Role of machine building in the development of Russian economy at the present stage

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Abstract. Machine building is a leading industry in advanced countries. It provides many industries with machines and equipment as it is the main link in the system of intersectoral linkages. Thus, it secures full employment for highly skilled employees, promotes the growth of the level of educational background of the population and contributes to the development of the scientific and technological potential of the country. However, underinvestment in innovation technologies and processes, a limited character of the import substitution model and an insufficient support of the export model greatly hinder rapid and effective development of the machine-building industry. Specific peculiarities of the machine building development such as R&D intensity, labor intensity, and metal intensity, a need in cooperation and consumer orientation influence their geographic location.

1. Introduction
Manufacturing industries in general and machine building play a leading part in industrial production realizing scientific and technological progress, modern methods of organization of production based on the output of priority industries and creating an active part of basic production assets for modern economy. This in its turn affects the major indices of production effectiveness in the economy. Investigation of the importance of the role of engineering was carried out at the country and regional levels.

2. Trends in the development of mechanical engineering in the Russian Federation
The significance of manufacturing industries in the economy of the country depends on a great number of factors which include the level of economic development, demand for products of a certain sector, the degree of outsourcing of particular elements of the value-added chain of manufacturing in service industries and the character of the stimulation policy. The role of natural resources in the economy also influences the development of manufacturing industries. As a result of these factors’ effect, the GNP share of manufacturing industries in leading countries varies from 10 % in Great Britain to 33 % in China. In 2018, the share of manufacturing industries in gross value added (GVA) in the Russian Federation amounted to 14 % and in the long term it tends to decrease (Table 1). However, recently positive changes have become evident.

Until 2008, manufacturing industries were actively developing, which was due to highly favorable economic conditions, great internal consumer and investment demand, as well as low real interest rates.
Table 1. Share of machine building and manufacturing industry in GVA, %

|             | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|-------------|------|------|------|------|------|------|------|------|------|------|
| Manufacturing industry | 14.8 | 14.8 | 13.4 | 13.6 | 12.9 | 13.1 | 13.8 | 13.0 | 13.7 | 14.3 |
| Machine building     | 3.2  | 3.4  | 3.0  | 3.3  | 3.1  | 3.2  | 3.6  | 3.1  | 3.4  | 3.2  |

According to ROSSTAT (Russian statistics service) the manufacturing sector in the Russian Federation remains one of the most significant sectors in terms of the GVA share in GNP and is inferior only to the commerce sector in the number of the employed. [1] An average number of people employed in the manufacturing industry is quite stable and is about 6% of the total number of people employed in Russia. The number of manufacturing enterprises has considerably decreased (from 402.5 thousand to 309.8 thousand) since 2010 though the share in the total number of enterprises remains at the same level (7.3 % - 7.4 %).

Despite some negative tendencies in the manufacturing industry the share of machine building output in the structure of manufacturing industries in the Russian Federation is on average 23.5% and tends to increase. Nonetheless, the contribution of machine building to GVA is quite stable and amounts to 3.2%. The number of people employed in the machine building industry has decreased both in absolute and relative terms (by 8% since 2010) while the number of machine building enterprises has decreases by half (from 81.3 thousand to 40.7 thousand).

In the structure of export in the Russian Federation the share of manufacturing enterprises (as compared to European countries) is not big. The share of machine building output is about 6.5% and tends to decrease. But in money terms the export of machines, equipment and transport vehicles increases though at a decelerating rate (Figure 1).

![Figure 1. Export of machines, equipment and transport vehicles, million US dollars](image)

The diversification of the industry, training of highly qualified specialists and application of innovation developments, as well as an increasing interest of the government in developing both the machine building industry and other industries having high value added will make it possible for the machine building industry to grow. However, economic slowdown in the world greatly limits positive prospects, which reduces demand for goods.

Analyzing costs for innovations in the manufacturing industry we can observe an insignificant reduction in 2014-2015 after an accelerated growth in 2010-2013. However, costs for innovations continue to grow both in the economy as a whole and in the machine building industry (Figure 2).

We should pay attention to a strong correlation between the amount of costs for innovations and the volume of exports of innovation products. A close correlation between these indices is observed in the
manufacturing industry as a whole (0.96 and 0.91 correspondingly). The output volume and exports of manufacturing innovation products reveals a strong linear dependence ($r=0.98$). All theses indices are less correlated in the machine building industry though the correlation is sufficiently strong.

![Figure 2. Structure of costs for innovations in the manufacturing industry, million Rub](image)

3. **Innovative activity in manufacturing industry**

Russian Statistics attributes the manufacture of computers and electronic and optical devices to high-tech manufacturing. The manufacture of electrical equipment, machine-tools for material processing, special purpose machines, transport vehicles, trailers, and semitrailers, as well as other transportation means and equipment is attributed to medium-tech manufacturing of a high level [2].

Innovation activity in Russian machine building was analyzed:

1) by basic high-tech and medium-tech manufacturing of a high level (with regard for changes in OKVED);
2) at the macro level (because of the absence of official innovation industry statistics from RF regions);
3) over the period from 2008 to 2017 (with regard for changes in OKVED; 2017 was analyzed separately);
4) by the structure of costs (marketing, organizational and technological) [3].

The analysis of statistical data on innovation activity of individual types of machinery production has shown:

1) over the period from 2008 to 2016 against the background of decreasing the overall level of innovation activity in manufacturing industries as a whole (0.2 p.p.) the greatest decrease in activity can be seen in the manufacture of aircraft (6.4 p.p.) though the greatest number of these organizations are involved in innovation activity (32.7 % in 2016). In 2017, the highest level of innovation activity was observed in the manufacture of computers and electronic and optical devices (Figure 3). The number of organizations applying organizational innovations decreased most of all.
2) over the period under study a reduction in the innovation cost share (10.9 p.p.) is observed in the manufacturing industry. High-tech machine building was augmenting process innovations against the background of an overwhelming role of technological innovations (98.3 % in 2017). The shares of marketing and organizational innovations are extremely low and are decreasing.

3) The amount of innovation goods, developments and services in the total volume of shipped goods is increasing both in manufacturing industries (by 2 p.p. as of 2017) and in machine building production under analysis. In this case 10.5 % of the innovation products are created by high-tech manufacturing enterprises under government and municipal contracts (Figure 4). The share of exported (high-tech) innovation goods is growing.

**Figure 3.** Innovation activity of RF machine building organizations, 2017, %

**Figure 4.** Production of innovation goods, developments and services in RF machine building, 2017, %
4. Analysis of the regional specialization of the Russian industry

The geography of the machine building industry distribution over the Russian Federation territory is quite peculiar. It is assumed that it is undoubtedly influenced by labor intensity, metal intensity and research intensity. Taking into account the fact that the manufacture of machines requires much work time and highly qualified human resources, this industry is often located in densely populated regions.

When we speak of labor intensity, there is no doubt that highly qualified engineering personnel welcome the development and application of new samples of technical facilities. The most famous are such sub-sectors as machine tool manufacture in Moscow, instrument making and production of electronic facilities in Ulyanovsk and Novosibirsk, the aircraft industry in Samara and Kazan. It is an open secret that metal intensity is an inherent factor of the machine building complex. It is this industry that consumes the greatest amounts of ferrous and non-ferrous metals. Thus, it is quite natural that machine building enterprises tend to be located near metallurgical bases. Hence, big heavy machine-building plants are located in the Urals (Yekaterinburg). The focus on the manufacture of state-of-the-art and advanced technical equipment makes it necessary to concentrate on regions with highly developed scientific bases, for example, research institutes and design bureaus (in Moscow, St. Petersburg and Novosibirsk), as well as pilot-producing plants. Focus on the research potential is one of the factors that influence the choice of machine building enterprise locations.

However it is also necessary to mention the orientation of the produced output to the consumer sector. This factor is especially significant for manufacturers producing bulky machines because of the difficulties caused by their transportation. For example, grain-harvesting machines are manufactured in the North Caucasus right in the areas of their use (Taganrog and Rostov-on-Don). Some sectors of the machine building complex are located in regions suitable for cooperation, first of all in terms of their geographical location. Machine building plants are usually located near large transport hubs and highways.

The location of the machine building industry on the RF territory makes us ponder over the question which exactly regions can be considered to specialize in machine building. The identification of the current professionalization of the region and the legitimacy of its effective specialization are the significant issues in the system of regional relations. When determining the industries of regional specialization, we should use a system of indicators that has to be confirmed theoretically. These indicators should be related to each other via another geographical division of labor indicators. The geographical division of public labor forms the foundation of regional markets specialization. Thus, the determination of the region participation in social division of labor should be the basis for the identification of professional branches.

The analysis of revealing an industry of region specialization was based on a comprehensive approach with the calculation of such well-known indicators as the localization coefficient, a specialization level, inter regional marketability, a level of industry development in the region, per capita production, etc. All these indicators represent theoretical basics that serve as tools for calculating a quantitative level of the region specialization.

The research is based on the calculation of the specialization ratio which helps to determine a specialization industry of regions, federal cities, and federal territories. This indicator is calculated by using the gross regional product (GRP) which in its turn is one of the most important indicators of the results of economic activity of the region.

The ratio of the specialization level \( K_c \) [4] shows the relation of the share of a region’s industry in the country’s output volume to the share of a region’s economy in the economy of the country.

\[
K_c = \frac{O_p}{O_c} \times 100 / \frac{X_p}{X_c} \times 100, \tag{1}
\]

where \( O_p \) is a region industry;

\( X_p \) is the region economy;

\( O_c \) is a country industry;

\( X_c \) is the country economy.
An industry is a specialization industry when specialization ratios are greater than 1.

Specialization ratios for all Federal districts and 85 subjects of the Russian Federation were calculated in the research over the period from 2007 to 2017. The calculations were carried out for all types of economic activity according to the OKVED classifier. The results of the specialization ratio calculation in section D “Manufacturing Industries” for RF federal districts showed that according to statistical data this specialization industry is peculiar to the Central Federal District (CFD), the Northwestern Federal District (NWFD), the Volga Federal District (VFD), and the Siberian Federal District (SFD).

Further more detailed analysis shows that the manufacturing industry is present mostly in the Sverdlovsk and Chelyabinsk regions in the Ural Federal District (UFD). These two regions are the largest metallurgical centers in Russia. Ironworks are concentrated in the Sverdlovsk region and machine building and chemical industries are also highly developed in this region. About 40 % of finished metallurgical items of the total output of the country are produced in the Chelyabinsk region.

Most regions in the Southern Federal District (SFG) specialize in agricultural production. Their natural and climatic conditions as well as the natural and resource potential are the main factors of developing this industry in southern regions of Russia. Agriculture and the hotel and catering industry are the prevailing industries in the North-Caucasian Federal District (NCFD). The fisheries industry forms the basis of the economy of the Far Eastern Federal District (FEFD).

The calculations made revealed specialization industries in each region. The RF subjects whose specialization industry is manufacturing in particular machine building are presented in Table 2. It is these 19 regions that have not changed their specialization industries over the period from 2008 to 2017.

Table 2. Calculated values of specialization ratios for the RF subjects in section D – “Manufacturing Industries” over the period from 2008 to 2017

| FD   | Subject of the Russian Federation | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|------|----------------------------------|------|------|------|------|------|------|------|------|------|------|
| CFD  | Vladimirskaya oblast'           | 1.77 | 1.76 | 1.78 | 1.71 | 1.76 | 1.77 | 1.83 | 2.01 | 2.1  | 2.72 |
|      | Kaluzhskaya oblast'             | 1.66 | 1.72 | 1.89 | 2.14 | 2.3  | 2.08 | 2.06 | 1.87 | 2.15 | 2.42 |
|      | Lipetskaya oblast'              | 2.78 | 2.5  | 2.32 | 2.19 | 1.87 | 1.95 | 2.49 | 2.38 | 2.38 | 2.73 |
|      | Ryazanskaya oblast'             | 1.32 | 1.45 | 1.56 | 1.66 | 1.48 | 1.52 | 1.62 | 1.7  | 1.72 | 2.1  |
|      | Tul'skaya oblast'               | 1.85 | 1.61 | 1.71 | 2.1  | 1.92 | 1.86 | 2.29 | 2.3  | 2.35 | 2.85 |
|      | Yaroslavskaya oblast'           | 1.4  | 1.47 | 1.41 | 1.53 | 1.53 | 1.44 | 1.48 | 1.59 | 1.56 | 1.91 |
| NWFD | Vologodskaya oblast'            | 2.7  | 2.28 | 2.08 | 2.16 | 1.92 | 2.08 | 1.83 | 2.26 | 2.09 | 2.21 |
|      | Leningradskaya oblast'          | 1.36 | 1.58 | 1.4  | 1.39 | 1.3  | 1.48 | 1.69 | 1.68 | 1.66 | 1.94 |
|      | Novgorodskaya oblast'           | 1.71 | 1.78 | 1.74 | 1.82 | 1.96 | 1.98 | 2.01 | 2.07 | 1.99 | 2.3  |
| VFD  | Respublika Bashkortostan        | 1.48 | 1.28 | 1.58 | 1.91 | 2.15 | 1.74 | 1.75 | 1.71 | 1.61 | 2.24 |
|      | Permksiy kray                   | 1.81 | 1.57 | 1.7  | 1.83 | 1.79 | 1.78 | 1.86 | 1.79 | 1.83 | 2.16 |
|      | Kirovskaya oblast'              | 1.37 | 1.19 | 1.29 | 1.51 | 1.48 | 1.42 | 1.58 | 1.66 | 1.66 | 2.03 |
|      | Nizhegorodskaya oblast'         | 1.65 | 1.56 | 1.74 | 1.7  | 1.74 | 1.71 | 1.77 | 1.8  | 1.82 | 2.06 |
|      | Samarskaya oblast'              | 1.34 | 1.2  | 1.39 | 1.43 | 1.46 | 1.43 | 1.46 | 1.39 | 1.3  | 1.55 |
|      | Ulyanovskaya oblast'            | 1.11 | 1.03 | 1.18 | 1.23 | 1.28 | 1.26 | 1.47 | 1.5  | 1.55 | 1.88 |
|      | Sverdlovskaya oblast'           | 1.71 | 1.63 | 1.65 | 1.57 | 1.56 | 1.54 | 1.65 | 1.77 | 1.79 | 1.92 |
|      | Chelyabinskaya oblast'          | 2.09 | 2.04 | 1.98 | 2.05 | 2.04 | 2.07 | 1.8  | 2.05 | 2.09 | 2.05 |
| UFD  | Krasnoyarskiy kray              | 1.95 | 2.02 | 1.96 | 1.92 | 1.72 | 1.63 | 1.89 | 1.88 | 1.88 | 1.94 |
|      | Omskaya oblast'                | 2.02 | 2.11 | 1.97 | 2.1  | 2.18 | 2.11 | 2.29 | 2.1  | 2.18 | 2.7  |

*FD – Federal District
After analyzing all regions and their industries it can be concluded that regions with a great resource-based potential are least diversified. Regions with high social and economic indicators not involved in the mining industry changed their specialization several times over the period under study. It is caused by the fact that a great number of industries are developed in these regions.

Regions specialized in machine building faced a number of obvious problems and managed to solve them. First of all, it is necessary to change the specialization of the industry which for a long time used to be a defense industry. A major part of smaller human settlements failed to cope with diversification on their own. And without financial support it will be impossible to do after a long time. We can add here rare opportunities of upgrading equipment and as a result obvious machine idly time and output of products whose quality does not conform to international standards.

One of the major tasks of the machine building industry is radical reconstruction and advanced growth of such industries as machine-tool construction, instrument-making, electrical and electronic industry, and manufacture of computers, which will allow Russia to gather pace to approach the global economic level

5. Conclusion
Russian machine building is characterized by a whole range of peculiarities:
1) Machine building is a leading industry of the Russian economy dominating in the manufacturing industry by all indicators. Despite the reduction in the number of enterprises and people employed in the industry, the contribution of machine building to GDP of Russia remains stable.
2) Investments in innovations in the manufacturing industry are practically at the same level. However, costs for innovations in machine building increase, which promotes the growth of production and exports of innovation products, developments and services.
3) Against the background of decreasing innovation activity of machine building enterprises, an extremely low share of costs for measures related to a fuller satisfaction of needs, development of new markets, mastering of new methods of running business, organization of production, and establishment of foreign relations is observed.
4) The share of innovation products, developments and services including exported products grows with the support of the government.
5) Not all well-known enterprises in the Russian machine building industry are located in the regions whose specialization industry is manufacturing.

The government policy should take into account the above peculiarities when developing measures to stimulate the development of the machine building industry. Innovative and technological renewal and upgrade of the real sector industries and the modernization of the economy create favorable conditions for an intensive growth of production volumes in the machine building industry. Investment support of innovation activity in these industries has a multiplicative effect in the related industries and first of all in metallurgy. But it only the continuity of the process of modernization of the fixed capital in the consumer-oriented industries with a constant flow of facilities from the machine building industry will provide the sustainability of the process of modernization of the economy as a whole.

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