to inflation. Meanwhile, investments with the same employment can reduce the cost of labour and material resources, increase output, decrease the price level, redirect free labour resources into other fields of industry, etc. Moreover, according to the calculations of economists of the Goldman Sachs Bank, the USA, the introduction of innovations can deprive 300 million people of work (Fomin, 2022).

The theory based on AD-AS curves is false, since it does not take into account the volume and composition of the intermediate product and output, as well as inter-industry relations. The same can be said about the theory of IS-LM curves and other neoclassical theories, which are currently taught in educational institutions. It is necessary to start the teaching of political economy in terms of the modern phenomena analysis.

### **Conclusions**

The issues of the Russian engineering industry became more complicated and require urgent solutions. There is a need in both accelerated growth and qualitative renewal of the industry's products. It will be difficult to achieve the country technological sovereignty without solving these issues.

The one of the main suggestions to solve them is increasing the import of equipment and components primarily for updating and expanding the technical base of machine tool construction and related industries. Indeed, it is possible to significantly accelerate the development of mechanical engineering in general, provide all sectors of the economy with new equipment and in the future significantly reduce dependence on imports of equipment and components, achieve technological sovereignty.

The implementation of these methods is possible only through state planning use. It is the only one capable to solve the wide range of issues: financial, and in the field of R&D and personnel training, optimize foreign trade, establish consistency in the work of related industries, ensure the sale of products, etc. State planning should include establishing the order of design and production of labour tools, in terms of their urgency and efficiency, the construction of new machine-building and related enterprises. Competitive technology will provide the basis for enterprises using it to successfully displace necessary imports, increase sales of products and investments. It will also allow the enterprises to increase revenues.

However, if the created equipment is not able to compete with imports, then the tasks of achieving technological sovereignty will not be solved (Vinokurov & Grichik, 2022). Hence there is an importance of establishing technical and economic tasks for the design and production of equipment, taking into account world achievements.

The state adjustment of the banking system in the interests of production growth allows us to solve the problems of shortage of working capital and investment resources for enterprises. Russia has everything to achieve technological sovereignty within 10-15 years. There is only a need in the cardinal chang

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### **FUNDING**

The work was done on a personal initiative.

**CONFLICT OF INTEREST**

The author declares no conflict of interest.

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Received 01.03.2023

Revised 23.03.2023

Accepted 25.03.2023