Таблиця 2

Динаміка непрямих податків з імпортних операцій

Показники	7 міс. 2014 р. (факт.)	7 міс. 2015 р. (факт.)	Темпи зростання, %
ПДВ із увезених товарів, млрд грн	53,8	74,0	137,5
Акциз із увезених товарів, млрд грн	7,9	12,9	163,3
Мито ввізне, млрд грн	6,4	19,4	303,0

Джерело [2]

Висновки з даного дослідження і перспективи подальших розвідок у даному напрямку. За суттєвих змін в економіці уряд за допомогою нових правових норм підсилює фіскальну ефективність непрямих податків. Складність таких процесів обумовлена впливом різних об'єктивно-суб'єктивних чинників, особливо загостренням основної фіскальної суперечності між необхідністю та можливістю забезпечення достатніх податкових надходжень.

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UDC 330.43

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METHODICAL APPROACH TO STATISTICAL ANALYSIS OF FORCED INTERREGIONAL MIGRATION

The article deals with statistical research of the structure and dynamics of changes in the number of internally displaced persons, defined irregularity of distribution of social assistance payments in Dnipropetrovsk region. The mathematical model and predictions of number of displaced persons in two periods have been developed.

Key words: *internal migration; mathematical model; statistical research; dynamic range; prediction.*

Проведено статистичне дослідження структури та динаміки змін чисельності вимушено переміщених осіб, визначено нерівномірність розподілу виплат соціальної допомоги по Дніпропетровській області. Розроблено математичну модель і проведено прогнозування чисельності переміщених осіб на два періоди.

Ключові слова: *вимушена міграція; математична модель; статистичний аналіз; динамічний ряд; прогнозування*.

Problem formulation. The research problem of number, dynamics of changes and nature of structure of forced interregional migration takes a special place among existing economic, social and political challenges in our country.

The relevance of this issue is related with necessity of adoption of management decisions by local government, state-owned enterprises (SOEs) and non-governmental organization (NGOs). A scientific validity is necessary condition for such decisions. Therefore, the use of statistical methods of research allows to analyze the phenomenon and to make predictions by building an analytical model.

Analysis of recent researches and publications. Currently, the problem of internally displaced persons is especially actual. Thus, M. Bludova [1] in her work paid attention to the need for attracting foreign investments for the purpose of creation of new workplaces, E. Libanova [2], I. Nikolaichuk [3] analyzed the problems associated with mass migration and the possible solutions of them. Practical recommendations for fields of activity were worked out at the International scientific-practical conference [4].

However, a sufficient number of statistical studies that would become the basis for theoretical foundation for management decisions has not taken place.

Purpose of the article – to research the structure and dynamics of the number of forced interregional migration between regions Ukraine; to make a prediction of future changes, applying third-order polynomial approximation; to research a concentration of internally displaced persons' social payments by cities of Dnipropetrovsk region, using a graphical method of calculating income distribution: the Lorenz Curve and the Gini Coefficient.

Main material. All calculations are real, conducted on the basis of official data. To characterize the change of internally displaced persons' number consider the structure in the following groups: working age population, children, pensioners, invalids. The diagrams clearly show up changes (fig. 1–3).

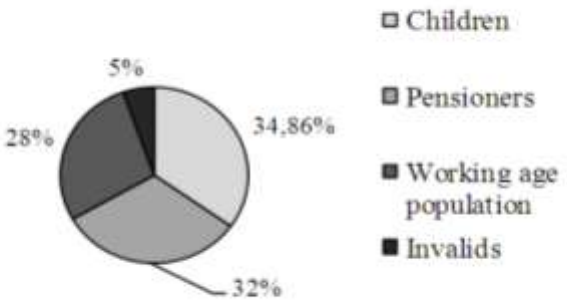

Fig. 1. Structure of the number of internally displaced persons in Ukraine as of 12.11.2014

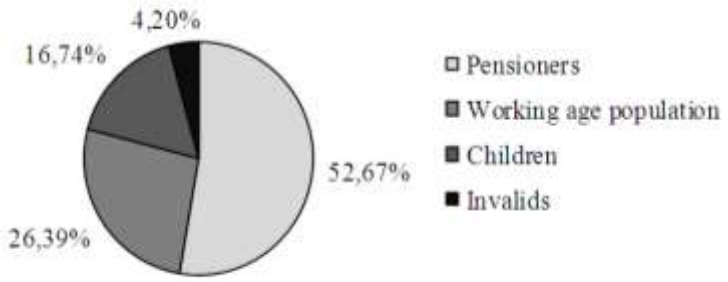

Fig. 2. Structure of the number of internally displaced persons in Ukraine as of 02.02.2015

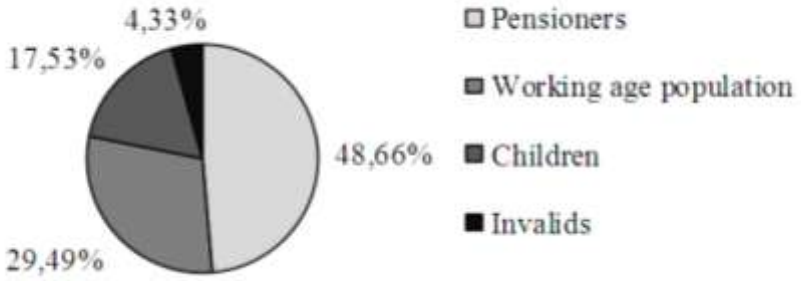

Fig. 3. Structure of the number of internally displaced persons in Ukraine as of 27.04.2015

As of 12.11.2014 the category of children had the largest share – 35 %, pensioners – 32 %, working age population – about 28 % and the category of invalids – 5 %. Gradually, the structure was changed: as of 02.02.2015 the category of pensioners became the biggest group – more than 50 %, working age population had the share 26 %, children – 17 %, invalids – about 4 %. At the end of the study period (27.04.2015) the pensioners' proportion decreased – by 4 % (48,66 %), the proportion of the group of working age population (26,39 % to 29,49 %) and the group of children (16,74 % to 17,53 %) increased, the share of category of invalids almost unchanged – 4,33 %.

Based on the results, it is possible to form the following current and future tasks for the government of Dnipropetrovsk region:

– enabling children to access education. A particular problem is the overcrowding of pre-schools [1];

– employment both (local and forced) population. Thus, 20 % of internally displaced persons (IDPs) are in need of employment (14 998 people from 72 893 as of 01.04.2015);

– ensuring the increasing needs of medicine;

– ensuring stable operation of the infrastructure of the pension system and system of social assistance payments.

To characterize the distribution of population by income (social assistance payments) it is used the Lorenz Curve and the Gini Coefficient.

Output parameters and calculations which are needed for construction of the Lorenz Curve and for calculation the Gini Coefficient are provided in Table 1.

The graph of Lorenz Curve represents the inequality of income distribution. In this case, the graphic (fig. 4) shows the uneven benefits of applications of various types of social support in cities of Dnipropetrovsk region. To describe line of Equality eight cities of Dnipropetrovsk region was divided at the equal groups (x = 12,5 %).

Table 1

The calculation of the concentration of social assistance payments to the forced population in Dnipropetrovsk region as of 05.11.2014

City	Appealed for the payment of various types of social support, % x	Paid, % y	xy	x_{accum}	y_{accum}	xy_{accum}
Synelnykove	12,5	1,41	17,63	12,5	1,41	17,625
Novomoskovsk	12,5	1,85	23,13	25,0	3,26	40,75
Petropavlivka	12,5	3,05	38,13	37,5	6,31	78,875
Marhanets	12,5	3,37	42,13	50,0	9,68	121
Nikopol	12,5	5,01	62,63	62,5	16,69	183,63
Pokrovske	12,5	5,01	62,63	75,0	19,7	246,25
Pavlohrad	12,5	20,02	250,25	87,5	39,72	496,5
Dnipropetrovsk	12,5	60,28	753,5	100,0	100	1250
Σ	100,0	100,0	1250	×	×	2434,625

According to fig. 4 social payments distribution for the cities of Dnipropetrovsk region holds the uneven. 12,5 % of internal migrants receive 1,41 % of payments, 25 % – 3,26 % of payments, 37,5 % of internal migrants receive 6,31 %, 50 % – 9,68 %, 62,5 % – 14,69 %, 75 % – 19,7 %, 87,5% – 39,72% and finally 100 % of internal migrants receive 100 % of payments. Almost 60 % of all payments account the city of Dnipropetrovsk. The smallest share of social assistance provided to migrants who are living in Synelnykove (1,41 %).

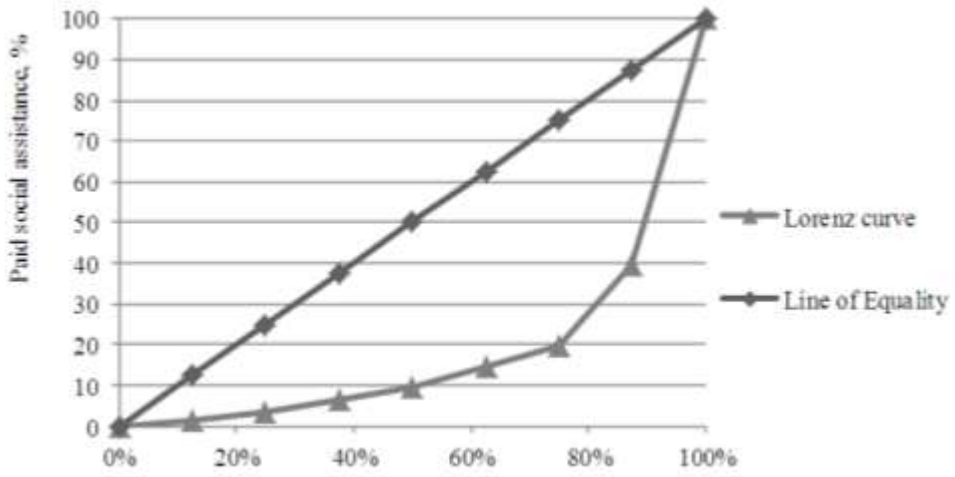

Fig. 4. The uneven distribution of social payments between the cities of Dnipropetrovsk region on the basis of the Lorenz curve (source: own calculations)

To describe the degree of inequality of social payments we need to calculate the Gini Coefficient of income concentration using (1).

$$K_G = 1 - 2\sum_{i=1}^{n} x_i y_i^{''} + \sum_{i=1}^{n} x_i y_i \,, \tag{1}$$

As the concentration ratio of social payments in Dnipropetrovsk region as of 05.11.2014 is 0,638, this figure confirms the uneven distribution and polarization of social benefits.

Consider the trend in the number of IDPs using ratio characteristics of time series (Table 2).

Table 2

Indicators of dynamics of the number of internally displaced persons to Dnipropetrovsk region on a specified date

Date	Registered, persons	Absolute change, persons		Growth coefficient		Growth rate, %	
		Chain	Base	Chain	Base	Chain	Base
12.11.2014	16 372	–	–	–	1	–	–
01.12.2014	37 493	21 121	21 121	2,290	2,290	129,01	129,01
05.01.2015	58 093	20 600	41 721	1,549	3,548	54,94	254,83
02.02.2015	64 423	6330	48 051	1,109	3,935	10,90	293,49
02.03.2015	71 022	6599	54 650	1,102	4,338	10,24	333,80
01.04.2015	72 893	1871	56 521	1,026	4,452	2,63	345,23
27.04.2015	73 209	316	56 837	1,004	4,472	0,43	347,16
Σ		56 837	×	4,471 598	×	×	×

Absolute changes (chain(2) and basic(3) are calculated by the following formulas:

$$\Delta_i^c = y_i - y_{i-1}, \quad (2)$$

$$\Delta_i^B = y_i - y_0. \quad (3)$$

The formula for calculating average absolute change (4):

$$\bar{\Delta} = \frac{1}{n} \times \Delta_n^B. \quad (4)$$

So, for the period 12.11.2014 – 27.04.2015 the number of IDPs have been changed with average monthly increasing 9473 persons.

Chain (5) and basic (6) growth coefficient are calculated using formulas:

$$k_i^c = \frac{y_i}{y_{i-1}}, \quad (5)$$

$$k_i^B = \frac{y_i}{y_0}. \quad (6)$$

Average growth coefficient are calculated using (7):

$$\bar{k} = \sqrt[n]{k_n^B}. \quad (7)$$

Thus, the monthly number of displaced persons had 128,35 % of the number for the previous month; the number was growing every month by (average) 28,35 % (according to the growth rate).

To identify the trends and make a prediction we apply curve fitting. The using of visual analysis of the empirical distribution graphics is the need for selecting an approximating function (fig. 5).

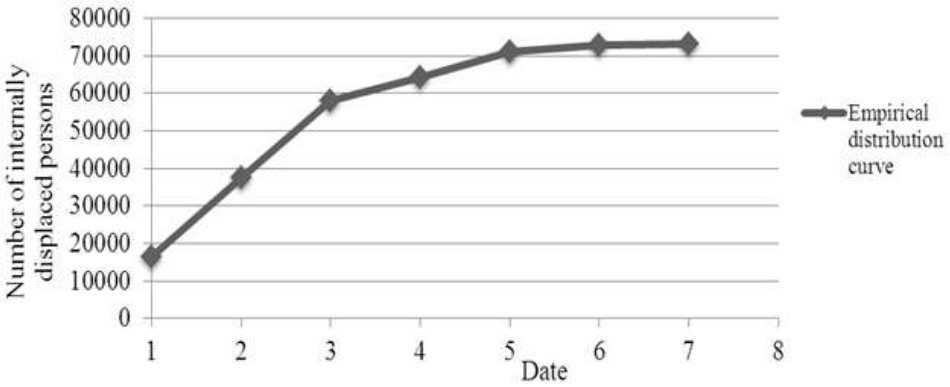

Fig. 5. Empirical distribution curve of the number of forced interregional migration (source: own calculations)

Based on the figure 5 linear, exponential and hyperbolic functions can not be applied. Seasonal fluctuations are not detected in the chart, therefore application of the Fourier series makes

no sense. So, in the analysis of time series use made of curves of second degree (parabola) (8) and third-degree polynomial (9).

$$\hat{y} = a_0 + a_1 \times t + a_2 \times t^2, \tag{8}$$

$$\hat{y} = a_0 + a_1 \times t + a_2 \times t^2 + a_3 \times t^3. \tag{9}$$

The method of least squares define the functions that better approximates the empirical data.

We determine the values of a_0, a_1, a_2, a_3 by the usage of partial derivatives, the system of normal equations obtained by the method of least squares: the system (10) for the parabola of second degree and system (11) for third-degree polynomial curve.

$$\begin{cases} a_0 + a_1\bar{t} + a_2\overline{t^2} = \bar{y} \\ a_0\bar{t} + a_1\overline{t^2} + a_2\overline{t^3} = \overline{yt} \\ a_0\overline{t^2} + a_1\overline{t^3} + a_2\overline{t^4} = \overline{yt^2} \end{cases} \tag{10}$$

$$\begin{cases} a_0 + a_1\bar{t} + a_2\overline{t^2} + a_3\overline{t^3} = \bar{y} \\ a_0\bar{t} + a_1\overline{t^2} + a_2\overline{t^3} + a_3\overline{t^4} = \overline{yt} \\ a_0\overline{t^2} + a_1\overline{t^3} + a_2\overline{t^4} + a_3\overline{t^5} = \overline{yt^2} \\ a_0\overline{t^3} + a_1\overline{t^4} + a_2\overline{t^5} + a_3\overline{t^6} = \overline{yt^3} \end{cases} \tag{11}$$

Calculation of the parameters for the system (10) are shown in Table 3. Substituting figures (12) in the system of normal equations (10).

Table 3

Alignment of time series by the curves of second degree (parabola)

Date	i	y	t	t^2	t^3	t^4	yt	yt^2
12.11.2014	1	16 372	1	1	1	1	16 372	16 372
01.12.2014	2	37 493	2	4	8	16	74 986	149 972
05.01.2015	3	58 093	3	9	27	81	174 279	522 837
02.02.2015	4	64 423	4	16	64	256	257 692	1 030 768
02.03.2015	5	71 022	5	25	125	625	355 110	1 775 550
01.04.2015	6	72 893	6	36	216	1296	437 358	2 624 148
27.04.2015	7	73 209	7	49	343	2401	512 463	3 587 241
Average		56 215	4	20	112	668	261 180	1 386 698

$$\begin{cases} a_0 + 4a_1 + 20a_2 = 56\,215 \\ 4a_0 + 20a_1 + 112a_2 = 261\,180 \\ 20a_0 + 112a_1 + 668a_2 = 1\,386\,698 \end{cases} \tag{12}$$

We solved systems of equations (12) by matrix method. We find trends equation (13), substituting parameters into formula (8):

$$\hat{y}_{par} = -8266{,}7 + 27\,854{,}5 \times t - 2346{,}8 \times t^2 \qquad (13)$$

Make a similar actions for parameters of function (9).

Table 4

Alignment of time series by the third-degree polynomial

Date	y	t	t^2	t^3	t^4	t^5	t^6	yt	yt^2	yt^3
12.11.2014	16 372	1	1	1	1	1	1	16 372	16 372	16 372
01.12.2014	37 493	2	4	8	16	32	64	74 986	149 972	299 944
05.01.2015	58 093	3	9	27	81	243	729	174 279	522 837	1 568 511
02.02.2015	64 423	4	16	64	256	1024	4096	257 692	1 030 768	4 123 072
02.03.2015	71 022	5	25	125	625	3125	15 625	355 110	1 775 550	8 877 750
01.04.2015	72 893	6	36	216	1296	7776	46 656	437 358	2 624 148	15 744 888
27.04.2015	73 209	7	49	343	2401	16 807	117 649	512 463	3 587 241	25 110 687
Average	56 215	4	20	112	668	4144	26 402,85714	261 180	1 386 698	7 963 032

The system of normal equations (14):

$$\begin{cases} a_0 + 4a_1 + 20a_2 + 112a_3 = 56\,215 \\ 4a_0 + 20a_1 + 112a_2 + 668a_3 = 261\,180 \\ 20a_0 + 112a_1 + 668a_2 + 4144a_3 = 1\,386\,698 \\ 112a_0 + 668a_1 + 4144a_2 + 26\,402{,}857a_3 = 7\,963\,032 \end{cases} \qquad (14)$$

To find trend's equation (15), substituting the parameters in the formula (9):

$$\hat{y}_{pol} = -16\,774{,}714 + 37\,544{,}143 \times t - 5182{,}8095 \times t^2 + 236{,}33 \times t^3 \qquad (15)$$

By the method of least squares, the sum of the squares of the deviations (calculated values from empirical or) is a minimum. So the second mathematical model (trend's equation (15) is closer to observed values, because $\sum(y_t - \tilde{y_t^{pol}})^2 < \sum(y_t - \tilde{y_t^{par}})^2$ (11 880 250,95 < 23 944 594,95). There is trend's equation graph (fig. 6).

It is necessary to determine the adequacy of function before forecasting, using F-Fisher criterion. Estimated value (Fest = 235,27) is bigger than critical (Fcr = 8,94). That is, with probability 95 % we can conclude adequacy of mathematical model.

Extrapolation of this time series are based on trend's equation (14).

The prediction for May and June 2015 are developed by substituting t = 8 and t = 9 in the formula (15). The resulting values are calculated with a confidence interval. So, if current trends and the socio-economic situation in Ukraine retain, with 95 % probability it can be argued that in May in the Dnipropetrovsk region number of IDPs from temporarily occupied territory and anti-

terrorists operation conduct districts will be in the range of 66 808 to 78 955 people and probably will make 72 881 person, in June – from 67 094 to 80 110 people and will make 73 062 persons.

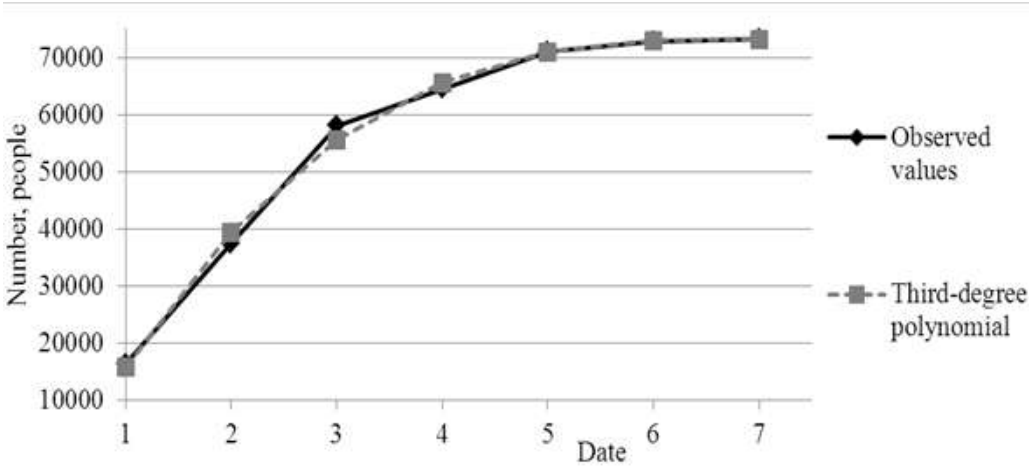

Fig. 6. Observed values and third-degree polynomial of the number of IDPs to Dnipropetrovsk region as of 12.11.2014 – 27.04.2015 (source: own calculations)

Conclusions and further researches directions. The carried-out statistical analysis shows the current state and dynamics of changes in the number of forced migrants from Donetsk, Luhansk and Crimea regions. Calculations show the need for adequate management solutions in the education, medicine and the labor market. The Lorenz Curve and the Gini Coefficient describe polarization of social payments in various cities of Dnipropetrovsk region. Developed mathematical model (third-degree polynomial curve) serves as the basis for forecasting future number of refugees. Thereby, in case of retaining the current trends of socio-economic, military and political state it is expected (with reliability 95 %) an increase in the number of displaced persons – within up to 72 881 persons in May and to 80 110 people in June.

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