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IMPLEMENTATION OF ECONOMETRIC APPROACH TO DETERMINATION OF PROSPECTIVE DIRECTIONS IN THE DEVELOPMENT OF LOCAL MARKETS OF CROP PRODUCTS

The article considers the main development trends for the local markets of crop products. Methodological approaches are proposed on the application of econometric methods to identify prospective directions for their development. Factor indicators were systematized based on the analysis of linkages between the indicators of the state and development of local food markets. Multifactor equations of complex econometric models are formalized for key strategic local markets of crop products.

Keywords: *local markets; crop production; econometric approach; forecasting.*

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РЕАЛІЗАЦІЯ ЕКОНОМЕТРИЧНОГО ПІДХОДУ ДО ВИЗНАЧЕННЯ ПЕРСПЕКТИВНИХ НАПРЯМКІВ РОЗВИТКУ ЛОКАЛЬНИХ РИНКІВ РОСЛИННИЦЬКОЇ ПРОДУКЦІЇ

У статті розглянуто основні тенденції розвитку локальних ринків рослинницької продукції. Наведено методичні підходи до застосування економетричних методів визначення перспективних напрямків розвитку цих ринків. На основі аналізу взаємозв'язків показників стану і розвитку локальних продуктових ринків проведено систематизацію факторних показників. Формалізовано багатофакторні рівняння комплексних економетричних моделей для основних стратегічних локальних ринків рослинницької продукції.

Ключові слова: *локальні ринки; рослинництво; економетричний підхід; прогнозування.*
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РЕАЛИЗАЦИЯ ЭКОНОМЕТРИЧЕСКОГО ПОДХОДА К ОПРЕДЕЛЕНИЮ ПЕРСПЕКТИВНЫХ НАПРАВЛЕНИЙ РАЗВИТИЯ ЛОКАЛЬНЫХ РЫНКОВ ПРОДУКЦИИ РАСТЕНИЕВОДСТВА

В статье рассмотрены основные тенденции развития локальных рынков продукции растениеводства. Представлены методические подходы к применению эконометрических методов для определения перспективных направлений развития этих рынков. На основе анализа взаимосвязей показателей состояния и развития локальных продуктовых рынков проведена систематизация факторных показателей. Формализованы многофакторные уравнения комплексных эконометрических моделей для основных стратегических локальных рынков продукции растениеводства.

Ключевые слова: *локальные рынки; растениеводство; эконометрический подход; прогнозирование.*

Problem setting. Sustainable development of local markets under uncertainty and high risks requires science-based methods of modelling and forecasting with the

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use of formalized instruments for identification of the main objective laws of development and basic trends which would enable taking into account impartially the current economic conditions and changes at the market (Buzdalov, 2009; Bobryshev, 2014; Vasilieva and Urbanovych, 2011). In this regard the increasing importance of scenario forecasting of local market systems is conditioned by global transformations of external conditions state regulation of market structures, further integration of these systems with other localities, including those beyond the agrarian sector (Krylatykh, 2013; StSAU, 2010; Sklyarov and Sklyarova, 2013).

Latest research and publications analysis. Conceptual aspects of modelling and forecasting of local markets development which emerged through transformations are reflected in the papers of such authors: A. Altukhov (2009), M. Vasilieva (2012), T. Gurnovich et al. (2013), E. Krylatykh (2006), I. Sklyarov et al. (2010), N. Telnova (2012), O. Shatalova (2012), A. Gerasimov et al. (2014) and others. Specific aspects in forecasting of development of branches and markets of agroindustrial complex are investigated by the following authors: L. Agarkova et al. (2013), A. Gladilin et al. (2011), A. Gerasimov et al. (2013), O. Uglitskikh and J. Klishina (2013), T. Yarkova (2013) and others.

The research objective is to validate the theoretical and methodological framework for an econometric approach implementation to determine the prospective development directions at local markets of crop products; build a model of the state of local market of crops products using the example of regions-constituent entities of the North Caucasus Federal District (NCFD).

Key research findings. Indepth study of the local markets development for crops products in today's Russia implies validation of special approach and development of specific methods adopted for the solution of a number of particular issues. A study of any economic processes requires using mathematic methods and models as efficient tools for managerial solutions, validation of summary and conclusions, strategic planning and development of a system of practical activities (Krylatykh, 2006; Gerasimov et al., 2013). Any formal models are eventually aimed at achieving quite real goals:

- validation of forecasted development of the process under study;
- identification of near-, mid- and long-term development prospects;
- correction of previous forecasts, improvement of modelling methods and scenario forecasting.

Econometric approach to modelling and forecasting of local markets development under study eventually allows selecting the best option of managerial solutions and ensures the efficiency of proposed activities. At the same time synthesis of econometric models enables getting quantitative estimations of the impact of factors within the process under study, and thus it facilitates more consistent evaluation and increases forecasts accuracy (Gladilin et. al, 2011a; 2011b).

The above approach to modelling and forecasting of the key parameters of the state and development of local markets under study intends to resolve the following research tasks:

- setting the task of economic and mathematical research, justification of the necessity of development and using a complex econometric model;

- formalization of the system of resultant and factor indicators of the model;
- building the source data base of the research: establishment of units and period of monitoring;
- specification of equations for the complex econometric model dependence per local markets under study;
- using step-by-step procedures for selection of essential factor variables for each equation in the system;
- parameterization of econometric equations of the system through using special methods for parameters evaluation according to the level of complex model identification, evaluation of their practical importance;
- using statistically significant econometric models forecasting values of endogenous variables which characterize the state of local markets, all that enables developing proper qualitative forecasts;
- specification of trend models for point estimation of forecasted values of factor variables chosen for using in equations of appropriate system for each of the monitored objects;
- calculation of confidence limits of the forecast representing optimistic and worse-case scenarios of forecasted changes of parameter values;
- calculation of generalizing value of forecasted estimation of resultant indicators of the system being an aggregated result for all monitored objects;
- analysis of the obtained results of modelling and scenario forecasting of parameters under study for elaboration of a set of activities intended to stimulate further development of markets under study.

Application of econometric models enables better understanding of the processes and phenomena, which helps formulating impartial conclusions based on obtained results and for more accurate forecasts of necessary parameters. Thus, econometric approach allows choosing the best option for making a managerial decision which ensures better efficiency of activities to be implemented within the region.

Within the mentioned approach to modelling of key parameters of local markets conditions and development, it's expedient to apply complex econometric models, which take into account the character and trends in the relationships between the subsystems of the parameters applied for quantitative and qualitative assessments of the given processes. One of the paramount goals in the specification of complex econometric models of the state and development of local markets of crop products is the formalization of the system of resultant and factor variables included into the equations.

The system of resultant and factor variables for building complex econometric models of the conditions and development of local markets of crop products should include the groups of endogenous variables where the values of variables are to be determined inside the model, and groups of exogenous variables which are external variables towards the model. Values of exogenous variables are to be determined outside the model, so they are considered as fixed values.

As the research objective is to determine prospective directions of local markets development based on the study of objective trends, we suppose the following groups of endogenous variables to be distinguished:

- group of endogenous variables characterizing production of main types of crop products: Y_{11} – the total yield of grain crops, ths tons; Y_{12} – the total yield of sugar beet, ths tons; Y_{13} – the total yield of vegetables, tons; Y_{14} – the total yield of sunflower, ths tons;

- group of exogenous variables characterizing crop products sales at local markets: Y_{21} – sold grain crops, tons; Y_{22} – sold sugar beet, tons; Y_{23} – sold vegetables, tons; Y_{24} – sold sunflower, tons;

- group of endogenous variables characterizing the consumption of crop products and derived crop products: Y_{31} – consumption of bread and bakery products per capita, kg; Y_{32} – consumption of sugar per capita, kg; Y_{33} – consumption of vegetables per capita, kg; Y_{34} – consumption of vegetable oil per capita, kg.

The following parameters of socioeconomic development of the markets under study were used as exogenous variables for building a complex econometric model, and they can be grouped as follows:

Group I – General social parameters of territories' development: X_1 – population (at the end of the year), people; X_2 – natural increase rate, ‰; X_3 – population engaged in economic activity, ths people; X_4 – population engaged in agricultural production, people; X_5 – employment level, %; X_6 – average monthly nominal wage paid to an employee engaged in economic activity, RUB.

Group II – General economic development parameters of agricultural products markets: X_7 – average annual value of fixed assets, mln RUB; X_8 – fixed investment, mln RUB; X_9 – price index of industrial producers; X_{10} – share of agriculture in the gross regional product, mln RUB; X_{11} – accounts receivable-payable ratio; X_{12} – depreciation of fixed assets in agriculture; X_{13} – price index of agricultural producers.

Group III – Parameters of agricultural production volumes: X_{14} – planted areas of grain crops, ths ha; X_{15} – planted areas of sugar beet, ha; X_{16} – planted areas of vegetables, ths ha; X_{17} – planted areas of sunflower, ths ha; X_{18} – cattle stock, ths head; X_{19} – pig stock, ths head; X_{20} – stock of sheep and goats, ths head; X_{21} – poultry stock, mln head.

Group IV – Parameters of production intensity at local markets: X_{22} – yield capacity of grain crops, c/ha; X_{23} – yield capacity of sugar beet, c/ha; X_{24} – yield capacity of vegetables, c/ha; X_{25} – yield capacity of sunflower, c/ha.

Group V – Parameters of production efficiency and sales at markets of agricultural products: X_{26} – production costs of 1 centner of grain crops, RUB; X_{27} – production costs of 1 centner of sunflower, RUB; X_{28} – production costs of 1 centner of sugar beet, RUB; X_{29} – production costs of 1 centner of vegetables, RUB; X_{30} – average current prices of grain crops, RUB/t; X_{31} – average current prices of sunflower, RUB/t; X_{32} – average current prices of vegetables, RUB/t; X_{33} – average current prices of sugar beet, RUB/t; X_{34} – break-even level of grain crops (including subsidies and compensations), %; X_{35} – break-even level of sunflower (including subsidies and compensations), %; X_{36} – break-even level of vegetables (including subsidies and

compensations), %; X_{37} – break-even level of sugar beet (including subsidies and compensations), %.

Analysis of current situation at local markets of crop products, assessment of the level of food supply for population, and well-grounded system of resultant and factor variables of complex econometric model enabled proposing a structural-logical scheme of linkages and dependencies of the groups of endogenous variables of production (Y_{11}–Y_{14}), sales (Y_{21}–Y_{24}) and processing (Y_{31}–Y_{34}) of crop products at local markets and main groups of exogenous variables with account of earlier research results (Figure 1).

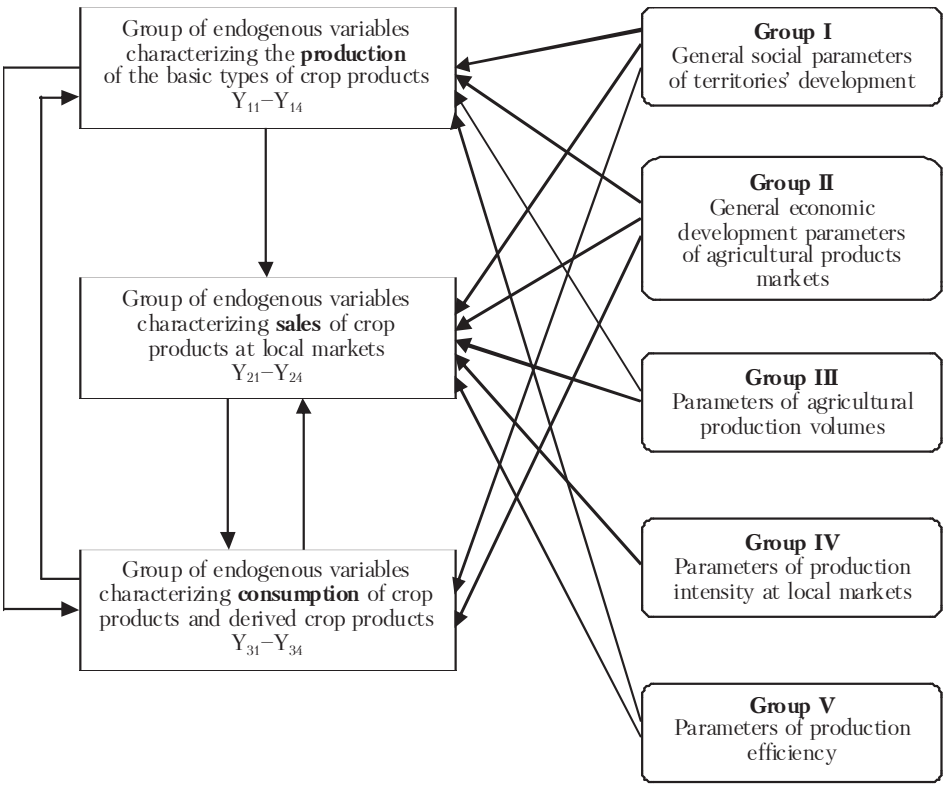

Figure 1. **Structural logical scheme of linkages between parameter groups of the conditions and development of the local markets under study,** *developed by the authors*

Analysis of linkages between the distinguished groups of parameters of the conditions and development of local food markets, as well as the systematization of factor values per groups of structural logical scheme allowed formalizing in general the multifactor equations of complex econometric models for appropriate local markets of crop products. The presented dependencies should be considered in the form of multiple linear regression equations, as further that will facilitate the interpretation of the obtained results.

To specify the current and forecasted levels of food supply at specific territories we propose to use balanced identities (β_1–β_4 – specific balance of food supply security of appropriate local markets) in the complex econometric models for appropriate local markets:

- market of grain and bread products: $\beta_1 = 1000 \times k_1 \times Y_{21} : X_1 - Y_{31}$;
- market of beet sugar: $\beta_2 = 1000 \times k_2 \times Y_{22} : X_1 - Y_{32}$;
- market of vegetables: $\beta_3 = 1000 \times Y_{23} : X_1 - Y_{33}$;
- market of vegetable oil and fat: $\beta_4 = 1000 \times k_3 \times Y_{24} : X_1 - Y_{34}$,

where k_1–k_3 – are the correction factors characterizing the average output of appropriate products after processing agricultural raw materials.

So, if $\beta_i < 0$, then local market is an import-based market, if $\beta_i = 0$ – that is a self-sustainable local market, if $\beta_i > 0$ – then local market is an export-based local market.

Thus, complex econometric models which characterize the processes of production, marketing and consumption of main types of crop products within appropriate local markets can be presented as follows:

- regional market of vegetable oil and fat through the example of production, marketing and processing of sunflower seeds

$$\begin{cases} Y_{14} = a_{40} + a_{41}X_4 + a_{42}X_7 + a_{43}X_8 + a_{44}X_9 + a_{45}X_{12} + a_{46}X_{14} + a_{47}X_{15} + a_{48}X_{16} + \\ \quad + a_{49}X_{17} + a_{410}X_{27} + a_{411}X_{35} + \alpha_{41}Y_{34}; \\ Y_{24} = a_{80} + a_{81}X_3 + a_{82}X_9 + a_{83}X_{11} + a_{84}X_{18} + a_{85}X_{19} + a_{86}X_{20} + a_{87}X_{21} + a_{88}X_{25} + \\ \quad + a_{89}X_{31} + \alpha_{81}Y_{14} + \alpha_{82}Y_{34}; \\ Y_{34} = a_{120} + a_{121}X_1 + a_{122}X_2 + a_{123}X_5 + a_{124}X_6 + a_{125}X_{10} + a_{126}X_{13} + \alpha_{121}Y_{14} + \alpha_{122}Y_{24}; \\ \beta_4 = 1000 \times k_3 \times_{24} : X_1 - Y_{34}. \end{cases} \quad (1)$$

Models representing production, marketing and consumption of other local markets of crop products under study are built similarly.

In the models of production, consumption and marketing of main types of products of local market of crop products the endogenous variables in one type of dependencies act as resultant values, and in others, being on the right hand side of the equation, they act as factor values which influence the variation of other endogenous variables. Such approach enables representing diversified character and reveal trends in interdependences of conditions changing for some types of products of regional market on others.

In accordance with standard practice of econometric modeling it's necessary to select stepwise the essential factor variables in each equation of the system for the improvement of their practical relevance. At initial stage of forming the system of parameters, the system comprised all possible conditions of local markets of crop products performance. However, the key objective of building complex econometric models is not so much the assessment of relations between all distinguished parameters (strongly or weakly linked with resultant values) as modelling of processes and phenomena under study depending on the most essential factors which have dominant impact on endogenous variables.

Setting parameters of the presented regression dependencies is expedient to be performed basing on the systems of simultaneous equations (structural form of complex econometric model) which should be set up separately for each of the local markets under consideration.

Thus, for studying the interdependencies of main processes of local market of oil and fat products in the North Caucasus Federal District the following system of econometric equations was set up:

$$\begin{cases} \hat{\hat{Y}}_{14} = 4.397 + 0.000326X_8 - 0.115X_{12} + 0.148X_{14} + 0.002798X_{15} + \\ \quad + 0.000948X_{16} + 0.00426X_{17} - 0.0627\hat{Y}_{34}; \\ \quad (R^2 = 0.584;\ \hat{S} = 6.071;\ \mathrm{F} = 136.569;\ \mathrm{Sig.} = 0{,}000) \\ \hat{\hat{Y}}_{24} = -17.194 - 36.093X_3 + 29.286X_{19} + 2.125X_{21} + 0.0466X_{31} + 591.517\hat{Y}_{14}; \\ \quad (R^2 = 0.679;\ \hat{S} = 3313.98;\ \mathrm{F} = 288.925;\ \mathrm{Sig.} = 0{,}000) \\ \hat{\hat{Y}}_{34} = 8.359 + 0.0000013X_1 - 0.144X_2 - 0.0166X_5 + 0.000257X_6 + \\ \quad + 0.000584X_{10} + 0.135\hat{Y}_{14}; \\ \quad (R^2 = 0.714;\ \hat{S} = 1.846;\ \mathrm{F} = 283.318;\ \mathrm{Sig.} = 0{,}000) \\ \beta_4 = 510 \times \hat{\hat{Y}}_{24} : X_1 - \hat{\hat{Y}}_{34}. \end{cases} \quad (2)$$

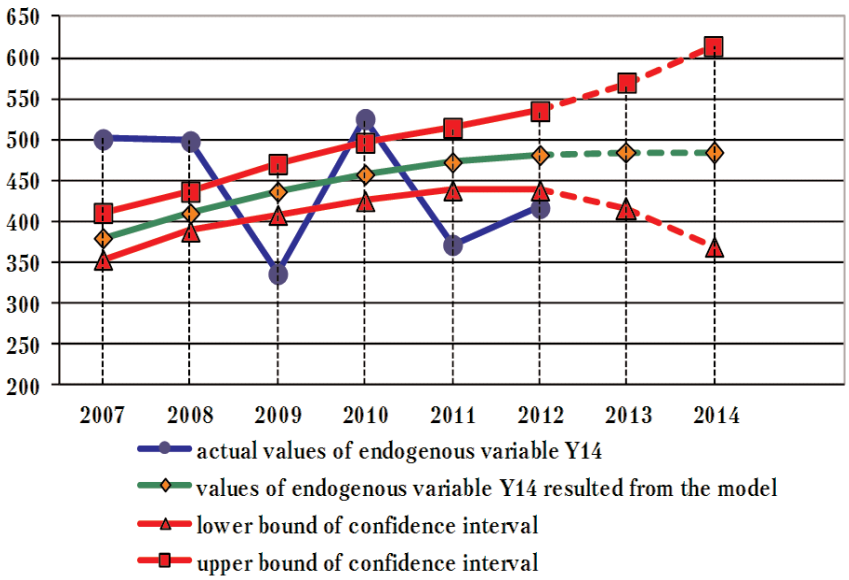

Figure 2. **Results of adaptive forecasting of the total yield of sunflower seeds ($\hat{\hat{Y}}_{14}$) in the NCFD,** *based on the authors' calculations*

In general, all the models built at this stage $\hat{\hat{Y}}_{14}, \hat{\hat{Y}}_{24}, \hat{\hat{Y}}_{34}$ should be considered as maximum significant as the significance value of F-criterion (Sig.) which represents the error probability $p \le 0.001$. At this stage the largest value of the multiple deter-

mination coefficient was for the equation $\hat{\hat{Y}}_{34}$, in accordance with that equation the consumption volumes of oil and fat products in the North Caucasus Federal District are by 71.4% determined by variation of such factors as population, natural increase rate, population employment level, average monthly nominal wage, volume of agriculture in the gross regional product, the total yield of sunflower.

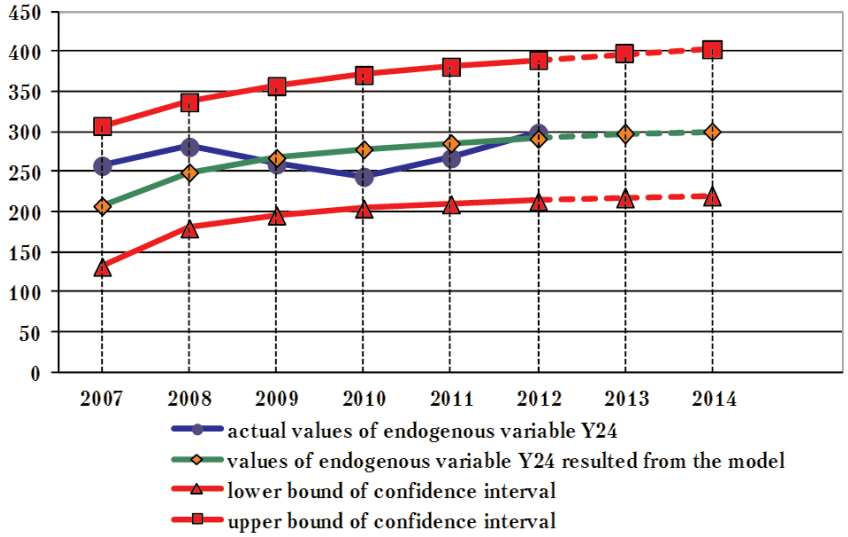

Figure 3. **Results of adaptive forecasting of marketing of sunflower seeds** $(\hat{\hat{Y}}_{24})$ **in the NCFD,** *ths tons, based on the authors' calculations*

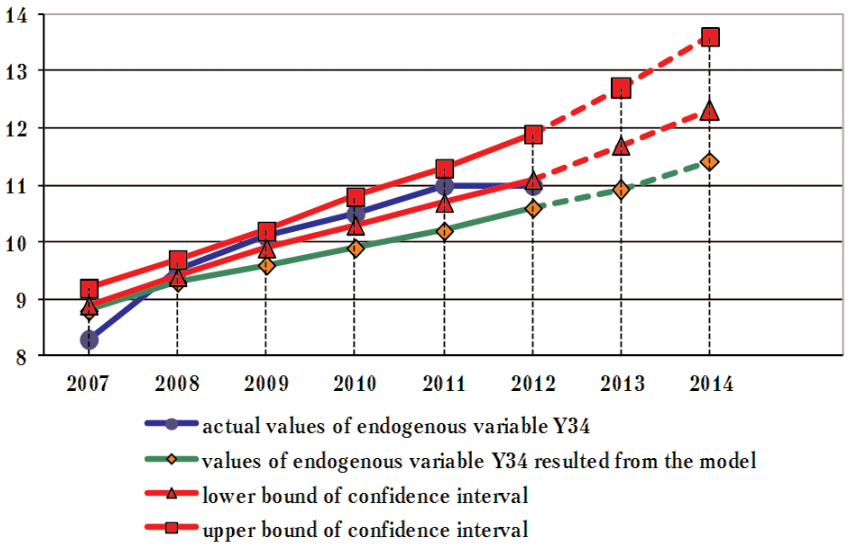

Figure 4. **Results of adaptive forecasting of the consumption level of vegetable oil per capita** $(\hat{\hat{Y}}_{34})$ **in the NCFD,** *based on the authors' calculations*

Synthesized systems of coupled equations allow using the obtained results in forecasting production volumes, sunflower seeds sales and consumption of their

derivative products in the region. The results of adoptive forecasting of endogenous variables in the developed system of econometric equations on production, marketing of sunflower seeds and consumption of their derivative products by population in the North Caucasus Federal District (NCFD) are shown in Figures 2–5.

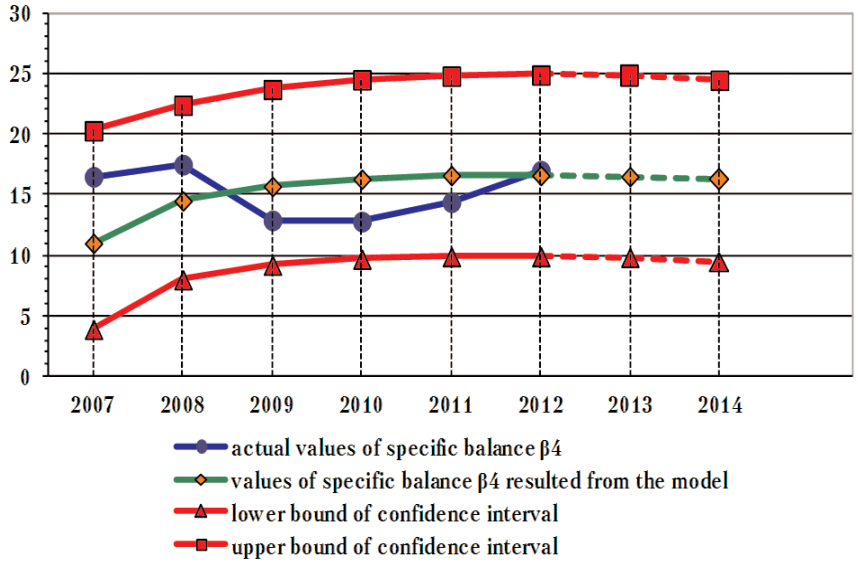

Figure 5. **Results of adaptive forecasting of the specific balance of food security at the local market of sunflower seeds and their derivative products β_4 in the NCFD,** *based on the authors' calculations*

Study of laws and development trends at local markets of crop products in the NCFD should be added with similar studies in the regions which are leaders in the production, vendibility and consumption levels of corresponding types of crop products.

Conclusions. Implementation of econometric approach in the determination of prospective directions of local crop product markets development resulted in the elaboration of methods for building complex econometric models of the abovementioned markets aimed at system verification of indicative parameters of the state and development of the objects under study. Approbation of these methods towards food complexes of the regions-constituent entities of the NCFD enabled adjusting considerably the existing scientific concepts of sustainable development of local crop product markets, and enabled determining the levels of food security of the regions-constituent entities of the NCFD taking into consideration the indicators of investments, production, processing and consumption of priority products in this sphere.

Within the forecasted scenarios of local crop products markets development in the NCFD we have provided adaptive forecasting of endogenous variables of the system of econometric equations set up for the processes of production, marketing and consumption of the mentioned products, which allows determining rational forms of economic behavior of professional participants at crop products markets for appropriate state institutions, and to calculate the levels for state support within their development strategies to be implemented.

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