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MODELS AND METHODS FOR EVALUATING THE EFFECTIVENESS OF USING COMPUTER SOFTWARE FOR ENTERPRISES

Abstract

The Industrial Revolution, which opens up fundamentally new opportunities for organizing production using smart contracts, big data, artificial intelligence, total automation, and so on, leads to the need to review the effectiveness of all the factors translated above.

Keywords: Markov models, machine vision, "smart" production systems, Carin systems, smart contracts.

Introduction

One of the most widespread scientific approaches to the study of economic phenomena is the use of the methodology of economic and mathematical modelling, which allows us to study the properties of economic systems and predict their development based on mathematical models that consider the main features of the systems under study. These properties and advantages of the economic and mathematical modelling toolkit allow us to use it for research and optimization of the processes of implementing "smart" production systems to solve the following tasks: identification and assessment of the impact of information factors, which are the driving forces for the formation of a smart industry; optimization of resource costs by focusing them on the most promising areas from the position of influencing the development of the smart industry; forecasting the development of the economy taking into account the influence of information factors and so on.

Literature review

Based on the generalization of foreign experience in economic and mathematical modeling of "smart" production systems, it is determined that most of the publications

devoted to the formation of the smart industry are either descriptive and introductory or consider this process from an engineering point of view. Publications of economic analysis are not numerous, their conclusions are of an empirical descriptive nature, based on existing observations, and the methodological variety of economic and mathematical models used mainly covers correlation and regression analysis. It is argued that economic and mathematical modeling of "smart" production systems should be carried out by developing well-known models with additional parametrization of specific conditions associated with the institutional features of different countries. Therefore, different parameters for evaluating the effectiveness of models are used for most countries.

Thus, theoretically, by examining the level of use of this information factor in the economy of various countries or in various industries, it is possible to assess the degree of compliance of these economies (industries) with the criteria of smart industrialization, or simply, the degree of their "smartization".Since one of the key trends in the current stage of industrial development is the increasing role of digital information technologies in all aspects of production activities, the justification of management decisions in this area requires an assessment of the criteria for compliance of individual enterprises, entire industries and even countries with the amortization criteria.

Purpose

The purpose of this study is to assess the level of smart industrialization of economies of different countries and individual enterprises.

Methodological approach and discussions

The use of articles substantiates that value added in the processing industry at the present stage of production development, in addition to traditional factors of production, the information factor, or the factor of "smartization" of production, has a significant impact. As traditional factors of production, the use of the number of hours worked in PP (as a factor of "labor") and the cost of machinery and equipment at comparable prices (as a factor of "capital") is justified. It is also proved that the best estimate of the information factor is the cost of computer software and databases in PP at comparable prices.

To assess the impact of the information factor on the PP of these countries, we will build production functions. This requires the use of appropriate indicators, which are currently lacking. According to the results of modeling the production function, the main factor for analyzing the level of amortization is the cost of the cost of bullpen and database. As we can see from one of the articles, this is the most effective analysis. The cost of bullpen' and databases correlates with the complexity and variety of tasks you perform, so this indicator dynamically reflects the increase in the complexity of tasks performed per unit of equipment used, in particular, the intellectualization of the machines used. In addition, this indicator is comparable for different economies and industries, it can be compared in dynamics and used at the micro level to assess the amortization of individual enterprises. The following countries were selected to develop the testing approach: Germany, the Czech Republic and Australia. Germany - as a standard of Information development processes in Europe; the Czech Republic - as an example of a developed country with a special, socialist past; as a developed country remote from Europe. In addition, the choice of countries is related to the availability of the necessary statistics on the cost of bullpen and database, which are presented for an arbitrarily limited number of countries. The cost of bullfinches and databases in Germany and Australia is steadily growing from year to year: for Germany, the increase was 120% (2.2 times), for Australia − 178% (2.78 times). In the Czech Republic, with an overall growth of 136%, growth was not always stable and was observed in 2003-2009 and 2013-2019, while in other periods there was a decrease in this indicator due to the global crisis and the COVID-19 pandemic. To assess the impact of the information factor on the PP of these countries, we will build production functions that include this factor of production along with traditional ones, according to the methodology justified in the work [5].

Based on the previous section, it is proved that the endogenous variable in this study should use value added in the processing industry of countries, namely Germany million. euro, Australia million. Australian dollars and Czech Republic million. CZK in 2021 prices (Y). As exogenous (factors of production):

- cost of computer software and databases in the processing industry, mln. euro, Australian dollars and Czech kronor 2021 (J);
- for Labor: the number of hours worked in the processing industry, million. hour. (L);

- for capital: the cost of machinery and equipment in the processing industry, mln. euro, Australian dollars and Czech kronor in 2021 prices (K).

The direct relationship between these factors and value added, which would not contradict the economic content of the production function, can only manifest itself as a result of the multiplicative effect of the connection of these factors with the growing factor of informatization. In this regard we construct a three factor multiplicative function of the form:

$$Y = a^0 \cdot J^{a^1} \cdot L^{a^2} \cdot K^{a^3} (1)$$

This is an analog of the Koba-Douglas function only for the three – factor case, where Y are the model values of value added in the processing industry; L, K, and J are, respectively, the costs of labor, capital, and informatization factors.

Substituting the obtained coefficients into equations (1, 2, 3), we obtain the following:

$$Y = 0{,}18 \cdot J^{1{,}48} \cdot L^{2{,}2} \cdot K^{-1{,}56} (2)$$

$$Y = 0{,}04 \cdot J^{0{,}97} \cdot L^{0{,}76} \cdot K^{0{,}17} (3)$$

$$Y = 0{,}000\,002 \cdot J^{-0{,}11} \cdot L^{1{,}17} \cdot K^{1{,}37} (4)$$

In all models, the coefficient of determination is greater than 0.86, which indicates the high quality of these models. The values of the F-criterion and P-level indicate the adequacy of the models.

So, after analyzing the A1 coefficient, we have that Australia(-0.11) is the outsider in terms of bullpen and database, and Germany (1.48) is the leader. Based on this model, we can conclude that German enterprises use the most effective computer software program.

Also, do not forget about the disadvantages of this model, namely:

- it is problematic and almost impossible to track the dynamics of the smart industrialization process and compare how much the level of smart industrialization of a particular economy has changed over a short period of time.
- Cobb-Douglas models are macroeconomic [5] and, therefore, are not suitable for studying and comparing individual industries and enterprises.

Conclusion

Analysis of the values of the proposed indicator for the manufacturing industries of Germany, the Czech Republic and Australia allowed us to conclude that among the countries considered, Germany is the leading country in terms of smart industrialization, Australia ranks second, and the Czech Republic lags behind. These data correlate with the available information on the level of development of advanced production in the countries under consideration.

Based on the results of the analysis, we can assume that the most effective bullpen in Germany. So, the most effective models produced in German industrial[6] enterprises, namely:

- models of artificial neural networks for machine vision, mechanical and robotic systems, production automation tasks and intelligent production systems.
- Markov and semi-Markov models, mathematical models of queuing systems theory, Petri nets for describing and automating production processes, creating new equipment, improving technological processes.

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