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FORECASTING THE IMPLEMENTATION OF INNOVATIVE PROCESSES BY FOOD INDUSTRY ENTERPRISES

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Abstract
The article is devoted to the study of the current state and main trends in the implementation of innovative processes at food industry enterprises in Ukraine. The main problems of innovative development are disclosed in the article. The development of food industry enterprises, which were involved in the introduction of innovations in Ukraine, is predicted. The tasks, the solution of which is a necessary prerequisite for the innovative development of the food industry, are outlined. An analysis of the dynamics of the development of the components of innovation processes was carried out. Forecasting of the dynamics of the number of food industry enterprises engaged in the production and sale of products new to the market was carried out. Three variants of predictive scenarios regarding the innovativeness of the Ukrainian economy are analyzed. Trends in the implementation of innovative processes at food industry enterprises are outlined.

Keywords: *Innovative Activity, Innovations, Production, Innovative Development, Innovation Management*.
JEL Codes: *Q16, Q42, O13, J24.*

Introduction

An important and indispensable element for the formation of the competitiveness of food industry enterprises is the introduction of innovations in production, which should become new for the market and for enterprises in particular, which in turn will ensure the successful and sustainable development of the industry.

As you know, innovations are an important tool for improving the production and sales activities of any enterprise, and, accordingly, they contribute to successful development in general, and to lowering the price and improving the production of many types of products, as well as reducing the workload of the company's employees and increasing labor productivity.

As a result, the actualization of this issue is gaining importance, which allows to evaluate and forecast the development of food industry enterprises that were engaged in the implementation of innovations in Ukraine.

Literature review

Carrying out a review of literary sources on this issue, we see a variety of studies on this issue, where extensive empirical research is used to obtain Thus, Spanish scientists of the University of Santiago de Compostela Aibar-Guzmán et al (2022) studying the influence and structure of capital on the financing of eco-innovations at the enterprise. The scientists studied 320 international companies that belong to the food industry and

found out that the majority of small-sized enterprises do not want to implement eco-innovations, unlike large-sized food industry enterprises. Italian researchers Capitanio F. et al. (2022) studying the main factors influencing the effectiveness of the introduction of innovations in the food industry in the country carried out an econometric analysis in the study to determine which among the key factors that have a decisive influence on the implementation of innovations, where it was concluded that the main factors that have the greatest influence are the ability of many companies to build relationships on the basis of marketing. Spanish scientists Sama-Berrocal C. and Corchuelo Martínez-Azúa (2023) studying the influence and relationship between various variables on the innovative efficiency of agri-food cooperatives, came to the conclusion and proposed for use their own conceptual model, which makes it possible to analyze the impact of each factor on the innovative performance of enterprises. Indian scientists Ali et al. (2022) conducted a study based on a survey of 294 Indian food industry enterprises, where scientists using logistic regression came to the conclusion that the introduction of innovations at large enterprises of the food industry already gives a tangible and effective result, while the implementation of innovations in small and medium-sized enterprises of the food industry does not immediately have tangible results, since in many cases they depend on the action of various internal and external factors , which would aim to further improve existing products and establish the production of new products so that small and medium-sized enterprises of the food industry in India occupy an appropriate niche in the market, and can maintain competitive positions by building up their own competitive advantages in the industry. Greek scientists, studying the influence of the main driving forces of innovation on the food industry, used data from 434 enterprises and carried out a factor analysis, where the model was confirmed for reliability, and the scientists came to the conclusion that each of the identified factors, and it is the focus on quality indicators, the focus of the enterprise on knowledge that will contribute to the effective management of innovations at food industry enterprises. Accordingly, this will ultimately prevent the agri-food company from increasing its productivity. In another study by the above-mentioned scientists Kafetzopoulos and Skalkos (2019), a regression analysis was carried out, where data from 436 food industry enterprises were used for calculation. As a result of the regression analysis, a model was developed, according to which the scientists managed to find out that those enterprises that carried out innovative developments to improve the quality of products achieved significant results and, accordingly, received certain results from the implementation of financial and economic activities. In a joint comprehensive study, Canadian and British scientists conducted a survey of food industry enterprises in Great Britain, where their calculations were based on the types of innovations studied at food industry enterprises. Thus, scientists, having applied a questionnaire survey and having analyzed 221 respondents' answers, came to the conclusion that food industry enterprises are more likely to introduce innovations in the products they manufacture, and also to implement certain innovative processes at the enterprise. Thus, food industry enterprises in Great Britain, according to the authors, see their mission and strategy in forming innovative ideas in employees, the implementation of which will ensure the successful development of enterprises in this industry in the country (Baregheh, A. et al., 2012).

Danish researchers Karantininis et al. (2009), using the results of a survey conducted in 444 food industry enterprises, tried to assess the impact and role of vertical integration in the industry on the level of innovation implementation. Accordingly, using the Poisson regression model, they concluded that the level of innovative behavior of food industry enterprises in Denmark is significantly influenced by the level of vertical integration of these enterprises, on the one hand, and on the other hand, the ability to build contractual relationships with many partners.

Scientists from New Zealand Sanaullah Khan R. et al. (2009), in collaboration with researchers from Canada and the UK, conducted a comparative analysis between two types of food industry enterprises, namely those that develop new food products and those that do not. These researchers conducted a quantitative survey of enterprises engaged in the production of food

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products in New Zealand, where the main criteria for conducting an empirical study were chosen as orientation towards the development of new products, promotion of innovative processes at the enterprise and commercialization of scientific developments. As a result, it was found that companies that develop new food products have obvious advantages over those that do not engage in these processes in production. Thus, according to the authors, small and medium-sized food industry enterprises in New Zealand should develop cooperation focused on the implementation of innovative research in this industry, which will improve the state of enterprises in the country as a whole.

Professor of the Agricultural University of Athens Chryssochoidis (2014). conducted a study on food industry enterprises, where he conducted calculations in the context of 44 enterprises. Based on the conducted surveys of enterprise managers, the author of the study identified three key elements for the implementation of innovative processes in companies: the use of new raw materials, new equipment, new management tools at enterprises. The results of the study show an interesting trend that the growth of innovative activity at enterprises is primarily associated with the implementation of innovative processes in companies that are engaged in the development of new types of products at food industry enterprises. Chryssochoidis' study on food industry enterprises is important for managers, as it provides an opportunity to implement research results in a practical context.

Brazilian scientists Oliveira et al. (2019) conducting diagnostics of the development of food industry enterprises to study the innovative potential of food industry companies conducted a study based on 120 food industry enterprises, where, based on empirical calculations, the authors based on partial least squares analysis formed results on the impact of innovations on the level of efficiency of food industry enterprises. The results show that the main factors that influence the innovative activity of food industry enterprises are characteristic of those enterprises that are trying to constantly develop in the market. Thus, the authors of the study in the article point out the importance of implementing innovations for enterprises and, based on the efforts they have made, outline the main directions of development of food industry enterprises in the future.

Interesting are the studies of Italian scientists who, studying the main trends in the development of the food industry (Matricano et al., 2022), believe that an important aspect for its development in Italy is investing in research and development. Thus, the authors selected 108 innovative startups and conducted a statistical marginal analysis, which showed that investments in research and development activities for startups in the food industry give a positive result and, accordingly, increase the competitiveness of enterprises in this industry.

In another study, Italian scientists from the University of Foggia Muscio et al. (2010) in collaboration with a scientist from the University of Adelaide in Austria interviewed managers of 87 food industry enterprises, where based on the interviews, scientists identified 285 needs of enterprises that require innovative solutions. What is most interesting in this study is that food industry enterprises understand which sectors they need to direct innovations to, but are not always ready to implement technological innovations, which does not allow to significantly improve the quality of production processes.

Belgian scientists from Ghent University Lefebvre et al. (2015) conducted a survey on the basis of 214 food industry enterprises, scientists accordingly used a binary logistic regression model. The results obtained confirm an interesting trend: cooperation with customers is important for obtaining new innovative products, cooperation with competitors is important for implementing organizational innovations. Thus, in this article, for the first time, the authors consider market and organizational innovations, which have not been considered in detail in economic scientific journals until now.

Italian scientists from the Institute for Research on Innovation and Services for Development De Martino and Magnotti (2018) conducted a survey of 122 small and medium-sized enterprises related to the food industry in Italy to determine their innovative capacity. Using cluster analysis, scientists studied food industry enterprises in Italy, which in turn were divided into three groups of clusters: group 1: innovative enterprises that cooperate, group 2: innovative

enterprises that do not cooperate, and group 3: food industry enterprises that do not innovate at all. The results of the study showed the following results: despite the small number of enterprises in the first group (16.2 percent), business entities in this group show stable revenue growth compared to the other two groups of clusters.

An interesting comprehensive study by researchers from Belgium, Ireland and the UK Avermaete et al. (2004), who surveyed 177 food industry enterprises located in rural areas of the EU countries, is interesting. Using multiple regression, the researchers concluded that the driving factor that has a significant impact on innovation is the level of educational qualifications of employees, investments in know-how, and others.

Thus, an in-depth review of the literature is strong evidence that the introduction of innovations by companies into production enables the growth of their profitability and competitiveness for both small and medium-sized food industry enterprises.

Methodical approach

The theoretical and methodological basis was the provisions of modern theories of economic development, strategic management, entrepreneurship development, scientific works of domestic and foreign scientists, which made it possible to investigate the implementation of innovative processes at food industry enterprises. The article uses such research methods as: generalization, systematization, dialectical cognition, synthesis, analysis, grouping.

The autoregressive and integrated moving average (ARIMA) method was used to forecast the dynamic series (Box, G. E. P., et al., 2015). This method makes it possible to take into account the previous features of the dynamic series, in particular, the presence of a seasonal component. Processing of primary data was carried out using the STATISTICA program and the "Time Series Analysis and Forecasting" module of this program. This program allows you to calculate the upper and lower limits with a given probability of 0.9. This, in turn, makes it possible to determine risk in forecasting. Since the dynamic series did not meet the criterion of stationarity (the presence of autocorrelation), it was decided to transform them by extracting the trend. During further forecasting, to return the primary data values, the trends function was added to the forecast values. When evaluating the ARIMA model for each dynamic series, the following parameters were determined:

$$y_t = c + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \cdots + \beta_p y_{t-p} + \varepsilon_t + a_1 \varepsilon_{t-1} + \cdots + a_q \varepsilon_{t-q}$$

yt- observation.

βi - coefficients representing the deviation from the annual average level in quarter i.

q - dummy (binary) variables for quarters.

εt - random component.

Research results

Let's consider the dynamics of enterprises that produced new innovative products.

At the same time, two groups of innovative enterprises are distinguished: the first of them is those enterprises that produced fundamentally new products for the market, and the second group is enterprises that produced new products for themselves. The conducted analysis made it possible to establish that in 2007 the total number of such enterprises was equal to 2467, while 65 produced fundamentally new products for the market, and 198 new products at their own production facilities. Then this number gradually increased, reaching the maximum in 2013 - 281 enterprises, but of them 33 - new products, and 261 enterprises under their own production1 program. After that, the number of these enterprises began to fall, reaching a minimum of 115 enterprises in 2019, of which only 30 produced fundamentally new products. In 2020, the total number increased slightly to 142, but the number of enterprises that produced new products (Kuznetsova, M. (edit.) et al., 2021).

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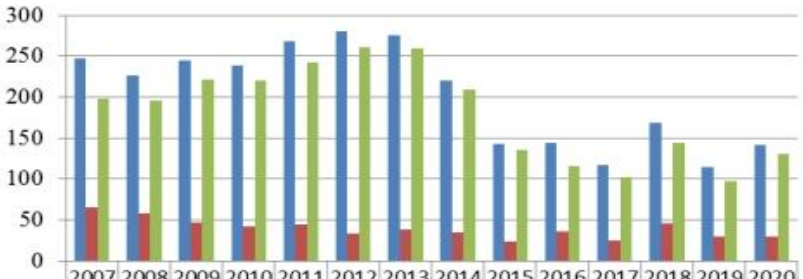


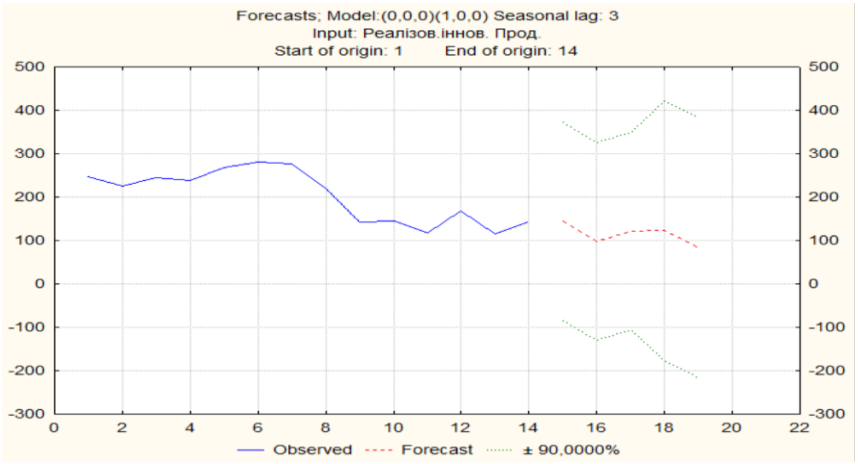
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
The total number of enterprises that implemented innovative products - total	247	226	245	239	268	281	276	220	143	144	117	169	115	142
New innovative products for the marke, the number of enterprises	65	58	47	42	44	33	38	35	23	36	25	46	30	30
New innovative products for the enterprise, number of enterprises	198	196	221	220	242	261	260	209	135	116	102	144	97	130

Figure1. Dynamics of food industry enterprises that produced innovative products in general, new for enterprises, and new for the market in 2007-2020

So, in this case, our forecast referred to the period 2021-2025. Of course, this forecast did not include the military aggression of the Russian Federation in 2022, which significantly affected the socio-economic development of Ukraine. We assumed that the trends that existed during the peace years would continue in the next five-year period. From our point of view, this makes real sense, since military actions must end one way or another, and the trends that existed before the war can continue in one way or another, albeit under a different situation.

Based on the above considerations, we decided to make this forecast. For this, the ARIMA function and the STATISTIKA 12.0 program were used. A forecast was made and it was established that, according to the main scenario, a non-linear nature of the dynamics of the number of food industry enterprises that produced and sold innovative products is possible.

We also analyzed the dynamics of the development of another component of innovation processes, namely the total number of enterprises that implemented innovative products.



Input: Реалізов.іннов. Прод. (Інновації)
Transformations: none
Model:(0,0,0)(1,0,0) Seasonal lag: 3 MS Residual= 16599,

Paramet.	Param.	Asympt. Std.Err.	Asympt. t(13)	p	Lower 95% Conf	Upper 95% Conf
Ps(1)	0,851487	0,179281	4,749452	0,000380	0,464174	1,238800

Figure 2. Dynamics of actual and forecast data on the total number of food industry enterprises that implemented innovative products in 2010-2025

In this case, we had a situation for the fourteen-year period we studied, namely: a gradual decline in the number of agro-industrial complex enterprises that were engaged in the production and sale of innovative products.

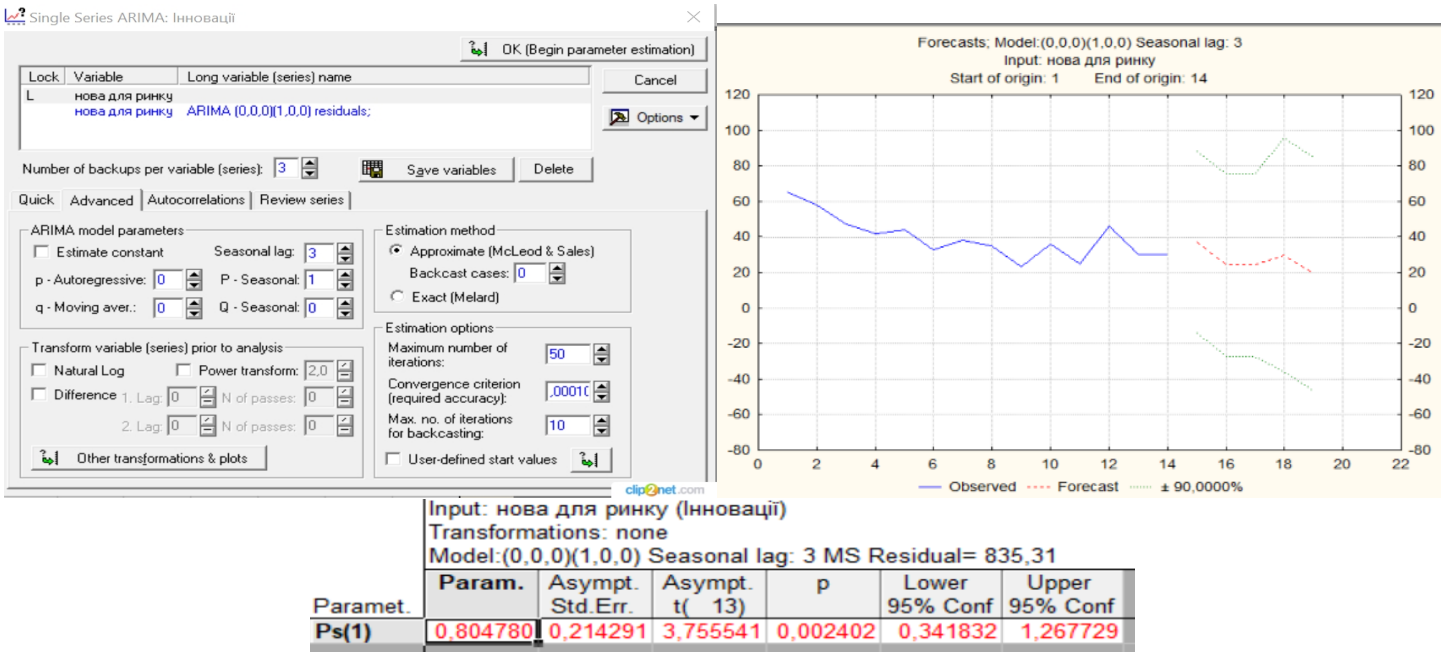
Their largest number was noted in 2012 – 281 enterprises, after that the stage of decreasing the number of these enterprises to the level of 115 units began. in 2019 with further growth to 142 units in 2020.

Our forecast for 2021-2025 shows that it was possible to develop a scenario in which the number of food industry enterprises decreased even more in 2021 (to 43.9 units) with a subsequent drop to 120.9 units. in 2023 and with further reduction to 83.4 units. in 2025.

Finally, the second indicator that characterizes the level of innovative processes in the economy of Ukraine is the number of Ukrainian food industry enterprises that produced and sold innovative food industry products that are new to the market.

We decided to forecast the dynamics of the number of food industry enterprises that were engaged in the production and sale of products new to the market based on data from 2007-2020.

At the same time, this dynamic series was characterized by a gradual decrease in the number of enterprises that were engaged in the production of new innovative products on the market.



Input: нова для ринку (Інновації)
Transformations: none
Model:(0,0,0)(1,0,0) Seasonal lag: 3 MS Residual= 835,31

Paramet.	Param.	Asympt. Std.Err.	Asympt. t(13)	p	Lower 95% Conf	Upper 95% Conf
Ps(1)	0,804780	0,214291	3,755541	0,002402	0,341832	1,267729

Figure 3. Dynamics of actual and forecast data on the total number of food industry enterprises that implemented innovative products new to the market in 2010-2025

So, if the number of enterprises engaged in production in 2007 was 65 enterprises, then in 2015 - 25 enterprises, and in 2020 - 30 enterprises.

In general, it should be noted that this may be evidence that the innovativeness of the Ukrainian economy is low and characterized by a further decrease.

Thus, according to the forecasting results, their number could reach 29.8 food industry enterprises in 2024, and in 2025 it should decrease to 19.4 enterprises.

Such results are also a confirmation that the innovative environment in Ukraine is very unstable and is still in a stage of stagnation. In turn, this requires the state to radically change the state policy regarding economic freedoms and the development of entrepreneurship.

This is a very negative scenario of the possible development of events, taking into account previous trends, which may indicate a general crisis with the development of innovations in Ukraine.

Finally, the third indicator that characterizes the level of innovative processes in the economy of Ukraine is the number of enterprises of the food industry of Ukraine, which

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produced new innovative products for agribusiness enterprises.

In this case, the trend was also similar for the previous two indicators. The largest number of new products occurred in 2012-2013. Then their number was equal to 260 units, respectively. After that, a rapid reduction of agro-industrial complex enterprises, which produced new innovative products for the enterprise to the level of 98 units, began. in 2019 and a slight increase in 2020 to 130.

Figure 4. Dynamics of actual and forecast data on the total number of food industry enterprises that implemented innovative products new to the enterprise in 2010-2025

Accordingly, taking into account these trends, a forecast was made that made it possible to predict that a situation was possible when the number of food industry enterprises engaged in the production and sale of innovative products new for the enterprise will decrease in 2021 to 122.5 units. with further growth to 110.7 units. in 2023 and up to 71 units. in 2025.

Conclusions

So, all three variants of the forecast scenarios turned out to be extremely negative regarding the innovativeness of the Ukrainian economy. In addition, this study does not take into account the factor of the full-scale war of the Russian Federation on the territory of Ukraine, that is, active military operations, which in turn destroy the industrial infrastructure in the southeastern region of Ukraine, and therefore many enterprises relocated their enterprises and employees to the western part of the country to avoid further more catastrophic consequences of war.

Thus, the continuation of the war and the destruction of civil infrastructure does not always give an opportunity to fulfill predictive expectations, since military actions are unpredictable, which, accordingly, can worsen the real state of affairs even more.

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