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MODELING THE UKRAINE BLACK SEA ECONOMIC REGION GRP DEPENDENCE ON SOCIO-ECONOMIC INDICATORS

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Представлено результати моделювання соціально-економічних явищ та екологічних процесів системного характеру на прикладі півдня України в умовах неповноти інформації. Сконструйована та реалізована типова інформаційна технологія комп'ютерного моніторингу стану складних процесів різного рівня.

Ключові слова: індуктивне моделювання, ітераційні алгоритми, метод групового урахування аргументів, МГУА, узагальнений ітераційний алгоритм, інформаційні технології, ВРП, соціально-економічні явища та процеси.

This paper presents the results of simulation socio-economic and ecological processes on example of the southern Ukraine under conditions of incomplete information. Construction and implementation of the information technology computer monitoring model of the complex processes state at various levels

Keywords: Inductive modeling, iterative algorithm, GMDH, generalized iterative algorithm, information technologies, GRP, socio-economic processes.

Представлены результаты моделирования социально-экономических явлений и экологических процессов системного характера на примере юга Украины в условиях неполноты информации. Сконструированная и реализована типовая информационная технология компьютерного мониторинга состояния сложных процессов разного уровня.

Ключевые слова: индуктивное моделирование, итерационные алгоритмы, метод группового учета аргументов, МГУА, обобщенный итерационный алгоритм, информационные технологии, ВРП, социально-экономические явления и процессы.

Introduction

Each region of Ukraine have its own peculiarities and differences in socio-economic development that are associated with a spatial basis, presence of minerals, availability human resources and so on. State regional policy aims to provide the necessary balance between individual regions by encouraging the most advanced straightening and implementation mechanisms to overcome economic and social problems of weak regions. This policy should encourage the integration processes in society, to resist risk increasing regional disparities.

Creating favorable conditions for sustainable and uniform regional development is one of the most important tasks of regional development, which includes: structural and technological changes in the economy, the development of small towns and reduce inter-regional gap in socio-economic development.

At the regional level summary measure that reflects the level of economic development of the region is the gross regional product, i.e. GRP, is one of several measures of the size of its economy. GRP is defined as the market value of all final goods and services produced area in a given period of time.

Paper presents results of simulation Ukraine's Black Sea economic region GRP, which occupies the territory of Odessa, Nikolaev, Kherson regions and the Autonomous Republic Crimea, located in the southern and south-western parts of Ukraine, dependence on socio-economic indicators using generalized iterative algorithm GMDH. According to the simulation results will be determined informative parameters of socio-economic development, which affect the dynamics of the region's GRP.

1. The generalized iterative algorithm

Let us briefly consider the iterative structure of algorithm used for solving the general problem of search for a better model under such formulation:

$$f^* = \arg\min_{f\in\Phi} CR(y, f(X,\hat{\theta}_f)), \tag{1}$$

where $\hat{\theta}_f$ is an estimation of parameters for any partial model f∈Φ , CR is a model quality criterion for selection of optimal model.

The set Φ of models being compared can be formed by various generators of model structures of diverse complexities. All structure generators developed within the GMDH framework naturally divided into two main groups – sorting-out and iterative ones which differ by techniques of variants generation and organization of search of a given criterion minimum. For simulation will be used the generalized iterative algorithm, GIA GMDH, fig.1 [1].

Formally, in the general case for layer *r* define the GIA GMDH as follows:

1) the input matrix is $X_{r+1} = (y_1^r,..., y_F^r, x_1,\ldots,x_m)$,

2) apply the operators:

$$y_l^{r+1} = f(y_i^r, y_j^r),\ l = 1,2,\ldots,C_F^2,\quad i,j = \overline{1,F} \tag{2}$$

and

$$y_l^{r+1} = f(y_i^r, x_j), l = 1,2,\ldots, Fm, i = \overline{1,F},\ j = \overline{1,m} \tag{3}$$

with a quadratic partial description

$$\begin{gathered} z = f(u,v) = a_0 + a_1 u + a_2 v; \\ z = f(u,v) = a_0 + a_1 u + a_2 v + a_3 uv; \\ z = f(u,v) = a_0 + a_1 u + a_2 v + a_3 uv + a_4 u^2 + a_5 v^2 . \end{gathered} \tag{4}$$

3) for each description is the optimal structure (an example for the linear partial description):

$$f(u,v) = a_0 d_1 + a_1 d_2 u + a_2 d_3 v , \tag{5}$$

where $d_k, k = 1,2,3$, $d_k = \{0, 1\}$ are structural elements of the binary vector $d = (d_1\, d_2\, d_3)$ taking values 1 or 0 (inclusion or not a relevant argument). Then the best model will describe: $f(u,v,d_{opt})$, where

$$d_{opt} = \arg\min_{l=\overline{1,q}} CR_l,\ q = 2^p - 1,\ f_{opt}(u,v) = f(u,v,d_{opt}) \qquad (6)$$

4) the algorithm stops when the condition $CR^r > CR^{r-1}$ is checked, where CR^r, CR^{r-1} are criterion values for the best models of (r–1)-th and r-th layers respectively. If the condition holds, then stop, otherwise jump to the next layer.

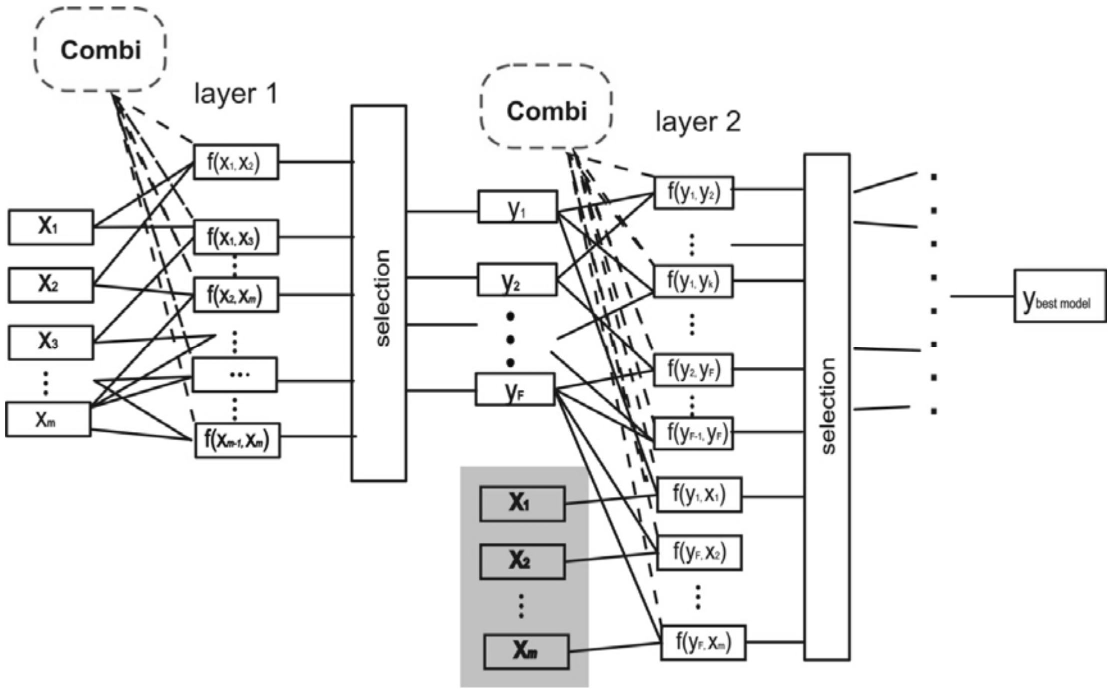


Fig.1. The generalized iterative algorithm schema

Define the GIA GMDH as many iterative and iterative combinatorial algorithms, described by vector of three elements DM (Dialogue Mode), IC (Iterative-Combinatorial), MR (Multilayered-Relaxative), ie any iterative algorithm is defined as a special case of a generalized: GIA (DM, IC, MR). This is possible with the help of specialized program complex of modeling based on iterative algorithms group method of data handling, which implemented the following features: automatic and interactive options for organization of user interface, management through the web interface, ensuring multiaccess. Constructed best model are presented by system for the graphic and semantic analysis, determined the effect of the arguments on the target factor, as well as analyzes and selects the most informative arguments [2]. Generalized specialized program complex schema is present on fig.2.

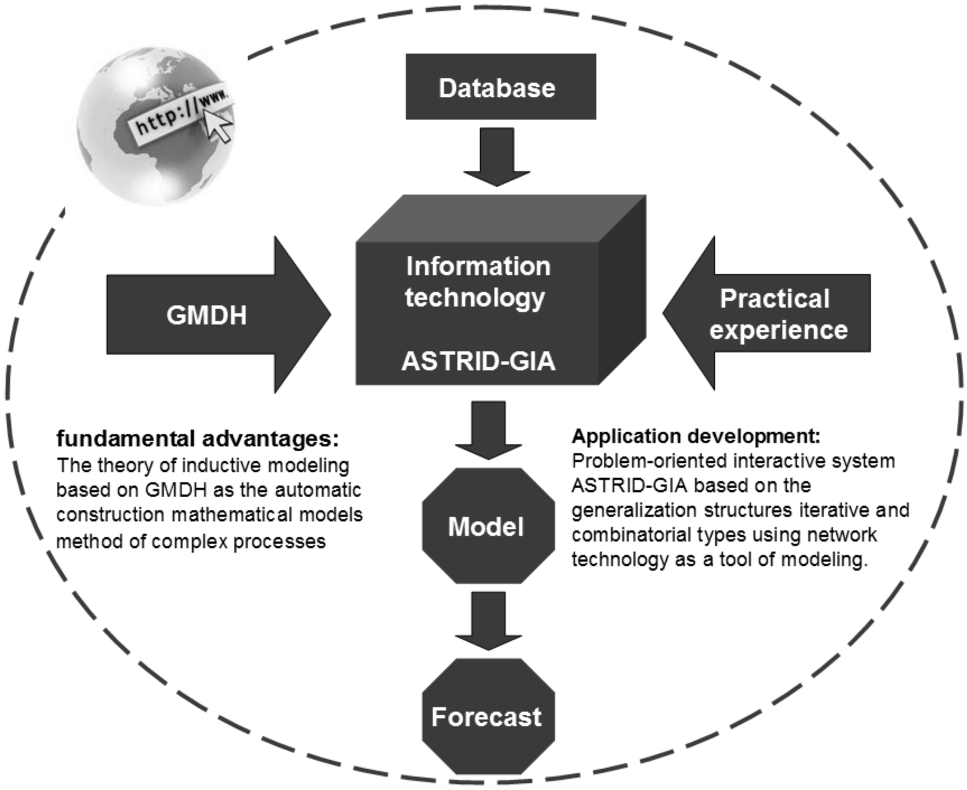


Fig.2. Generalized specialized program complex schema

2. Results of the economical process modeling

To identify the dependence of GRP growth (mln.) on the volume of socio-economic indicators were taken into account

Industry:

x_1 – Indices of industrial production, in% to previous year;

Production of major animal products:

x_2 – Meat production in all categories of farms;

x_3 – Milk production;

x_4 – wool production;

x_5 – eggs production;

Production of main agricultural crops:

x_6 – grains and legumes;

x_7 – sunflower seeds;

x_8 – potatoes;

x_9 – vegetables;

x_{10} – fruit and berries;

Fishing industry

x_{11} – fishing extraction and other aquatic resources;

Investment and construction activities:

x_{12} – commissioning housing;

Transport:

x_{13} – departure (transportation) of cargo;
x_{14} – departure (transportation) of passengers;
Foreign trade:
x_{15} – export goods and services;
x_{16} – import goods and services;
Internal trade:
x_{17} – retail turnover;
Job Market:
x_{18} – unemployment Rate;
x_{19} – the average monthly salary;
x_{20} – arrears of wages;

Data were taken on the State Statistics Committee [3-6].

Statistical sample of Ukraine's Black Sea economic region (fig.3) for the period from 2004 (1 quarter) to 2011 (4 quarter) contains totally 20 variables and 32 points and is divided into three parts: training A (20 points), testing B (8 points}, and examination C (4 points, 2011 year) sub-samples.

Fig.3. Ukraine's Black Sea economic region

Tab.1 and fig.4-7 shows result of modeling GRP values.

Table 1.

Result of modeling GRP values

Region	*AR*	Model accuracy	Model
AR Crimea	7,261	99	$y = 8000{,}79 - 0{,}0025x_2 - 0{,}0618x_6 + 0{,}067x_8 + 0{,}0489x_{10} - 0{,}000017x_{11} + 0{,}0048x_{12} - 23{,}939x_{14} + 0{,}000354x_{15} + 1{,}87x_{17} - 0{,}000056x_{18} + 5{,}693x_{19} + 0{,}000054x_{20}$
Mykolaiv region	0,787	99	$y = 1697{,}10 + 0{,}0306x_3 - 0{,}01315x_7 - 0{,}00549x_{11} + 1{,}815x_{12} - 0{,}00023x_{13} + 0{,}000027x_{16} + 0{,}00026x_{17} + 9{,}284x_{19} + 0{,}022x_{12}^2 + 24 * 10^{-10} x_{17}^2$
Kherson region	202,01	87	$y = -538{,}59 + 1{,}1376x_4 + 0{,}063x_6 + 8{,}228x_{19} + 0{,}000037x_7^2$
Odessa region	189.23	90	$y = -18548{,}99 - 0{,}00407x_7 + 0{,}541x_9 + 17{,}83x_{15} + 35{,}868x_{19} - 0{,}00014x_{15}x_9 - 0{,}0093x_{15}x_{19} - 0{,}000606x_{10}^2$

The accuracy of obtained models was calculated using the formula for coefficient of determination:

$$R^2 = \frac{\sum_{i=1}^{n}\left(\hat{y}_i - \overline{y}\right)^2}{\sum_{i=1}^{n}\left(y_i - \overline{y}\right)^2} 100\%, \qquad (7)$$

where $\overline{y}$ is the average value, $\hat{y}_i$ is the model output.

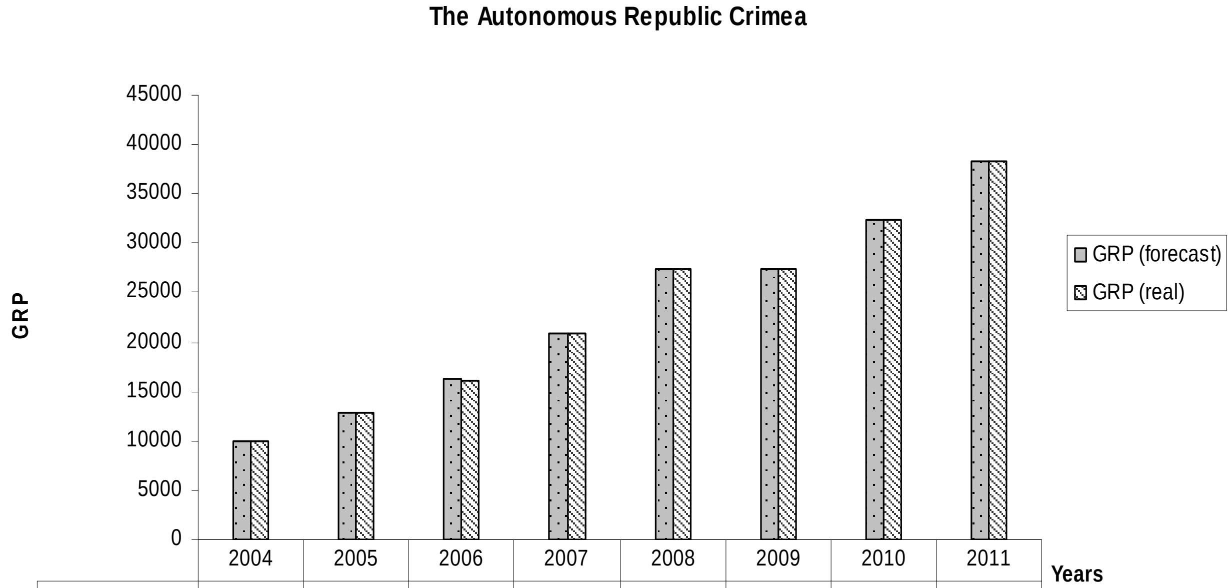
As the obtained dependence shows

- for AR Crimea among all the 20 investment indicators only 12 of them have the most significant effect on GRP: meat production in all categories of farms; grains and legumes; potatoes; fruit and berries; fishing extraction and other aquatic resources; commissioning housing; departure (transportation) of passengers; export goods and services; retail turnover; unemployment Rate; the average monthly salary; arrears of wages;

- for Mykolaiv region among all the 20 investment indicators only 8 of them have the most significant effect on GDP: milk production; sunflower seeds; fishing extraction and other aquatic resources; commissioning housing; departure (transportation) of cargo; import goods and services; retail turnover; the average monthly salary;

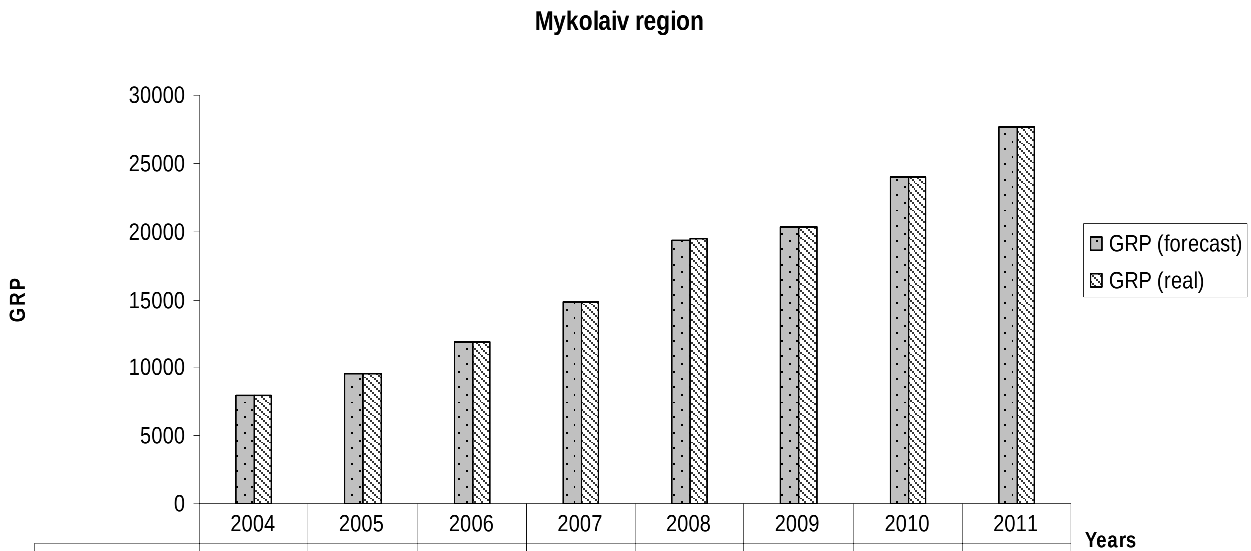
- for Kherson region among all the 20 investment indicators only 4 of them have the most significant effect on GDP: wool production; grains and legumes; the average monthly salary; sunflower seeds;

- for Odessa region among all the 20 investment indicators only 5 of them have the most significant effect on GDP: sunflower seeds; vegetables; export goods and services; the average monthly salary; fruit and berries;



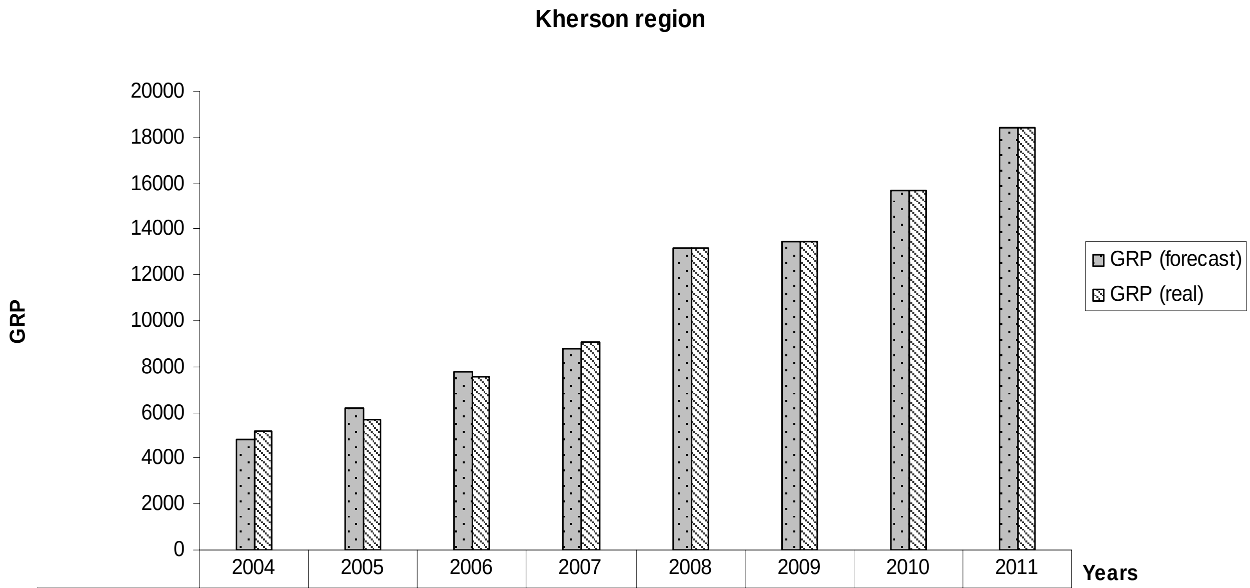
	2004	2005	2006	2007	2008	2009	2010	2011
GRP (forecast)	9903	12736	16238	20790	27366	27395	32425	38222
GRP (real)	9901	12848	16044	20874	27365	27396	32426	38220

Fig.4. Result of modeling GRP AR Crimea values, on years



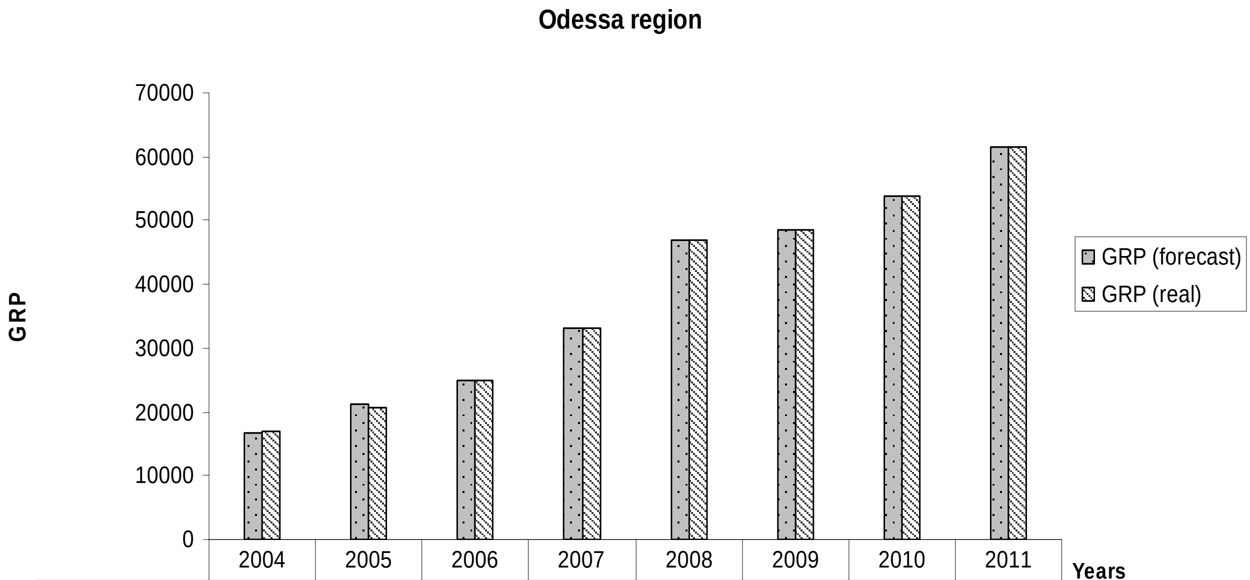
	2004	2005	2006	2007	2008	2009	2010	2011
GRP (forecast)	7924	9565	11866	14756	19389	20319	24031	27627
GRP (real)	7934	9553	11876	14767	19410	20336	24055	27663

Fig.5. Result of modeling GRP Mykolaiv region values, on years



	2004	2005	2006	2007	2008	2009	2010	2011
GRP (forecast)	4847	6183	7745	8749	13176	13433	15671	18446
GRP (real)	5200	5713	7565	9034	13174	13436	15649	18448

Fig.6. Result of modeling GRP Kherson region values, on years



	2004	2005	2006	2007	2008	2009	2010	2011
GRP (forecast)	16601	21177	24926	33253	46852	48639	53869	61509
GRP (real)	17029	20762	24898	33116	46994	48647	53878	61499

Fig.7. Result of modeling GRP Odessa region values, on years

Results of experiments show that features industry growth in industrial production resulted in its regional differentiation. Thus, the priority sector of the Black Sea Economic Region is the food industry and processing of agricultural products. These conclusions may serve as a basis for further study of the effect of uneven level and pace of economic development of the region for non-linear nature of the economy of Ukraine in general

3. Conclusion

Was solved task of simulation Ukraine's Black Sea economic region GRP dependence on socio-economic indicators using generalized iterative algorithm GMDH and program complex. According to the simulation results were determined informative parameters of socio-economic development, which affect the dynamics of the region's GRP. For solve this task was used the generalized iterative GMDH algorithm based on hybridization of iterative and combinatorial schemes and use of on-line technologies is newly developed for building of complex system models in the polynomial class.

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