PRODUCTIVE FORCES DEVELOPMENT AND REGIONAL ECONOMY

FORECASTING THE INFLUENCE OF FINANCIAL DECENTRALIZATION IN THE FORMATION OF THE POLTAVA REGION BUDGET ON THE BASIS OF ADAPTIVE MODELS

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Introduction. In the context of globalization of world economic and political processes, the main priority of developed and developing countries is to ensure internal and external democratic relations and economic stability of each region of the country. The main aspect for solving the tasks is to create a flexible system for making effective management decisions at the local level. The process of decentralization serves as a foundation for the creation of this system, which allows for a more adequate assessment and response to the priorities and demand of a particular region, a public association. However, the transition from a centralized to a decentralized system of government based on foreign experience had both positive and negative effects on the financial and economic stability of countries.

One of the main directions of the decentralization process is budget decentralization. The optimal strategy of inter-budgetary relations of territorial associations is the key to economic growth of the country.

Today, the optimization of inter-budgetary relations, analysis, forecasting, control of the economic situation, prevention of risks, economic instability and failure of the reform system are relevant.

Analysis of recent research sources and publications. American scientist and economist Charles Tibou is the founder of theories of budget decentralization, who in his work "Economic theory of fiscal decentralization in public finances: necessity, sources and uses" he notes that the growth of economic efficiency is due to competition from local governments. [7]

Domestic scientists N. Natalenko, A. Tkachuk, A. Nechypyronko, M. Treshchev in their scientific works considered in detail the importance and shortcomings of budget decentralization [5, 6, 8, 9].

Research and analysis of the quality of local budgets and ways to improve the reform are investigated in the scientific work by I.O. Zhuvahina "Analysis of the implementation of budget decentralization in the context of socio-economic development of the country" [10].

A meta-analysis of the impact of fiscal decentralization on the financial and economic development of the country was conducted by German scientist Tushyanthan Baskaran in his work "Fiscal Federalism, Decentralization and Economic Growth: A Meta-Analysis" [11].

In monographs [12, 13, 14] European scholars studied and analyzed the impact of fiscal decentralization on the economic stability and socio-economic development of countries with economies in transition, as well as the main problems and risks of reform.

To date, there are both positive and negative factors in the implementation of budget decentralization in countries with economies in transition. When implementing the reform, it is necessary to constantly analyze changes in the system and adjust the management strategy in the event of economic instability. Moreover, it is advisable to make a point adjustment, for each region separately, taking into account demand, supply, geographical and socio-political opportunities of the relevant territory of the country.

Setting objectives. The aim of the work is to study the implementation of the local budget of Poltava region, analysis of the impact of budget decentralization on ways to strengthen the financial base and forecast revenues to the local budget of Poltava region based on adaptive models with the highest estimated accuracy.

Basic material and results. Results. Decentralization reform is being actively developed and researched the moment of approval by the Decree of the President of Ukraine of the development strategy "Ukraine – 2020" on January 12, 2015, the priorities of which are public administration reform. Amendments to the Budget and Tax Codes of Ukraine are the first stage in the implementation of the decree.

In Ukraine, the decentralization process began in 2014 with the adoption of the Concept of Local Government Reform and Territorial Organization of Power in Ukraine (April 1, 2014), the laws of Ukraine "On Cooperation of Territorial Communities" (June 17, 2014), "On Voluntary Association of Territorial Communities" .2015) and amendments to the Budget and Tax Codes – on financial decentralization.

The Resolution of the Cabinet of Ministers of Ukraine of August 5, 2020 № 695 approved the State Strategy for Regional Development for 2021-2027. This Strategy was developed pursuant to the Decree of the President of Ukraine of September 20, 2019 № 713 "On urgent measures to ensure economic growth, stimulate regional development and prevent corruption" and in accordance with the Law of Ukraine "On Principles of State Regional Policy", Resolution of the Cabinet of Ministers November 11, 2015 № 931 "On approval of the Procedure for developing the State Strategy for Regional Development of Ukraine and the action plan for its implementation, as well as monitoring and evaluation of the effectiveness of the implementation of these Strategies and action plans.

The priorities of the reform are to expand the powers of local governments to make decisions and provide fiscal independence. The goals of the strategy are the introduction of an effective system of territorial organization, financial self-sufficiency of local governments and increase their budget [4].

Implementation of the strategy of regulation of all local budgets by horizontal equalization depending on the solvency of territories promotes the interaction of individual territorial units to achieve economic growth, both a particular territorial unit and the country as a whole.

Today, the questions of economic efficiency of the implementation of the reform system of governance and the definition of economic changes have occurred during the decentralization process. Already in the first years of the decentralization process, the country had positive results. According to the officially published information on the website of the Ministry of Finance of Ukraine, in the year after the reform, local budget revenues increased by 19.1%. [16]. Among the positive economic changes are changes in the structure of budget expenditures, improvement of the mechanism of inter-budgetary relations, introduction of targeted subventions from the state budget and improved the mechanism of financial borrowing.
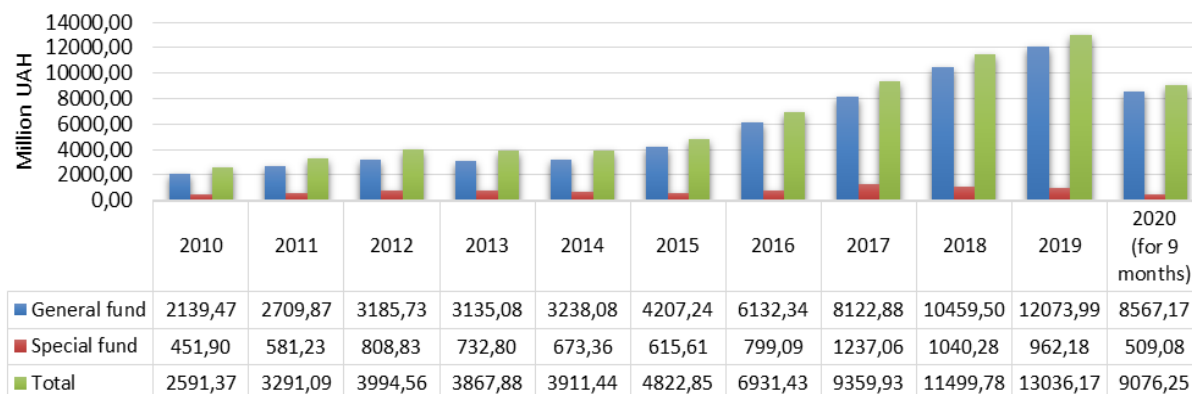
One of the important economic regional indicators that reflect economic changes are the indicators of budget program implementation.

On the example of Poltava region we will analyze the total receipts of the general and special fund to the budget and receipts without taking into account intergovernmental transfers for 2010-2020 (for 9 months of 2020) (Fig. 1). This period describes the economic situation 5 years before the implementation of the reform and 5 years after its implementation, which allows to analyze in detail the consequences of the reform.

According to statistics, there is a steady increase in revenue to the budget of Poltava region, but it is not economically correct to equate and analyze economic data without taking into account the decrease in the purchasing power of the currency compared to the base year.

The first step to the financial and economic analysis is the recalculation of the purchasing power of money (Ukrainian hryvnia), caused by inflation for the period between the base and current year (Fig. 2).

Receipts to the local budget of the Poltava region without support of intergovernmental transfers

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020 (for 9 months)
■ General fund	2139,47	2709,87	3185,73	3135,08	3238,08	4207,24	6132,34	8122,88	10459,50	12073,99	8567,17
■ Special fund	451,90	581,23	808,83	732,80	673,36	615,61	799,09	1237,06	1040,28	962,18	509,08
■ Total	2591,37	3291,09	3994,56	3867,88	3911,44	4822,85	6931,43	9359,93	11499,78	13036,17	9076,25

Aggregate revenues to the local budget of Poltava region

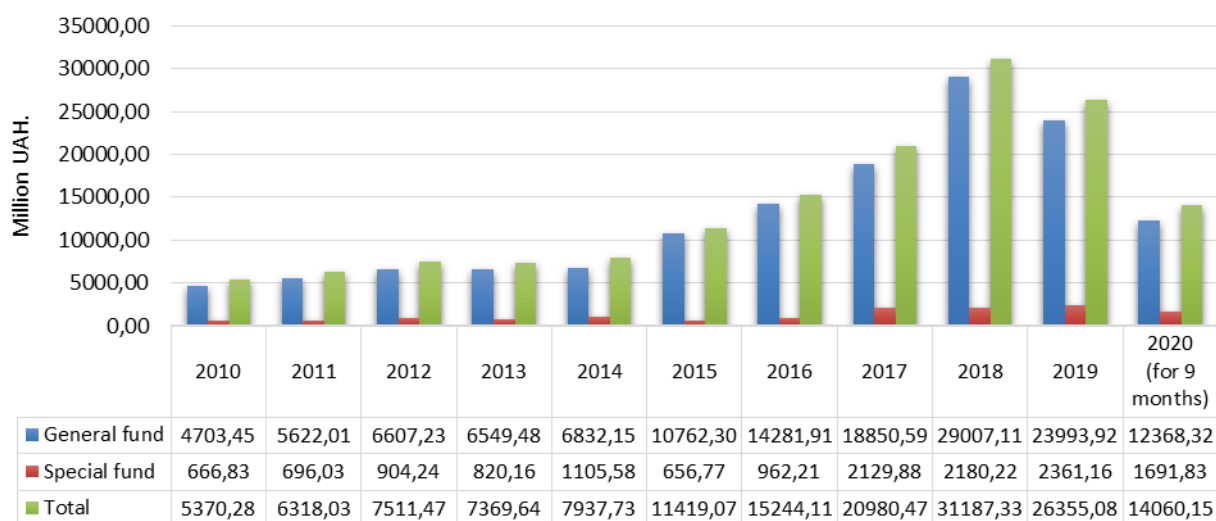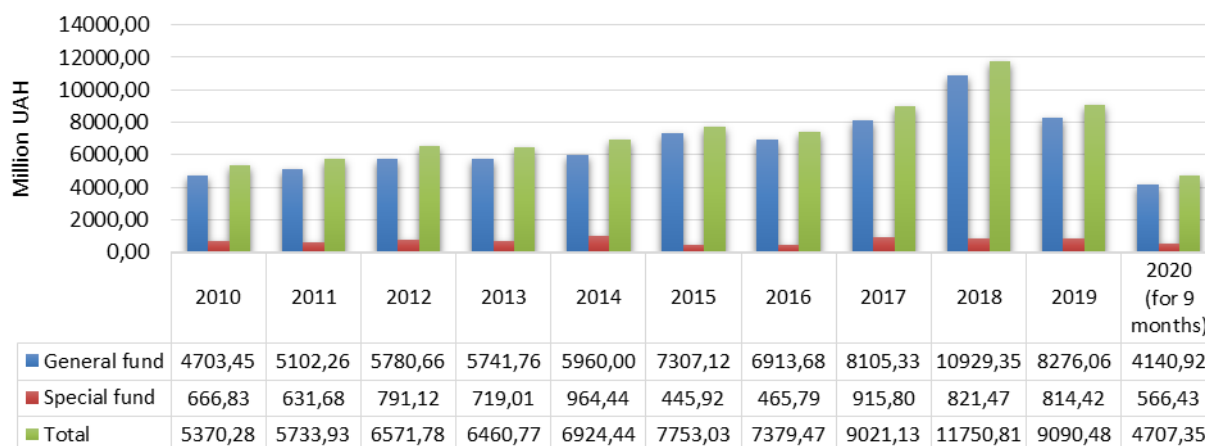|	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020 (for 9 months)
■ General fund	4703,45	5622,01	6607,23	6549,48	6832,15	10762,30	14281,91	18850,59	29007,11	23993,92	12368,32
■ Special fund	666,83	696,03	904,24	820,16	1105,58	656,77	962,21	2129,88	2180,22	2361,16	1691,83
■ Total	5370,28	6318,03	7511,47	7369,64	7937,73	11419,07	15244,11	20980,47	31187,33	26355,08	14060,15

Fig. 1. Receipts to the budget of Poltava region for 2010–2020 [15]

Inflation-adjusted statistics show that from 2012 to 2015 there is a period of stagnation and from 2015 to 2019 the revenue rate is gradually increasing. Compared to 2015, the revenue rate in 2019 increased by 44%. This shows that economic reform has had a positive impact on the financial results of Poltava region. Factors that contributed to the growth of revenues are the delegation of authority to dispose of certain revenues of the state budget:
- payment for the provision of administrative services in full;
- state duty in full;
- 10% tax on profits of private sector enterprises;
- environmental tax in the amount of 80% (before the reform - 35%).

Aggregate revenues to the local budget of Poltava region (including inflation)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020 (for 9 months)
General fund	4703,45	5102,26	5780,66	5741,76	5960,00	7307,12	6913,68	8105,33	10929,35	8276,06	4140,92
Special fund	666,83	631,68	791,12	719,01	964,44	445,92	465,79	915,80	821,47	814,42	566,43
Total	5370,28	5733,93	6571,78	6460,77	6924,44	7753,03	7379,47	9021,13	11750,81	9090,48	4707,35

Receipts to the local budget of the Poltava region without support of intergovernmental transfers (including inflation)

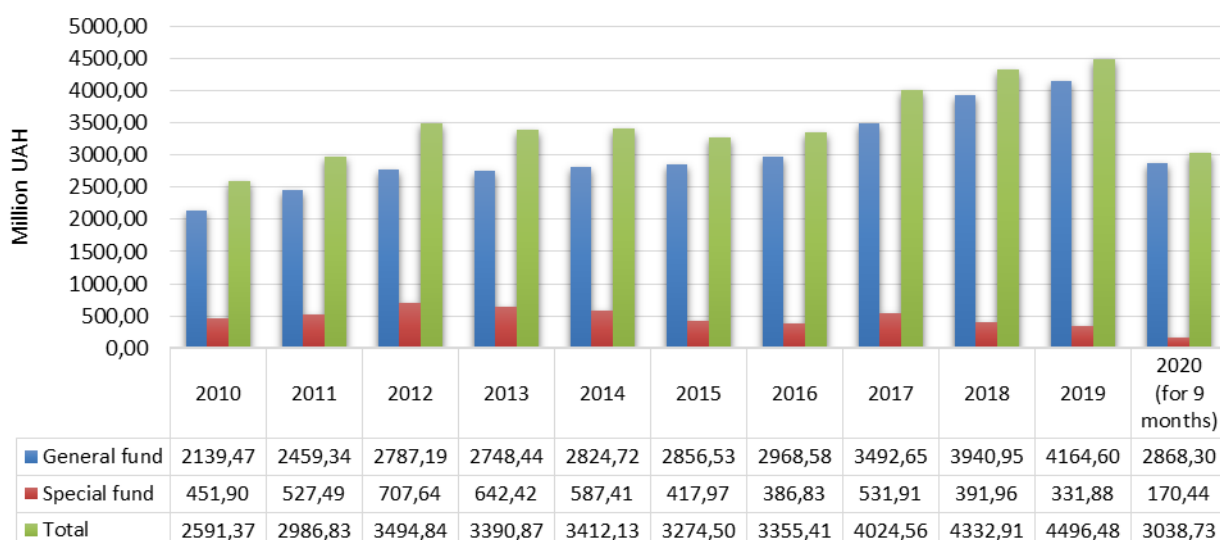|	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020 (for 9 months)
General fund	2139,47	2459,34	2787,19	2748,44	2824,72	2856,53	2968,58	3492,65	3940,95	4164,60	2868,30
Special fund	451,90	527,49	707,64	642,42	587,41	417,97	386,83	531,91	391,96	331,88	170,44
Total	2591,37	2986,83	3494,84	3390,87	3412,13	3274,50	3355,41	4024,56	4332,91	4496,48	3038,73

Fig. 2. Revenues to the budget of Poltava region for 2010–2020, taking into account inflation

Also a positive economic shift is the introduction of excise tax on the sale of excisable goods at a rate of 5% of the cost and improving the mechanism of intergovernmental relations. According to the statistics of total revenues, since 2015 we have seen an increase in transfer revenues and in 2018 revenues reached a record amount of UAH 1,987.55 million (Fig. 3).

In 2019, transfer revenues decreased significantly, but total revenues increased, which indicates the acquisition of financial independence of the region and the division of funding powers between local and central government.

Based on empirical data, the task is to make a forecast of revenues to the budget of Poltava region for 2020–2021 and analyze the success of the reform under the condition of stable changes in the development strategy. It is advisable to use adaptive models for forecasting because the input parameters (receipts) change over time, and adaptive models are able to quickly adapt their structure to changing conditions of trends and fluctuations.
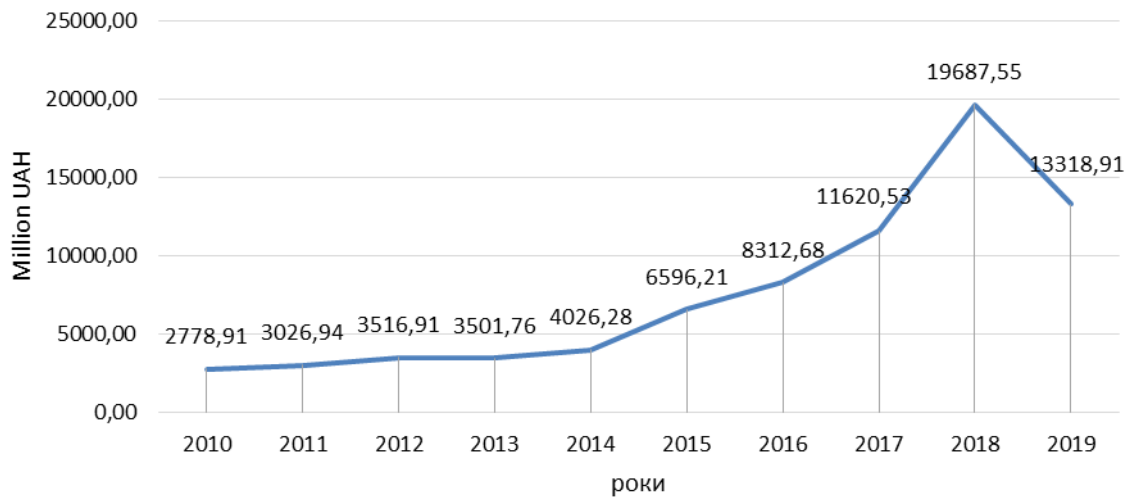
Fig. 3. Revenues of Poltava region received from intergovernmental transfers [15]

It was found experimentally that it is expedient to use the Brown Adaptive Model and the model based on the method of dynamic regression, as these economic and mathematical models have the highest indicators of forecast accuracy.

Since the initial data are the parameters of time and receipt, we use the first level model:

$$Y_p(t) = A_0 + A_1 t. \tag{1}$$

where t is the current time; k is the bias time; A0, A1k - parameters of the linear model.
Using the found parameters, the predicted value was found:

$$Y_p(t + k) = A_0(t) + A_1(t)k, k = 1. \tag{2}$$

According to formula 3 determine the forecast error:

$$e(t + k) = Y(t + k) - Y_p(t + k). \tag{3}$$

According to the error, set the values of the parameters of the model A0 and A1:

$$A_0(t + 1) = A_0(t) + A_1(t) + \alpha^2 e(t); \tag{4}$$

$$A_1(t + 1) = A_1(t) + \alpha^2 e(t), \tag{5}$$

where α is the discount rate.

Substituting empirical data to the model, we obtain the forecast values of revenues to the budget of Poltava region (Fig. 4).

According to the results of the forecast for the end of 2020 and for 2021, there is a tendency to a gradual increase in revenues. Taking into account statistical data for 9 months of 2020, where revenues amounted to UAH 3,038.73 million and the forecast value of UAH 4,092.14 million per year (with inflation recalculation of UAH 13,716.03 million) the model can be considered reliable.

Years	t	Yt (inflation)	Yt	A	B	Theoretical data with forecast	Yt-F (t)	β (varies)	AND	IN	(Yt-F (t)) ^ 2	(Yt-Yc) ^ 2	Forecast quality
2010	1	2591,37	2591,37	175,59	2570,22	2745,81	-154,44	0,4	175,59454	2570,22	23852,436	892302,76	0,12316
2011	2	2986,83	3291,09	150,88	2721,10	3022,87	-36,04		29,784937	184,8107	1298,707	301572,60	0,09270
2012	3	3494,84	3994,56	145,12	2866,22	3301,57	193,26		0,8128914	270,5351	37350,405	1693,54	0,06771
2013	4	3390,87	3867,88	176,04	3042,26	3746,42	-355,55		34,755909	8	126418,660	21060,88	0,07193
2014	5	3412,13	3911,44	119,15	3161,41	3757,17	-345,04		2543759,1	585514	119050,765	15341,13	0,07103
2015	6	3274,50	4822,85	63,95	3225,36	3609,03	-334,53				111908,578	68376,48	0,07713
2016	7	3355,41	6931,43	10,42	3235,78	3308,72	46,69				2179,806	32608,40	0,07346
2017	8	4024,56	9359,93	17,89	3253,67	3396,80	627,76				394088,092	238701,43	0,00944
2018	9	4332,91	11499,78	118,33	3372,00	4437,00	-104,10				10835,827	635075,03	0,04405
2019	10	4496,48	13036,17	101,68	3473,68	4490,46	6,02				36,240	922540,88	0,04090
2020	11		13 716,03			4592,14					827019,516	3129273,144	0,06715
2021	12		14 019,73			4693,82							93,28%

Yc =	3 535,99		
R =	0,858	R2 =	0,736
Fpos =	22,270		
Fcr =	0,828		

Fig. 4. Brown's adaptive model for forecasting revenues to the budget of Poltava region in 2020 and 2021

According to the calculations of Fisher's criterion, the model is adequate, and the accuracy of the forecast is 93.28% Graphical representation of the economic-mathematical model is shown in Figure 5.
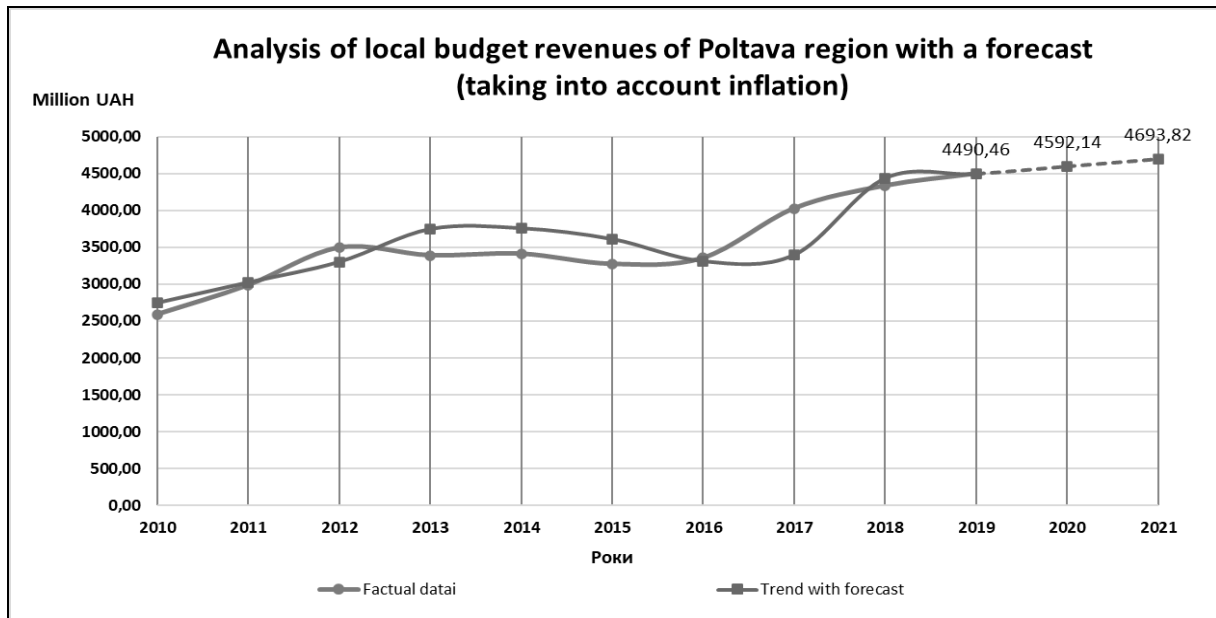

Fig. 5. Graphic display of forecasting of revenues to the budget of Poltava region for 2020 and 2021 on the basis of the Brown Adaptive Model

For a reliable economic analysis, it is necessary to make a comparative description of several adaptive models. To compare the forecast values, we apply an adaptive model by the method of dynamic regression based on the results of which the accuracy of the forecast is 98.57%. Predictive values of the model are determined by formula 6:

$$\widehat{y}^*_{yt_{+L}} = \hat{a}_0 + \hat{a}_0 t, \tag{6}$$

where,

$$\hat{a}_0 = 2y^1_t - y^2_t; \tag{7}$$

$$\hat{a}_1 = \frac{a}{1-a} - (y^1_t - y^2_t). \tag{8}$$

The parameters a0, a1 are the parameters of the trend level obtained by the method of least squares. Substituting empirical data for the model we obtain the results of calculations shown in Figure 6.

Years	t	Yt (inflation)	yt	Forecast F (t)	The square of the deviations (yt-F (t)) ^ 2	The difference between the actual value and the forecast	The difference between actual values and forecast	The product of differences	Square the difference by one period back	α	Forecast quality		(Yt-Yc) ^ 2
2010	1	2 591,37	2591,37	2591,372	0,000	reduction by two periods	reduction for one period				0,02378		892302,76
2011	2	2 986,83	3291,09	2591,372	156389,815						0,02378		301572,60
2012	3	3 494,84	3994,56	3494,837	0,000	903,465	903,465	816249,22	816249,22	1,000	0,01307		1693,54
2013	4	3 390,87	3867,88	3402,674	139,444	799,494	-103,971	-83124,21	10809,97	0,886	0,01379		21060,88
2014	5	3 412,13	3911,44	3411,046	1,175	-82,707	9,456	-782,05	89,41	0,885	0,01372		15341,13
2015	6	3 274,50	4822,85	3289,991	239,943	-128,174	-136,546	17501,62	18644,77	0,887	0,01475		68376,48
2016	7	3 355,41	6931,43	3347,418	63,898	-55,635	65,421	-3639,68	4279,90	0,878	0,01425		32608,40
2017	8	4 024,56	9359,93	3990,935	1130,666	734,570	677,142	497408,28	458521,82	0,950	0,01002		238701,43
2018	9	4 332,91	11499,78	4370,108	1384,018	985,488	341,971	337007,69	116943,84	1,109	0,00836		635075,03
2019	10	4 496,48	13036,17	4514,276	316,702	505,544	126,372	63886,46	15969,78	1,141	0,00783		922540,88
2020	11		13544,11	4534,578	159665,660						0,01434	98,57%	3129273,144
2021	12		13552,65	4537,437									

Yc =	3 535,99			
R =	0,974	R2 =	0,949	
Fроз =	148,791			
Fcr =	0,828			

Fig. 6. Forecasting of revenues to the budget of Poltava region in 2020 and 2021 by the method of dynamic regression

It should be noted that the adaptive model by the method of dynamic regression in comparison with the adaptive model of Brown has a greater accuracy of prediction and a greater correlation coefficient and determination. According to Fisher's criterion, it is determined that the model is adequate. Therefore, it is more expedient to analyze and summarize the forecast data according to the adaptive model by the method of dynamic regression, the graphical representation of which is given in Figure 7.
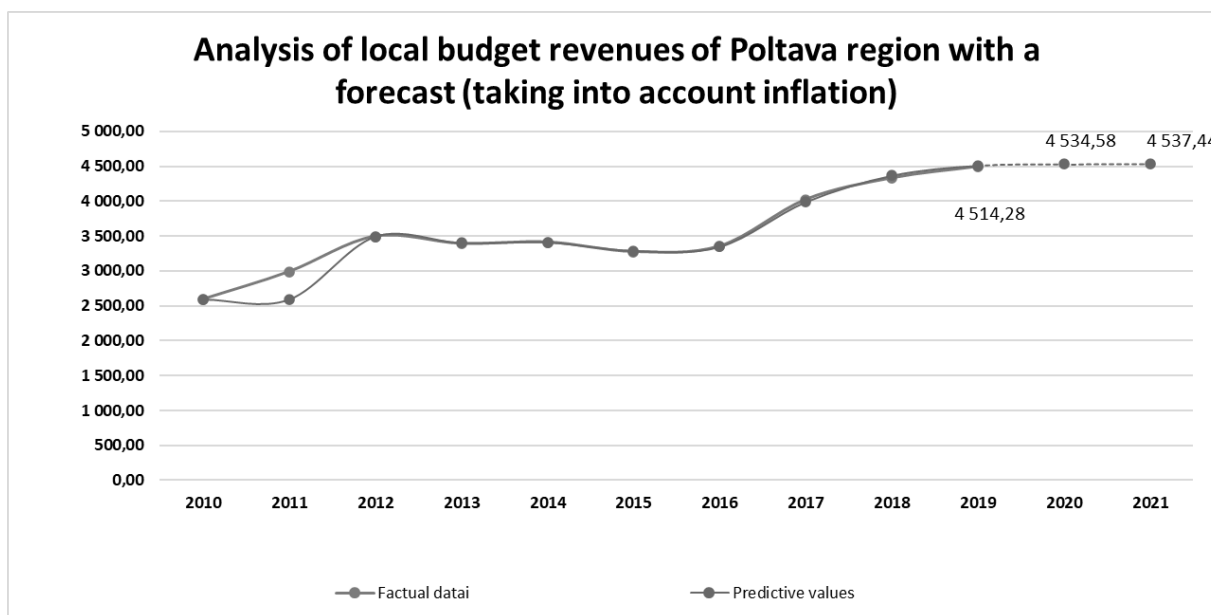

Fig. 7. Graphic display of forecasting of revenues to the budget of Poltava region in 2020 and 2021 by the method of dynamic regression

Therefore, according to the results of the forecast, there is a slight but stable increase in revenues to the budget of Poltava region, as evidenced by the reduction of subventions for 2019. However, it should be noted that the model reflects the stabilization of revenues in the coming years, and if you do not improve the system of filling the local budget, it is possible a period of economic stagnation, and eventually deterioration (reduction of revenues). This indicates that the economy, as a mechanism of the management system, needs constant change and improvement depending on the current living conditions.

Adaptive forecast models and analysis of data from previous years show an increase in financial and economic indicators of budget revenues of Poltava region. An important factor in this is the introduction of a system of distribution of state budget funds depending on the needs of the regions, which has significantly increased the region's revenues from inter-budgetary transformations.

Conclusions. Based on static data, the impact of the decentralization process on the budget revenues of Poltava region is analyzed and on the basis of adaptive models, the forecast values of revenues for 2020–2021 are calculated.

According to the results of the forecast based on Brown's adaptive model, there is a tendency to a gradual increase in revenues. Taking into account statistical data for 9 months of 2020, where revenues amounted to UAH 3,038.73 million and the forecast value of UAH 4,092.14 million per year (with inflation recalculation of UAH 13,716.03 million) the model can be considered reliable. According to the calculations of Fisher's criterion, the model is adequate, and the accuracy of the forecast is 93.28%.

According to the results of the forecast based on the adaptive model by the method of dynamic regression, the accuracy of the forecast is 98.57%, which is higher than the Brown model. The estimated value of revenues to the local budget is UAH 4,534.58 million (with inflation recalculation of UAH 13,544.11 million).

According to the latest statistics of the Department of Finance of the Poltava Regional State Administration, the amount of revenues to the budget of the Poltava region for 2020 is 13054.80 million UAH. Taking into account the forecast values, the smallest forecast error occurs when using an adaptive model by the method of dynamic regression. However, the error is UAH 489.30 million and now there is a need to improve the forecast model using the geographical, industrial, social features of the region. For a detailed forecast, it is advisable to add a dynamic correlation coefficient to the forecasting model, which will affect the result of the forecast value depending on the characteristics of a particular region. With the help of the appropriate factor it is possible to achieve more accurate forecast values.

To further develop the reform of the governance system, it is necessary to expand the rights of local governments, strengthen budget independence, define responsibilities, improve the system of local taxes and fees, ensure the effectiveness of intergovernmental regulation and develop and implement state social standards.

REFERENCES:
1. The Verkhovna Rada of Ukraine (1996). Constitution of Ukraine. Available at: https://zakon.rada.gov.ua/laws/card/96-BP (Accessed 12 March 2021).
2. The Verkhovna Rada of Ukraine (2010), "Budget Code of Ukraine". Available at: https://zakon.rada.gov.ua/laws/show/2456-17 (Accessed 12 March 2021).
3. The Verkhovna Rada of Ukraine (2015), The Law of Ukraine "On voluntary association of local communities". Available at: http://zakon4.rada.gov.ua/laws/show/2404-17 (Accessed 13 March 2021).
4. President of Ukraine (2015), Decree "Sustainable Development Strategy "Ukraine – 2020". Available at: https://zakon.rada.gov.ua/laws/show/157-19 (Accessed 13 March 2021).
5. Treshchov, M. (2015), "Decentralization as a means of resource self-sufficiency of territorial communities: a theoretical aspect", *Derzhavne upravlinnia ta mistseve samovriaduvannia*,vol. 2, pp.60-69.
6. Samoilova, I. (2019), "Analysis of state policy on the implementation of budget decentralization and the effectiveness of reforming the budget system in Ukraine", *Derzhavne upravlinnia: udoskonalennia ta rozvytok,* vol. 1
7. Tiebout, C. M.(1956), "A pure theory of local expenditures", *The Journal of Political Economy*, vol.64(5), pp.416-424.
8. Tkachuk, A.F. and Natalenko, N.V. (2016), Pro biudzhet i ne til'ky. Spetsial'no dlia ob'iednanykh terytorial'nykh hromad [About the budget and not just. Specially for the united territorial communities], Kyiv, Ukraine.
9. Nechyporenko, A.V. (2016). "Theoretical aspects of budget decentralization of local self-government in Ukraine", *Naukovyj visnyk Uzhhorods'koho natsional'noho universytetu. Seriia: Mizhnarodni ekonomichni vidnosyny ta svitove hospodarstvo,* vol. 6(2), pp. 122-125.
10. Zhuvahina, I.O. and Filipishyna, L.M. (2017), "Analysis of the implementation of budget decentralization in the context of socio-economic development of the country", *Molodyj vchenyj*, vol.4.4(44.4), pp. 35–39.
11. Baskaran, T., Feld, L.P., and Schnellenbach, J. (2016), "Fiscal Federalism, Decentralization, and Economic Growth: A Meta-Analysis", *Economic Inquiry*, vol.54(3), pp. 1445-1463.

12. Tselios, V., Rodríguez-Pose, A., Pike, A., Tomaney, J. and Torrisi, G. (2012), "Income inequality, decentralization and regional development in Western Europe", *Environment and Planning A,*vol.44(6), pp.1278-1301.

13. Sacchi, A. and Salotti, S. (2014), "The effects of fiscal decentralization on household income inequality: Some empirical evidence", *Spatial Economic Analysis*, vol. 9(2), pp.202-222.

14. Carniti, E., Cerniglia, F., Longaretti, R. and Michelangeli, A. (2018), "Decentralization and economic growth in Europe: for whom the bell tolls", *Regional Studies*, pp.1-15.

15. The official site of Derzhavna sluzhba statystyky Ukrainy, available at: http://www.ukrstat.gov.ua (Accessed 12 March 2021).

16. The official site of Ministerstva finansiv Ukrainy, R available at: https://mof.gov.ua/uk (Accessed 12 March 2021).

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Прогнозування впливу фінансової децентралізації при формуванні бюджету Полтавської області на основі адаптивних моделей. Реформа децентралізації, що активно розвивається в Україні, потребує нових підходів до формування регіональної економічної політики. Розвиток України як демократичної, незалежної країни потребує підвищення якості державного управління, формування ефективної соціально-економічної політики. Вектором реформаторських змін економічної системи регіону слугує фінансова децентралізація, яка спирається на соціальні потреби об'єднаних територіальних громад. Фінансова децентралізація є однією з важливих умов незалежності існування органів місцевої влади і сприяє ефективному забезпеченню надання суспільних послуг відповідно до місцевих потреб. Досліджено вплив бюджетної децентралізації на виконання бюджету Полтавської області. Проаналізовано статистичні дані надходжень та видатків у період до початку реформи й після її впровадження. На основі емпіричних даних за допомогою адаптивних моделей розраховані прогнозні значення надходжень до місцевого бюджету на майбутній період, визначено відсоток точності та якості прогнозу. Визначено основі недоліки застосування моделей загального використання й запропоновано методи їх удосконалення шляхом пристосування коефіцієнтів кореляції до факторів української економіки. Виявлено перспективи розвитку реформи в Україні.

Ключові слова: децентралізація, бюджет, надходження, реформа, адаптивна модель, прогноз.

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Forecasting the impact of financial decentralization in the formation of the budget of Poltava region on the basis of adaptive models. The decentralization reform that is actively developing in Ukraine requires new approaches to the formation of regional economic policy. The development of Ukraine as a democratic, independent country requires improving the quality of public administration, the formation of effective socio-economic policy. The vector of reform changes in the economic system of the region is financial decentralization, which is based on the social needs of united territorial communities. Financial decentralization is one of the important conditions for the independence of local authorities and serves to effectively ensure the provision of public services based on the necessary local needs. The scientific article examines the impact of budget decentralization on the budget of Poltava region. The statistics of revenues and expenditures in the period before the reform and after its implementation are analyzed. On the basis of empirical data with the help of adaptive models the forecast values of local budget revenues for the future period are calculated, the percentage of accuracy and quality of the forecast is determined. The disadvantages of using models of general use are determined on the basis and methods of their improvement by adaptation of correlation coefficients to factors of the Ukrainian economy are offered. Prospects for the development of reform in Ukraine have been identified.

Keywords: decentralization, budget, revenues, reform, adaptive model, forecast**.**