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ANALYSIS OF THE MACHINE-BUILDING SECTOR IN UKRAINE AND GENERATION OF THE FACTOR CHARACTERISTICS FOR THE EVALUATION OF THE ENTERPRISE MANAGEMENT EFFECTIVENESS

Проаналізовано динаміку розвитку машинобудівної галузі в структурі промислового комплексу України. Статистичний аналіз машинобудівного сектору економіки дозволив сформулювати ряд факторів зовнішнього та внутрішнього середовища, що покладені в основу побудови багатofакторної регресійної моделі, які стануть дієвими інструментами при дослідженні ефективності керівництва підприємством.

Ключові слова: машинобудування, керівництво, індекс промислової продукції, зовнішні та внутрішні фактори.

1. Introduction

Machine-building is the main sector of the economy since it provides every production with machines and equipment and the population – with consumer goods. An effective management of the machine-building enterprises influences the economic development of the state, its industrial potential, the pace and extent of scientific and technical achievements implementation, the competitiveness of innovative products in the international markets. Governance is the activity, which permeates the entire management system. Thus, creation of the governance system in the machine-building enterprises is a strategic issue. The research of this problem is very actual because it requires development of new innovative methods of influence, innovative forms of power and innovative styles of leadership for the manager.

2. The object of research and its technological audit

An active development of each industry depends on the perception of its leaders to innovations. However, in the recent years the level of the innovative activity of Ukrainian managers has declined. It is caused by the lack of conditions for conducting effective innovative activity. The managers face financial, political and legal obstacles on the way of the innovation implementation.

The basic condition for achieving long-term positive growth rates of the national economy and the region is an active innovative activity of the enterprises, which is accompanied by effective leadership. Therefore, it is very important to study the issues of management in the machine-building enterprises, in particular in Lviv region, which will result in introducing the advanced forms of the organization of production, continuous developing and improving the means of production, creating principally new machines and equipments.

In the modern conditions of Ukraine's development, the machine-building sector places an important role in accelerating scientific and technological progress. It supplies the national economy with machine-tools, means of transport (ships, diesel locomotives, electric locomotives, carriages, automobiles, aircrafts etc.), agricultural machinery, excavators, generators for power plants, technological equipment for factories and thereby contributes to the development of all sectors of the economy. Manufacturing means of production for different sectors of the economy, the machine-building sector provides complex mechanization and automation of production. The level of the knowledge-intensive machine-building development influences the competitiveness of the economy, the GDP growth and the quality of life in the country. That is why creating new and strengthening actual competitive advantages of this sector provides similar competitive advantages to the whole national economy [1].

3. The aim and objectives of research

The staged sequence of research of the external and internal factors influence on the economic results of the machine-building enterprise are revealed as a result of the initial data analysis. The conducted research will lay in the basis of the numerical model, aimed to evaluate the efficiency of the machine-building enterprise management.

The study of these problems determines setting the following goals:

1. Analysing the main trends of the machine-building sector development in Ukraine.
2. Defining the main causes of negative tendencies in the innovative development of machine-building enterprises.
3. Defining the factors of the machine-building enterprise external and internal environment, which have to form the basis of the multifactorial regression model to analyse the management efficiency.

4. Developing the stages of consistent research of the factor characteristics influence on the economic results of the machine-building enterprise.

4. Literature review

The machine-building complex of Ukraine was investigated by the following Ukrainian scholars [2–8]. These scholars pay their attention mainly to the problems of reproduction of innovations in the machine-building enterprises through implementation of automated systems design [2], use of synergistic benchmarking [3], technical recovery of production funds [4, 5], quality management, accumulation of innovative resources [8], activation of competitiveness on the basis of strategy-oriented management [9], mental measuring of innovation culture, a new type of man – «homo innovaticus» [10–12]. However, the influence of the leader of the machine-building enterprise on its innovative development and the state of the sector in conditions of economic crisis have not been revealed enough. However, the following issues are not revealed enough: the state of the machine-building sector in conditions of the economic crisis; the impact of managers on the innovative development of the enterprise; the factors of the machine-building enterprise external and internal environment.

5. Materials and methods of research

To achieve the aim and objectives of the research, the following scientific methods were used: statistical analysis, econometric modelling, deduction, measurement, generalization, monographic and grapho-analytical methods.

6. Research results

The machine-building sector of Ukraine includes the following segments: manufacture of computers, electronic and optical products, electrical equipment, other machinery and equipment, production of motor vehicles, trailers, semi-trailers and other vehicles. As Ukraine became independent in 1991, machine-building was the leading sector in a structure of the industrial complex with a share of over 30%. Before the start of the financial crisis it was developing at a rapid pace ahead of other sectors (Fig. 1, 2). However, the machine-building sector of Ukraine has been experiencing not the best times in recent years. Decrease of production is observed in all segments. The share of its output in the total volume of industrial products is less than 15%. While this rate is from 25% to 50% for economically developed countries (in Germany, Japan and the United States it is more than 45%, in England, Italy, China and Canada it is more than 30%). Although most machine-building products manufactured in Ukraine are exported, the growth rate of imports of these products is 1,9 times larger, than the growth rate of exports.

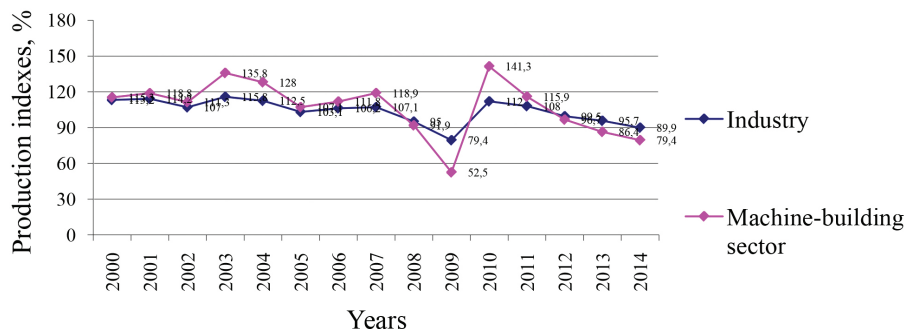


Fig. 1. Industrial production and machine-building production indexes in 2000–2014, %.

Note: calculated by the author according to [13]

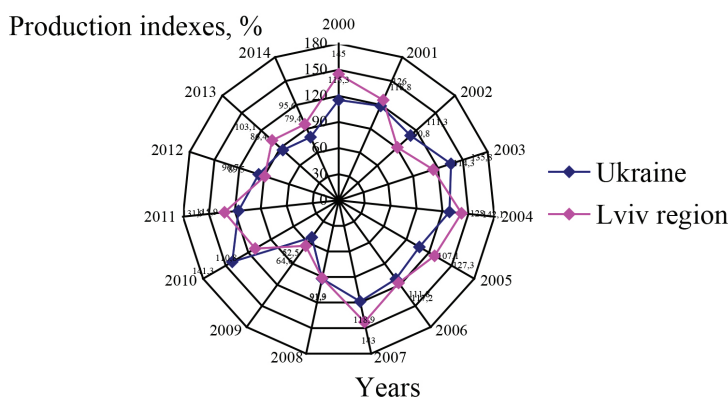


Fig. 2. Machine-building production index in 2000–2014, %.

Note: charted by the author according to [13]

The machine-building sector experienced heavy losses after the financial and economic crisis. The decrease of production in this sector was the most significant. The main reasons are the decline of economic activity in the internal markets; the reduction of sales in the foreign markets, in particular the Russian because of its active policy of import substitution; the lack of investments for the modernization of equipments; the lack of support from the state; inefficient management. So, first of all it is necessary to pay attention to the analysis of the role of a manager in the development of the machine-building sector of Ukraine in the period of crisis. The further economic development of Ukraine depends on the ability of managers to work in crisis.

Analyzing the general industrial production index and the machine-building production index (Fig. 1), we may see mixed trends in the period of 2000–2014. The largest decline of the overall industry production as well as the machine-building production, if compared with the previous year, is observed in 2009 (79,4% and 52,5% respectively). But in 2010 a significant growth in the volume of the machine-building production – by 141,3%, took place. This growth rate was even larger, than the total industrial production growth rate of 112% and it was the largest during the period of 2000–2014. The causes of such ambiguous trends are: first, export-orientation of the machine-building sector of Ukraine (about half of the produced goods are sold in the foreign markets); second, reduction of consumer credits, given to the Ukrainian people, the bulk of which were directed to the purchase of cars. Exports flowed mainly to the CIS countries, which were heavily affected by the global financial crisis. On the other hand, the growth of the machine-building sector in 2010

is connected with the revival of investment demand in the foreign markets and increase of export.

The dynamics of the machine-building production index for Lviv region in 2000–2014 is slightly different from that for Ukraine (Fig. 2). The biggest decline of 64,6 % was observed in 2009, but the growth was experienced in 2000 (145 %), 2007 (143 %) and 2011 (131,9 %).

The problem of the machine-building sector development in Ukraine could be explained by the lack of support from the state, low level of the innovative activity of enterprises, slow development of the machine-building sector segments, poor management, and high level of the shadow economy. Since the development of the machine-building complex of the region and the country depends on the development of individual enterprises, it is necessary to pay attention to their management capacity. The basic indicators of the innovative activity in Ukraine and Lviv region are listed in the Table 1.

In 2014 there were 359 machine-building enterprises in Ukraine and 19 machine-building enterprises in Lviv region which carried out innovative measures – only 3,6 % of all industrial enterprises in the country and 2,4 % of all industrial enterprises in the region respectively (Table 1). The number of machine-building enterprises, in particular innovative-active plants, significantly decreased in 2014

in Ukraine and Lviv region in comparison to the year 2010 (Fig. 3). According to the Fig. 3, the present level of the innovative activity of machine-building enterprises in Ukraine and Lviv region is considerably lower than in 2005. The main causes of these negative tendencies are:

- the imperfect legal framework for regulating the innovative activity;
- the mass privatization and downsizing of the machine-building enterprises;
- no mechanism established to support the innovative activity of the enterprises by the state and the local authorities;
- the lack of effective and adequate national and regional innovation development programs;
- almost total lack of effective institutions, which could coordinate, guide and finance the implementation of innovations;
- the long-lasting decline of the industrial production;
- the shortage of financial resources in domestic enterprises;
- the lack of the adequate systems of innovation management;
- the lack of interest from investors and managers to implement innovations.

Table 1

The basic indicators of the innovative activity in Ukraine and Lviv region

The indicators of the innovative activity	Ukraine			Lviv region		
	2005	2010	2014	2005	2010	2014
Number of industrial enterprises, units	10047	10606	10010	710	716	787
Number of machine-building enterprises, units	1793	1881	1333	94	101	77
Number of innovative-active industrial enterprises, units	1193	1462	1609	44	102	129
Number of innovative-active machine-building enterprises, units	394	417	359	12	19	19
Volum of sales of machine-building enterprises, mln. UAN	59668,1	97056,9	101924,7	1737,7	1958,0	2794,0
Volum of sales of innovative-active machine-building enterprises, mln. UAN	9153,7	10780,4	6904,5	214,9	166,4	38,175
Share of innovative products realizes by machine-building enterprises in the industry, %	18,2	10,5	6,8	14,6	7,2	1,4
Share of machine-building enterprises, which implemented innovations, %	17,0	19,8	23,0	10,6	16,8	19,4
Share of machine-building enterprises, engaged in innovations, %	22,0	22,2	26,9	12,8	18,8	24,7
Total costs of innovative-active machine-building enterprises, mln. UAN	1619,3	2541,6	2267,1	5,225	11,367	18,672

Note: calculated by the author, according to [13]

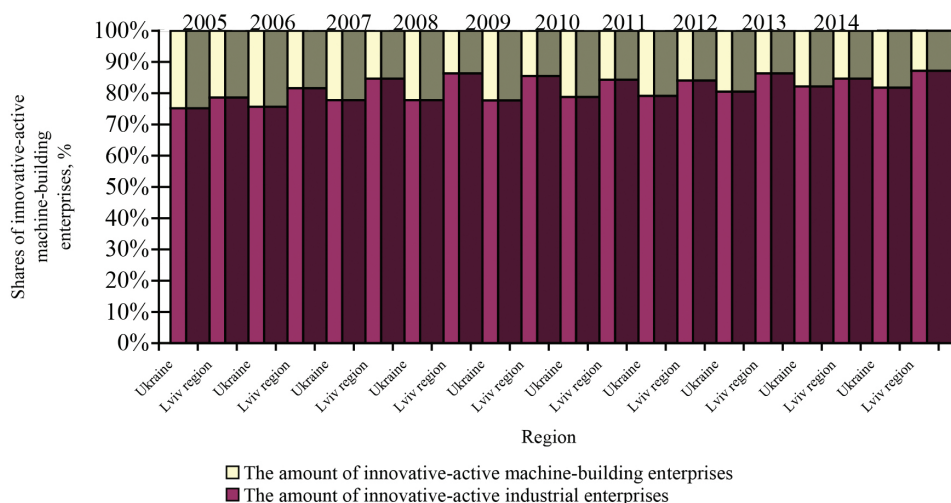


Fig. 3. Shares of innovative-active machine-building enterprises in total amounts of innovative-active industrial enterprises in Ukraine and Lviv region.

Note: charted by the author according to [13]

The purpose of the detailed statistical data analysis is to evaluate the influence of external and internal factors on the results of the economic activity of machine-building enterprises. One of the main indicators here is a volume of sales. The most influential external factors are economic conditions (favourable, unfavourable). The influential internal factors include a number of personnel, a cost of fixed assets and a quality of management. It is advisable to display implicitly the quality of management in machine-building enterprises by a comprehensive indicator of its innovation activity effectiveness. The evaluation methodology is based on the proposed indicators, which characterize the intellectual potential (an indicator of a manager's general level of labor activity (P_l)), the management potential (a rate of scientific, engineering and technical personnel in the total number of employees (P_v)), an educational level index (P_o) and the technological potential (an indicator of products progressiveness (P_p), a technological progressiveness indicator (P_t), an innovation potential indicator (P_h)) of the manager.

For the analysis of the intellectual potential indicator, the criteria defined in scores based on the expert assessments methods are used. The information for carrying out the calculation of the managerial and technological potential is taken from the financial statements, which record all transactions committed by the enterprise. The criteria defined in scores based on expert assessments are used.

The sum of the indexes forms a comprehensive indicator of the innovative activity effectiveness of the manager according to the formula:

$$P_{rez.} = \sum_{i=1}^n P_i \times k_i, \quad (1)$$

where P_i – indicator; k_i – weights for indicators; n – number of indicators.

Using the proposed integrated matrix of the ABC-XYZ-analysis, an assessment of the managerial potential of the innovation-active machine-building enterprises of

Lviv region in 2014 has been carried out. According to the results, the enterprises, whose leaders pay more attention to the development of innovations, are chosen: LLC «Ukrainian-German Joint Venture «Elektrotrans», LLC «Lvivagromashproekt», LLC «Plant Elektronpobutprylad», Ukrainian-German Joint Venture in the form of LCC «International Cutter Manufacturer GmbH», State Enterprise «Pilot plant «Wave».

The results will form the basis for the multifactorial regression model, which is an effective tool to research the efficiency of the machine-building enterprise management:

$$y = f(x_1, x_2, x_3, \dots, x_n) + e, \quad (2)$$

where y – dependent variable; $x_1 \div x_n$ – independent variables; e – random unobserved value.

So the following independent variables are outlined: a number of personnel in the enterprise (L , persons); a cost of fixed assets (K , thousands UAN); a comprehensive indicator of the innovative activity effectiveness of the enterprise manager (R_1 , scores); assessment of the economic conditions for innovative activity (R_2 , coefficients). The qualitative variable «belonging to the group of companies» is reduced to the quantitative form by using a dummy variable d (for innovative-active enterprises $d=1$; for innovation-nonactive enterprise $d=0$). The dependent variable is «volume of sales» (y , thousands UAH).

The stage sequence of research of the external and internal factors influence on the economic results of the machine-building enterprise are presented in the Table 2.

Given different orders of numeric indicators, included in the initial data array (Table 2), it would be necessary to transform them to the normalized values while evaluating the regression models parameters. However, this would complicate the economic interpretation of the results. At the same time the erection of power models to linear forms by taking the logarithm allows us to align numeric variables values in a natural way.

Table 2

The stages of research of the external and internal factors influence on the economic results of a machine-building enterprise

The stages of research	Contents and influential factors	Variables	Type of model	Form of relation
1. Research of the influence of internal factors on the volume of sales (y)	The main factors are: a number of a personnel and a cost of fixed assets. In order to establish an impact of belonging to a certain group of enterprises a characteristic of an enterprise innovativeness is introduced	Independent variables — L, K, d	Multifactorial regression	Power
2. Research of the influence of a time factor on the volume of sales	The influence of a time factor is defined for the period of 2005–2014, as at that time a global economic crisis was observed, which caused decline in the volume of sales	Independent variables — L, K, d, t	Multifactorial regression	Power
3. Research of the influence of internal and external factors on a share of the innovative production sales (u)	The quality of management is reflected in directly by the comprehensive indicator of its innovative activity effectiveness (R_2). Selection of a share (but not amount) of the innovative production sales in a total volume of sales as a dependent variable is caused by the heterogeneity of the enterprises by the characteristic (y)	Independent variables — R_1, R_2	Regression with two factors	Linear
4. Research of the influence of economic conditions for machine-building enterprises innovative activity on the volume of sales dynamics (z_l)	Rates of change in a volume of sales reflect the effect of many factors, in particular economic conditions for the innovative activity of enterprises, which belong to a certain group	Independent variables — d, R_{2l}	Regression with two factors	Linear

Note: proposed by the author

Therefore, in order to eliminate negative tendencies and to activate the innovative development of the machine-building sector the author propose to develop and introduce into practice the norms and measures of improving the innovative activity management, both at the macro level (public administration) and the micro levels (organizational management). This will ensure that the innovative potential of the country, the region, and the machine-building enterprise is used effectively.

7. SWOT-analysis of research results

1. The strength of the conducted research is analysis of the main indicators of innovative activity in Ukraine and Lviv region and identifying the main causes of the negative tendencies in the innovative development of machine-building enterprises.

2. The weakness of the conducted research lies in the difficulties of the data collection and analysis, caused by the structural changes in the machine-building industries during the research period.

3. The opportunities for further research are the following: setting the degree of the external and internal factors influence on the industrial and economic activity results of machine-building enterprises; creating the benchmark for estimation of the economic conditions for the enterprises innovative activity and numerical model construction.

4. The threat for the results of the conducted research is that the development of potentials of the machine-building industries are very different: the automobile industry is affected by the creditworthiness of the banks, the instrument making industry is influenced by the critical situation in the East of Ukraine, heavy engineering industry is affected by the problem of physically and morally outdated equipment. So it is necessary to consider the degree of the external and internal factors influence on the industrial and economic activity results of machine-building enterprises in different industries.

8. Conclusions

1. The research of the machine-building complex in Ukraine in the period of 2000-2014 has been conducted. The results show mixed trends. The volume of production in the machine-building sector reached its critical minimum in 2009 and amounted to 52,5 %. However, in 2010, the amount of production reached its maximum of 141,3 % and was the largest during the period of 2000–2014. The main reason of such ambiguous trends is that the machine-building sector of Ukraine is export-oriented. The export was carried out mainly to the countries of the CIS, which suffered heavily from the global financial crisis. Output increase in 2010 was caused by the investment demand recovery and increasing exports of machine-building products.

2. The main reason of the negative innovative development of the machine-building complex in Ukraine lays in the lack of a proper system of innovative activity management on the macro and micro level.

3. On the basis of the detailed statistical data analysis a number of factors of external and internal environment, which affect industrial and commercial activity results of the machine-building enterprises, are highlighted. Selected results form the basis of the multifactor regression model, which will be an effective tool of research of the machine-enterprise management efficiency.

4. The staged sequence of research of external and internal factors influence on economic results of the machine-building enterprise is proposed.

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ХАРАКТЕРИСТИКА МАШИНОСТРОИТЕЛЬНОГО СЕКТОРА УКРАИНЫ И ФОРМИРОВАНИЕ ФАКТОРНОГО ПОКАЗАТЕЛЯ ДЛЯ АНАЛИЗА ЭФФЕКТИВНОСТИ РУКОВОДСТВА КОМПАНИИ

Проанализирована динамика развития машиностроительной отрасли в структуре промышленного комплекса Украины. Статистический анализ машиностроительного сектора экономики позволил сформировать ряд факторов внешней и внутренней среды, которые положены в основу построения многофакторной регрессионной модели, которые станут действенными инструментами при исследовании эффективности управления предприятием.

Ключевые слова: машиностроение, руководство, индекс промышленной продукции, внешние и внутренние факторы.

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