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Determinants of sustainable development of machine building industry under the new industrialization

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Abstract—**Identification of priority areas for the development of industrial sectors of economy during the transition to a new technological mode is closely linked to the definition of determinants of their sustainable development. Using the theory of sustainable development is the methodological basis for the building of a new industrial policy. Empirical research is aimed at evaluating the determinant of sustainable development of machine building industry in Russia. The authors systematized the basic approaches to identifying and assessing the factors of sustainable development of the industry within the framework of the concept of structural economy. Using the Panzar-Rosse model the assessment of interest income elasticity of engineering enterprises is made at factor prices of productive resources. Advantage of this method is that the reliability of statistical sampling is used, the complexity of the model used, the possibility of using the proposed tools for further multivariate analysis. The results of the study indicate a low level of sustainable development, focusing on getting immediate results, lack of strategic and innovative prospects. This state is adaptive behavior of constant tweaking under the macroeconomic and institutional changes and crises. Despite the large number of strategic programmes and scenarios of the development of machine building industry depends more on not consistency overall economic policy, the impact of economic crises. We can say that in the short term for engineering industries determinant for further development must be development strategy focused on optimization, improving the quality, efficiency, management of major production resources.**

Keywords— sustainable development, new economic policy, structural economy, industrialization, machine building industry, innovation, the Panzar-Rosse model, elasticity.

I. INTRODUCTION

In the search for new models of economic development of the country, move on to the next technological mode, reducing the technological gap, the need arises to define sustainable development determinants of individual sectors and the economy as a total. The choice of development model for Russia is largely defined by its geopolitical situation, where the priority of all historical stages is the development of the industry. [1].

New industrialization for industrial sectors of the economy is a moving to the new determinants of sustainable development, where the foundation to become the human potential that defines creative and innovative future development. Thus, high-tech manufacturing become the foundation for the transition to a new technological mode.

At the same time taken at the micro-level strategies are a consequence of the prevailing institutional structure environment, industry competition, innovation and other factors of the external environment. At the same time, the changes require durable determinant of development in the context of global competition on world markets.

The branches of machine building industry are the object of research. The importance of industries for the Russian and world economy cannot be overestimated. The share of machine building industry in the industrial production of the country is about 20%, the industry employs about 35% of the working population of the country [2].

The selection of the object is not accidental. An analysis of the experience of reforming the industry represents doubtless interest. Machine buildingperforms the following system functions in the macroeconomic system:

1. Maintenance of process reproduction in the national economy. Due to machinery replaces worn-out production funds, as well as capacity expansion in all industries. Implementation of this function is the key to possible restructuring of the economy.
2. Innovative-technological upgrading of enterprises. Implementation of this function ensures the competitiveness of industries in the global market, achieving innovation in technology, lead to a change of technological modes.

Machine building industry is submitted by more than 200 subdivisions where there is a segment of traditionally "heavy"machinery, military engineering, and segments of

small and medium engineering (production of equipment, appliances, tools). At the same time, diversity strategies and business models characterized by prevailing way, management practices, that demonstrates the limited choice of sources of sustainable development.

For today, the heavy mashinery sector to be in prolonged recession, about 4% for 10 months of 2018, and in the sector of small and medium engineering there is a slight increase in 3.3% over the same period [3].Instability of the situation caused by the foreign policy and economic factors significantly destabilize the industry. Thus, the objective of the study is search and evaluation of determinant of sustainable development of the industry in the face of structural changes in the economy and the need to move to a new technological mode.

II. THE CONTENT OF SUSTAINABLE DEVELOPMENT IN THE CONTEXT OF NEW STRUCTURAL ECONOMICS

Contemporary literature is rich with theories of economic growth and sustainable development, however, there is still no consensus about the essence and contents of the category "sustainable development"

At the level of the economic system as a whole under the sustainable development refers to the maintenance of a balance between the interrelated elements of the system: the economic, social and environmental [4].

Domestic authors define "sustainable development" as a social revolution, calling for changes in regulations, ethical attitudes and value systems in modern society [5].

In this case, according to S. Kazajkinaeach country has a sufficiently dynamic and subjectively evaluated potential socio-economic sustainability.It includes resources and reserves of the national economy, institutional governance, efficiency levels of economic activity, the level of participation in international organizations, economic policy. Besides it includes the ability promptly and efficiently respond to changes in the external environment, the behavior of the world's political and economic leaders[6].

Interesting interpretation seems to be the term "sustainable development", byG. Yarullinn. Under the "sustainable development" he understands the process appropriate continuous irreversible aimed natural changes over time, characterized by a transition to a new, improved state [7].

At the level of an enterprise "sustainable development" is defined by many factors of sustainable economic growth, as expressed in the balance of efficiency, effectiveness and economy of the activities. According to S. Orekhova an essential condition for a sustainable growth is the balance of the selected indicators of its activity [8].

Industry level factors of sustainable development include the following:

- institutional factors: industrial production specificity [9]; the level of functioning of financial infrastructure; the opportunity to compete on world markets [10]; access to productive and labour resources [11].
- internal factors: organizational structure, the size of the company [9], particularly management style [12].

In the framework of structural economy proposed by D. Lynn [13], "sustainable development" is related to objectively strengths and advantages, which define its security factors of production, such as labor, natural resources, human and physical capital.

Thus, the determinants of the sustainable development of industry in the framework of the implementation of the concept of structural economy is balanced use of factors of production, aimed at promoting sustainable advantages in a competitive market.

This approach can also be seen as a basis for changing the methodology for defining determinants of development of industries in the context of the transition to the new industrialization.

The most common approaches to assessing sustainable development industry is profitability, added profitability indicators proposed the concept of B. Stewart [14].In S. Avdasheva’s work modified formula of the Tornquist index is offered, allowing to assess changes in resource productivity [15]. S. Orekhova, when evaluating the factors of sustained growth of metallurgy used the same method of "golden rule economy" based on a comparison of the rate of profit growth, sales and assets [8].

I. Ivashkovskskaja proposes to use the matrix model for evaluating the quality of economic growth of the industry [16].

None of these techniques allows you to comprehensively assess the contribution of the used production resources in achieving sustainable growth of the industry.

As part of this study, it is interesting to determine the relevance of basic production factors on the sustainable development of mashine building industries. To solve this problem the authors are encouraged to use the Panzara-Ross model.

III. EVALUATION OF KEY FACTORS IN THE DEVELOPMENT OF ENGINEERING USING THE PANZAR-ROSS MODEL

The Panzar-Rosse model allows to get a more complete result in assessing the level of competition in the industry, taking also into account the influence the dynamics of the prices on basic productive resources. This model is widely used to evaluate non-structural market factors in different sectors of the economy: the insurance market [17], security[18], in the market of banking services [19], container transportation market [20].

The Panzar-Rosse model allows us to assess not only the degree of monopolization of the industry based on the dynamics of revenue of the industry, but also to determine the impact of prices of production factors on its growth (decrease). Thus, a model that defines not only the level of competition in the industry, but also describes the significance of the dynamics of the prices of factors of production to increase the revenue of the enterprises in the industry.

The model is performed econometric assessment of the elasticity estimates of interest income of the enterprises on the

three factor prices-cost attracted assets AFR (Average Funding Rate), the cost of manpower PPE (Price of Personnel Expense) and the cost of other expenses PONILE (Price of Other Non Interest and Labor Expenses). As a result of summing the estimated elasticity estimates the value of H-stat, which is as follows:

$$H = \sum_j \frac{\partial R}{\partial w_j} \frac{w_j}{R}, \qquad (1)$$

where w is the prices of production factors; R is a revenue in the industry in terms of balance: R (z, w) = p'q (p', z), where p' is the result of a decision by the enterprise profit maximization objectives (1), z-exogenous factors. H-stat value reflects the percentage change of enterprise revenue in balance, if the prices of all of the factors of production will increase by 1%.

According to the first Panzar-Rossetheorem, in the case of monopoly H-stat is not positive. In the case of monopolistic competition H-stat value ranges from 0 to 1, and in the case of perfect competition, the second Panzar-Rossetheorem is equal to 1. [21]

The advantage of the approach to measuring degree of monopolization of the market proposed by J. Panzar and J. Rosse is that only one function is a subject to the specification - a function of revenue [22].

In the Panzar-Ross model for analysis of level of competition in the industry and identify the most important factors of development were used the following factor prices on attracted resources in long-term and short-term, manpower and product-related expenses.

Accordingly, to determine the price of attracted resources the values of long-term and short-term borrwingswere used.The division is principal, as long-term borrowingsis a reflection of the ongoing technological and innovative projects at the enterprise.The level of short-term borrowings will determine the nessesity to fill the current shortage of working capital. Furthermore, an indicator reflecting the level of prices on the manpower for machine building enterprises is remuneration. Negotiable assetshad become an indicator reflecting the level of prices for resources associated with the production of the products. Rate negotiable assets, is also an indicator reflecting not only costs, but also features production organization.

Thus, the log-linear function of the equilibrium of revenue for machine building industries will look like the following:

$$InR_i = a + \beta_j In(CA) + \mu_j In(LTB) + \pi_j In(STB) + \rho_j In(R)$$

Where specific revenue - InRi; α, β, π, ρ, μ- parameters to be evaluated-circulating assets, CA – current assets, LTB - long-term borrowings, STB - short-term borrowings, R - remuniration.

With indicators of β, π, ρ, μreflect the elasticity factors of production, i.e. to show earnings growth at 1% of the prices of factors of production.

The Panzar- Roses model allows not only to assess the degree of monopolization of the machine building industries, but also the degree of significance of growth of prices of production factors in the size of revenue.

To build the model the authors selected 4 branches of machine building. The selection was in accordance with the requirements of building mathematical model for volume and quality of sampling and the desire of the authors to show typical machinery industry producing final products of industrial purpose, relevant the majority of industrial enterprises of other branches. Typical industries were selected for mid-size mashinery. When building the model database Spark-Interfax data was used in four branches according toRussian Classification of Types of economic Activity (OKVED) codes. The main characteristics of the industrial formulation presented in table 1.

TABLE I. THE MAIN CHARACTERISTICS OF THE INDUSTRIAL FORMULATION

№	OKVED code	Industry name	Major suppliers (adjacent markets)	Number of companies in the	Major companies in the industry (market share)	Markwet capacity in 2016 $ Bl
1	27.11	Manufacture of electric motors, electric generators and transformers	Metallurgical enterprises, machine building enterprises , mining and processing plants	1014	GC Electroshit-TM, ZAO (CJSC) – 0,05 SVAL Group, AO (JSC) – 0,026 Puskovoy element, AO (JSC) – 0,025	287,088
2	28.12	Manufacture of hydraulic equipment, pneumatic power equipment	Metallurgical enterprises, machine building enterprises, mining and processing plants	74	AKOZNA,AO (JSC) -0,10 CKBM, AO (JSC) -0,096 Camozzi Pnevmatica, OOO (OJSC)– 0,074	51,8
3	28.41	Manufacture of metalworking equipment	Metallurgical enterprises, machine building enterprises, mining and processing plants	835	TyazhPressMash, OAO(OS)– 0,104 Promoil, OOO (OJSC) –0,069 Yamazaki Mazak, OOO (OJSC) – 0,068	23,38
4	28.92	Manufacture of equipment for mining	Metallurgical enterprises, machine building enterprises, mining and processing plants	486	Chtz-uraltrac, OOO (OJSC)– 0,071 Uralmash plant ПАО, 0,062 Komatsu Manufacturing Rus, OOO -0,052	96,248

Geographic boundaries of sectoral markets analyzed machine building industries is the country borders, grocery borders are determined in accordance with OKVED codes,

time borders is the period from 2012 to 2016, which corresponds to the objectives of the research and allows to fully identify existing trends.

Table 2 presents the model building for the studied branches of machine building industries for 2016.

TABLE II. MODEL BUILDING FOR THE BRANCHES OF MACHINE BUILDING INDUSTRIES FOR 2016.

OKVED code	Log-linear function	Number of observations	Coefficient of determination
27.11	ln(y)=7,87+0,52*ln(CA) -0,07*ln(LTB)-0,01*ln(STB)+0,21*ln(R)	45	0,68
28.12	ln(y)=9,05+0,42*ln(CA) +0,20*ln(LTB)+0,04*ln(STB)+0,06*ln(R)	11	0,89
28.41	ln(y)=4,74+1,17*ln(CA) +0,12*ln(LTB)+0,15*ln(STB)+0,04*ln(R)	9	0,68
28.92	ln(y)=6,64+0,63*ln(CA) +0,01*ln(LTBC)+0,04*ln(STB)+0,02*ln(R)	26	0,69

Models of the major statistical tests and generally recognized as operable. Panel data for the five periods were estimated using the method of least squares, with temporary effects have been fixed. In general, the quality of models is high enough, as evidenced by the relatively high value of R2 which is about 0.68.

Estimating H-stat on the branches of machine building industries for five years from 2012 to 2016.is presented in table 3.

TABLE III. INDICATOR H-STAT BY BRANCHES OF MECHANICAL ENGINEERING FOR 2012-2016.

OKVED code	Total value	2012	2013	2014	2015	2016
27.11	0,704	0,7	0,73	0,8	0,65	0,65
28.12	0,89	0,8	0,891	0,89	0,71	0,72
28.41	0,689			0,7	0,97	0,60
28.92	0,71	0,89	0,97	0,85	0,64	0,7

The value of H-stat for the entire period is in the interval from 0 to 1, which corresponds to monopolistic competition.

As part of the study, it is necessary to assess the level of influence of basic production factors on the dynamics of revenue machine-building enterprises in the context of the prevailing market structure.

In Fig. 1. the dynamics of elasticity level of basic production factors in machinery enterprises analyzed industries in 2012-2016.

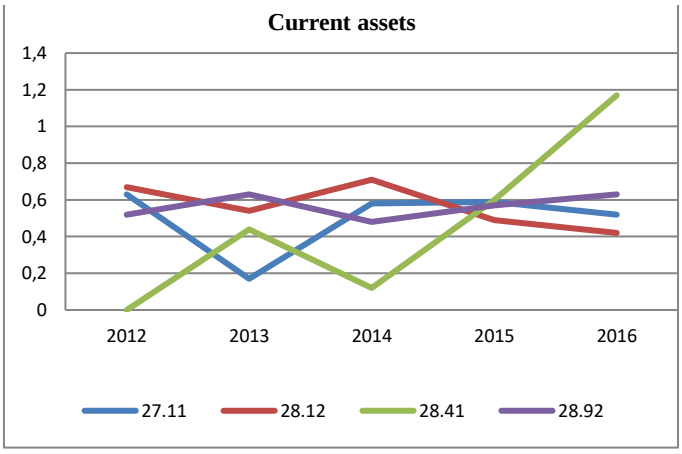

Fig. 1. Dynamics of changes in elasticity of the major productive resources analyzed industries 2012-2016.

The greatest influence on the formation of revenues has change in the prices of basic productive resources, so the value of elasticity of liquid assets will be changing within the range 0.17 to 1.17. Such fluctuations are related to high commodity dependence of the analyzed sectors, lack of established supply chains, crises in related industries.

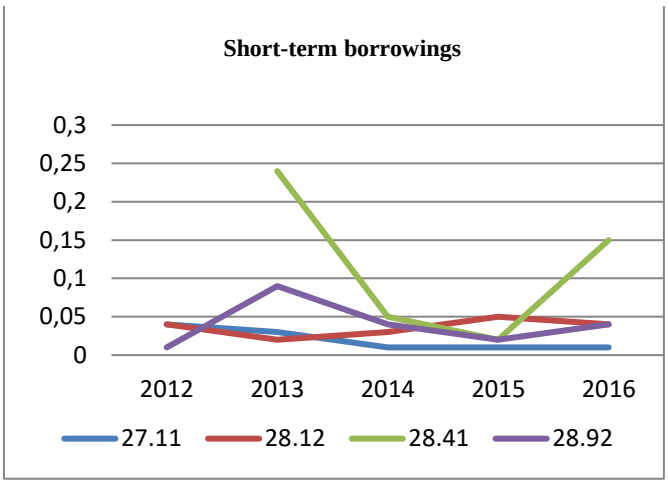

Fig. 2. Dynamics of changes in elasticity of the short-term borrowings of the analyzed sectors with 2012-2016.

The values of the elasticity of the short-term borrowings are in the range 0.01 to 0.24 say little influence of this factor to the rescue of the machine-building enterprises. Fig. 2.

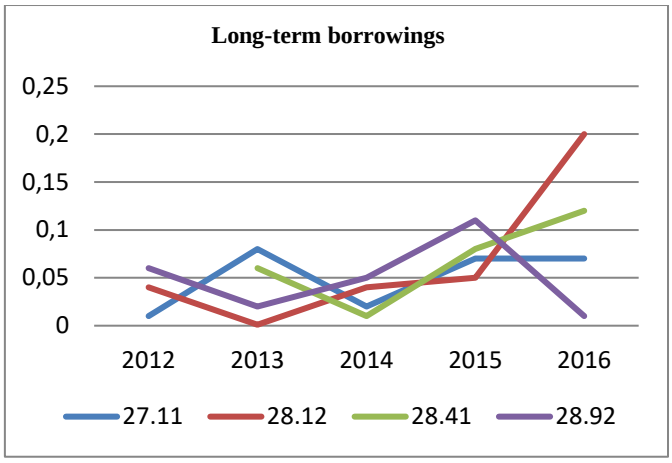

Fig. 3. Dynamics of changes in elasticity of the basic inputs of the analyzed sectors with 2012-2016.

Elasticity of long-term borrowing has low values throughout the period and range from 0.01 to 0.2, which confirms the marginal impact of this factor on the level of earnings of machinery enterprises. Such a tendency inherent in long-term and short-term borrowing, said about the absence of innovative activity in the analyzed sectors. Modernization and innovation projects requiring substantial financial resources aren't conducted. Fig. 3.

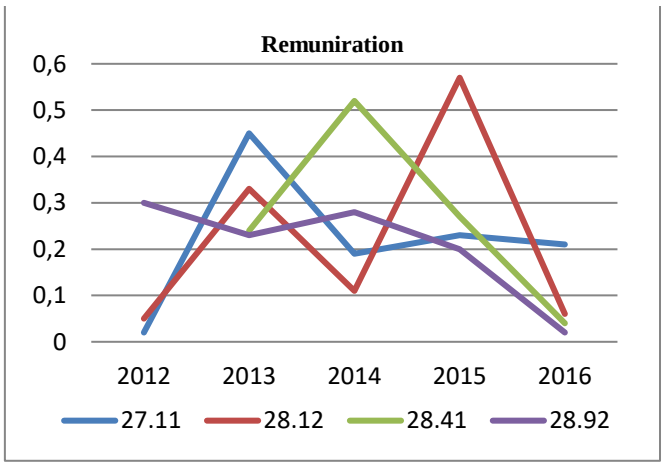

Fig. 4. Dynamics of changes the wage elasticity of the analyzed sectors with 2012-2016.

Elasticity level of remuneration has significant fluctuations as by year and researched branches of machine building. So the maximum value corresponds to elasticity of metal-cutting equipment manufacturing industry in 2015 and is 0.57, and lowest in the same industry, but already in 2016-0.02. Fig. 4. Such variations within the same sector and for such a short period may be associated with the growing crises. And, accordingly, in such circumstances, the personnel costsare optimizedthe first.

IV. INTERPRETATION OF RESULTS AND CONCLUSIONS

The results of the analysis are not unambiguous.
On the one hand, the findings are quite logical.

Indeed, the greatest significance of the factors of production in machine building industry play major productive resources. At the same time, we have witnessed significant fluctuations in the values of the elasticity, which can speak about significant commodity dependence of the industry. At that, for the studied sectors characterized by unstable supply chains, frequent change of suppliers.

The next factor in the volatility of the further development of the industry is the low level of elasticity of use of financial resources. It said the low level of leverage, both in the long run and in the short term. Accordingly, there is no industry modernization of basic production assets and more serious innovative development projects.

Significant fluctuations in the values of the elasticity of wages, also show the low importance of this factor in the sustainable development of the industry. This is connected both with the general institutional conditions of existence and with the low cost of this resource.

Thus, the current state of the industry is characterized by low quality, focus on getting immediate results, lack of strategic and innovative prospects. This state is adaptive behavior of constant tweaking under the macroeconomic and institutional changes and crises. Despite the large number of strategic programmes and scenarios of the development of engineering industry, it depends more on not consistency overall economic policy and the impact of economic crises.

We can say that in the short term for machine building industries the development strategy must be the determinant for further development, focused on optimization, improving the quality, efficiency, management of major productive resources. Exactly these perspective directions of development, could be considered as conditions of adaptation to the demands of the new engineering industrialization.

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