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MODELING OF BUDGET SPENDING OF DONETSK REGION

Current Ukrainian economic development is characterized by problems in tax and expenditure policy caused by imperfection of budgetary laws which regulates organizational and financial relations within public finance. The successful administration of public finance apart from everything else means the creating conditions for effective industrial development.

The planning and forecasting of local budget expenditures is an integral part of such administration. In domestic practice the development of scientifically-based techniques of forecasting of local budget expenditures using the mathematical economic models will contribute to effective regulation of social and economic processes in public finance area.

In practice, the process of budget forecasting is an element of a budget planning. However, there are some differences in this field. Firstly, the planning is a kind of strategic prediction of performance of the local government and the community, whereas the forecasting is a revision of the local budget to reflect changing market conditions [13, p. 410]. C. Swanson noted that an effective forecast model presents a range of possible outcomes, based on a set of diagnosed variables and assumptions [14, p. 60]. A. Harvey explained that forecasts of the budget categories are made by extrapolating the components estimated at the end of the sample [10, p. 14].

But, according to P. Galinski, the accuracy of this method is especially tied with the economic, legal and political stability, both in the country and the community. However, using only time-series forecasts in local governments during the budget preparation may cause some negative consequences, such as:

the constraint of the activity of the local authorities in the field of anticipating the potential future events which determine the local budget;

repeating the wrong decisions from the past;

the appearance of uneconomical operations in local authorities;

preparing the future budget taking advantage of the data from the actual budget, which is still the kind of the plan [9, p. 219-220].

Moreover, the EU practices showed that the Medium-Term Expenditure Framework (MTEF), based on simple extrapolation of expenditure and revenue appropriations, assuming similar trends set by the current policies, and introduced in several countries of South Eastern Europe was not very successful, because there are rather frequent changes in local government funding schemes, which cannot be predicted by the MTEF [12, p.7].

To avoid those negative consequences, the bulk of issues, related to budget forecasting, includes other econometric techniques for planning the budget revenues and spending at local level.

Thus, the experts of World Bank explained the expenditure forecasts on local levels for different parameters: personnel expenditures, non-personnel current Expenditures, direct payments to special-needs households, capital expenditures and debt service. They said that "*Multiyear projections of spending are generally built from accounting identity models under specific assumptions regarding levels of service*" [11, p. 69], however they noted that "*Different techniques can be used to forecast both revenues and expenditures. They range from simple judgmental approaches that rely on the knowledge of experts to sophisticated multivariate statistical techniques*" [11, p. 74]. The World Bank experts distinguish following general forecasting techniques, which can be more applicable to forecast local revenues and expenditures.

Judgmental Techniques

Judgmental forecasting essentially relies on the forecaster's special expertise – that is, knowledge of the local revenue system and the factors that tend to affect annual flows of revenue. Because this subjective approach is pri-

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marily dependent on the idiosyncrasies of the specific situation and forecaster, not much can be said about it other than that its implementation cost is likely to be low and that it can yield fairly accurate short-term forecasts.

Time-Series Techniques

Time-series techniques link expected future revenues or expenditures to past experience. These techniques can differ greatly in terms of complexity. Trend techniques are simple to use and to explain, but they rest on the assumption that the factors that have influenced a revenue or expenditure in the past will continue to exist.

Deterministic Techniques

Forecasters may find variables other than the passage of time more realistic as determinants of future revenues or expenditures. Forecasters use deterministic forecasts extensively in making projections of expenditures. Deterministic approaches to forecasting are quite simple. Unlike time-trend techniques, they do not require that the forecaster assume that future revenues or expenditures will rise (or fall) inexorably as they have in the recent past. The technique does, however, require that the forecaster make explicit assumptions regarding the variable(s) thought to drive the revenue or expenditure being forecasted. Such assumptions may turn out to be erroneous.

Statistical Models

Statistical forecasting models, sometimes termed econometric models, constitute the most complex approach to forecasting and require the most extensive amount of data. They allow the forecaster to attempt to capture the effects of one or more variables that conceptually should affect a revenue or expenditure and to base the relationship between those variables and the one being forecasted on statistical estimation techniques. Because local economic conditions are likely to affect local government revenues, revenue forecasts from statistical modeling are more common than spending forecasts from such modeling. The accuracy of forecasts from this technique relies on selection of reasonable independent variables, the correctness of the projected values of those variables, and the stability of the statistical relationship into the future.

Unlike judgmental techniques, the method makes explicit the factors that the forecaster is using to generate forecasts and therefore permits ex-post analysis of erroneous forecasts so that future forecasts might be improved. Unlike projections from trend-based forecasts, projections from a statistical model will depend on the expected changes in one or more independent variables; hence, the revenue or expenditure series may show decreases as well as increases into the future. Unlike the deterministic approach, the statistical technique permits the analyst to learn whether the hypothesized relationships between the chosen independent variables and the revenue/expenditure series are statistically relevant (statistically significant) [11, p. 54-57].

In USA, notably in New-York state, to forecast different local expenditures one can use different techniques. Thus, medicaid forecast provides a point-in-time estimate for program spending based on an analysis of current and historical claims and a number of other known factors. These estimates can be subject to considerable variance and are highly sensitive to economic conditions. The welfare program forecast methodology includes welfare caseload equations. Caseloads are estimated to vary based on factors such as entry-level employment levels and the State's minimum wage. The models also contain measures that attempt to capture the impact of administrative and programmatic efforts at the national, State, and local levels to reduce welfare dependency. debt service forecast methodology involves a multi-faceted approach to forecast debt service costs. This includes forecasts for both fixed and variable interest rate costs and projections for the amount of new fixed and variable rate debt that is planned to be issued to finance capital projects over the next five year period [8, p. 181-226].

Ukrainian economists, in contrast, pay insufficient attention to forecasting local spending and revenues. I. Lukyanenko et al. [3] developed a set of econometric models in order to forecast different local revenues and expenditures. B. Sylenkov [4] proposed a forecasting model of local budget expenditures based on program-oriented and goal-oriented approach. S. Legkostup and G. Sukrusheva [2; 5] analyzed the forecasting techniques based on mathematic economic models. I. Chugunov proposed the methodology of forecasting of revenue part of local budgets [6]. V. Vishnevskyy et al. [1] developed a system of monitoring of local budgets which involves the forecasting of local revenues and spending.

In current Ukrainian forecasting practice budget expenditures are often planned according to achieved results, taking into account the inflation rate. But this principle does not allow defin-

ing medium- and long term trends, which provides evidence of lack of adequate forecasting of local budget expenditures. Now the scientifically-based approach to forecast local budget expenditures is required; the latest is impossible without using of mathematical and economic models.

So, this paper is aimed to develop scientifically based methods and models in order to forecast local budget expenditures and to make a medium-term forecast of local budget expenditures for Donetsk region.

OECD's experts in their work "A Comparative Analysis of Health Forecasting Methods" analyzed the classification of mathematical economic models, used to forecast health expenditures. Adjusting this analysis to local budget expenditures, we distinguished the following classes of forecasting models.

Forecasting models typically project local budget expenditure at the level of individuals, groups of individuals or the community as a whole. At the same time, models can focus on specific sections of expenditure, such as health, housing and community amenities, education etc. By considering both the level of aggregation of the units analyzed and the level of detail of budget expenditure to be projected, it is useful to identify three broad categories of budget expenditure forecasting models (Fig. 1).

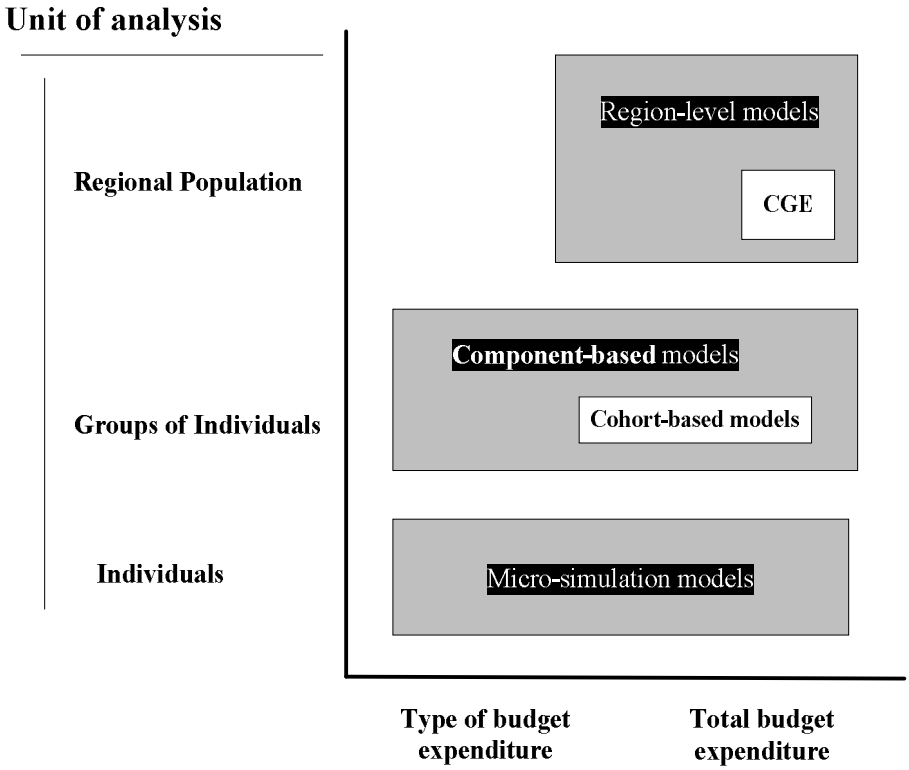

Fig. 1. Classes of local spending forecasting models

Models focusing on individuals as the unit of analysis for the projection are referred to as micro models. All examples of micro models in this review use microsimulation techniques. Those stratifying sections of budget expenditure into groups, or stratifying individuals into groups, or combinations of these two dimensions, are identified here as component-based models. Finally, macro-level models focus on total expenditure as the unit of analysis. Within this group, some regional-level models (for example, computable general equilibrium models, constructed on regional level) project future local budget expenditure trends within the context of the whole economy.

Microsimulation models

Microsimulation models are powerful tools which allow analysis and testing of relatively detailed "what-if" scenarios resulting from a variety of policy options. The scenarios can be very informative for policy makers as they may provide information beyond what is available from retrospective population studies. The units of analysis of the microsimulation

models are individuals. These individuals can be aggregated into policy-relevant groups and analysed using relevant indicators such as inequality and poverty indices.

Microsimulation models reproduce the characteristics and behaviour of a large sample of individuals representing the whole population of interest. To test the potential impact of a new policy, the microsimulation model is run twice – once with the base case or status quo scenario and then again with a policy change or variant scenario perturbing the environment in which the individuals operate. These scenarios produce a chain reaction where individuals react to the policy changes first and then, depending on the design of the model, may also react to the reaction of other individuals.

The results are the potential future outcome of the reform and are often compared with the base case to evaluate the potential impact of the reform. Microsimulation models require large amounts of data to effectively assemble a sample that adequately represents the whole population of interest and includes all of the characteristics of interest. Data are often gathered from a variety of sources, and sophisticated statistical techniques are often required to standardize the various databases so that they can be used to populate all of the desired attributes of individuals included in the sample.

Component-based-models

The most widely used class of models is component-based-models. This class includes a large variety of forecasting models that analyse budget expenditure by financing agents, by providers, by goods and services consumed, by groups of individuals or by some combination of these groups. When expenditures are grouped by financing agents, the models often consist of different layers, each of which may use a different technique to project a sub-component of expenditure. An important sub-class of component-based models is represented by cohort-based *models*. In cohort-based models, individuals are grouped into cells according to several key attributes. Further refinements are obtained by sub-dividing the cohorts according to other commonly-used attributes.

These models are often referred to as actuarial models or cell-based models, where the term cell identifies the sub-categories into which each cohort is divided. Each cell in the model is associated with an average cost of public goods and services (usually expressed in real terms). Future health expenditure is determined by multiplying the average costs by the projected number of individuals included in each cell. Cohort-based models have been very common over the years, probably because they offer a number of advantages. First, their implementation and maintenance tends to be simple and relatively inexpensive. This is because this class of models can be developed in an interactive spreadsheet, requiring a limited amount of data and generally including only a few parameters. Many of these parameters can be found in the literature, rather than being estimated. Secondly, the impact of policy changes can be assessed easily by simply modifying the policy parameters. Component-based models are typically less data demanding then microsimulation models which partially explains their popularity. However, the development of more sophisticated versions of the component-based models could require additional information.

Regional-level models

Regional-level models restrict the analysis to local budget expenditures. They are most appropriate for short-term projections in the presence of clear and undisturbed trends and in the absence of structural breaks. Therefore, these extrapolation methods can benefit from the inertia in the financial systems in the short-run.

Econometric regression analysis is used to fit time-series data. Projections can be based on pure extrapolation of the statistical models fitting the data or they can be based on the projected values of the critical explanatory variables, whenever included. The accuracy of forecasts was then compared to the results obtained from three different pure extrapolation methods (exponential smoothing, moving average and ARIMA methods). Within the class of regional-level models are "computable general equilibrium (CGE)" models on regional level.

These are models that allow for the measurement of broader consequences to the economy resulting from budget spending growth and for feedback or reaction from individuals and companies.

Regional-level models are typically the least demanding in terms of data requirements. This is particularly the case for pure extrapolation methods which use a single time series and for regression-based models which very often include just a few explanatory variables. The

computational and data requirements for Dynamic Computable General Equilibrium Models, on the other hand, are generally much higher and depend on the specification of the equations included in the model [7, p.18-22].

The aforesaid analysis allowed us to determine the forecasting technique which is the mixed variant of deterministic and econometric models. It based on using of correlatable factors, which influence directly on benchmark parameter – budget expenditures. This technique provides the forecasting of budget expenditures in Donetsk region for 2014-2016. The volatility of economic situation causes the reasonability for medium and short term forecasting. We should note that such forecasting is conceptually possible since the local budgets are inertial whereas they are related to financial of social expenditures, which can be sharply modified, so they are sufficiently predictable.

Developing and parameterization of model of budget expenditures in Donetsk region

Ukraine as the rest transformation countries inherited some problems related to forecasting the local budget expenditures, particularly:

lack of statistical data, caused by both of their inaccessibility and sharp changes in social and economic state policies, and also by strong propensity for spillover externalities, which even in presence of large arrays of economic data, makes them less informative and allows using only up-to-date information;

large relative share of inter-budgetary transfers in local budget; the disproportionality of formers distorts essentially the conceptual logics of expenditures and complicates the forecasting of budget spending based on classical techniques which evaluate total expenditures on account of standard sectional expenditures;

lack of control on budget revenue and spending on local level, which involves to take into account the "contingencies" in forecasting process; at this time such contingencies are hard to account since they are not considered in sets of regional economic indicators.

All aforesaid does not provide the possibility of using the deterministic model at this stage; one should be limited by set of stochastic (or even trend) models for some indicators and to test forecast accuracy on current statistical data.

Verification of forecasting models of local budget expenditures in Donetsk region

Model assumptions

Concerning the forecasting model of local budget expenditures, we assume that:

it can be classified as stochastic multidimensional model (additive, multiplicative or transcendental logarithmic one);

model of budget expenditures at national level conceptually is similar to model of budget expenditures at local level;

parameters which influence on amount of local budget expenditures, are the following: global economic indices, macroeconomic indexes and regional economic indexes (economic indexes at regional level).

Independent variables

As independent variables, according to the last assumption, we defined the following indexes:

global economic indices – world energy prices [15], particularly:

average oil price: Brent (Great Britain), West-Texas Intermediate (USA) and PEC Reference Basket of Crudes (x_{h1});

steam coal price (Australia) (x_{h2});

Russian natural gas border price in Germany (x_{h3});

macroeconomic indexes:

official exchange rate (UAH vs USD) (x_{m1});

inflation rate (on an accrual basis) (x_{m2});

GDP (x_{h3});

regional economic indexes:

population size in region (x_{l1});

average wage in region (x_{l2}).

The choice of indexes is determined by their direct influence on local budget expenditures: buildings maintaining needs energy expenditure; population size is directly related to amount of social expenditure; also, wages rate influences directly on amounts of inter-budgetary transfers.

Statistical information

Input model data includes official statistical data for all considering indexes and also for benchmark parameter – local budget expenditures, covering period 2006-2013, by half-year (Table 1). The forecast was made for Donetsk region for period of 2014-2016 both dates inclusive.

Choice of model type

Since the forecast was made on the basis of statistical samples, we've chosen the possible stochastic models (more specifically – models of multivariate regression type)

We've made a choice between four dilemmas:

linear or non-linear model;

additive or multiplicative model;

use of all independent variables or only naturally independent ones;

use as variable the minimum wage in country or average wage in region.

Consequently, four dilemmas resulted in sixteen variants of models. During three stages of comparison, we've omitted the following groups:

average wage in region was statistically more adequate than minimum wage in country;

modeling using all initial variables showed more adequacy in comparison with naturally independent variables, which are weakly correlated;

models which are represented as additive and multiplicative polynomials (transcendental logarithmic function), regardless of virtually absolute approximation of real data, showed the poor forecast accuracy, compared to simple additive (multivariate linear function) and multiplicative (linear logarithmic function).

As a result the final comparative verification was made for two models:

additive model – model of multivariate regression type for eight initial variables: $y = \sum_{i=1}^{8} x_{x_{hi}}^{a_{hi}}$.

multiplicative (logarithmic) model – model of multivariate regression type for logarithms of eight initial variables: $y = \prod_{i=1}^{8} x_{x_{hi}}^{a_{hi}}$.

Results of verification

For each of model we've built corresponding regression equation by 16 points (2006-2014 period). Predicted independent variables are presented in Table 2 (information for forecasting was taken from open sources).

Table 3 presents comparison of modeling results.

Table 2

Forecast values of independent variables for model of budget expenditure

Period	Oil price, USD per barrel	Natural gas price, USD per thousand cubic feet	Steam coal price, USD/t	Exchange rate (UAH vs USD)	Inflation rate (on an accrual basis)	GDP, USD billion	Population size, thousands	Average wage, UAH
2014,1	107,35	406,38	83,00	8,500	1,005	90,113	4341322	3795
2014,2	105,70	406,88	88,00	9,000	1,008	92,198	4326230	4104
2015,1	103,85	398,04	89,00	9,200	1,010	94,283	4311138	4263
2015,2	102,00	389,19	90,00	9,500	1,013	96,368	4296046	4642
2016,1	101,35	387,42	90,50	9,700	1,015	98,453	4280955	4807
2016,2	100,70	385,65	91,00	9,800	1,018	100,538	4265863	5266

Both models sufficiently exactly approximate initial statistical data. Thereat, the multiplicative model appears more exact in control forecasting for first half-year (Table 3), while the additive model is more stable in long-term forecasting (Table 4, columns 2, 3).

Such conclusion does not allow choosing either model for forecasting; thereat, it's advisable to made forecast as interval within predicted values of additive and multiplicative models.

Analysis of dependence between budget expenditures and GDP

It can be made a logical assumption that the benchmark parameter – budget expenditures, depends proportionally on GDP, i.e. this ratio is constant. Forecasting of budget expenditures by means of multivariate regression *a priori* confirms this hypothesis, but only in the case when other variables do not mar up because of autoregression.

Comparison in fact both of real statistical and forecasting data (Table 5, Fig. 2) shows that the given hypothesis is completely plausible for real economic indicators for 2006-2013.

[1] At this case we might choose between prices for all energy products or only coal prices.

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Table 3

Comparing of forecasts made by additive and multiplicative models

Period	Real budget expenditures, UAH million	Additive model	Multiplicative model
2006, 1	2918,20	3129,77	2992,905
2006, 2	3441,72	3070,15	3339,779
2007, 1	3704,83	3454,70	3584,707
2007, 2	4544,61	4420,25	4488,189
2008, 1	5302,82	5685,98	5442,340
2008, 2	5639,41	5831,45	5813,456
2009, 1	4903,16	4594,89	4797,156
2009, 2	6144,56	7190,37	6755,466
2010, 1	6792,60	6868,72	6740,357
2010, 2	8256,27	7947,33	8080,356
2011, 1	9202,07	8819,93	8922,352
2011, 2	11311,77	10967,72	10895,395
2012, 1	10064,62	10035,28	9927,105
2012, 2	11649,20	11133,82	11184,619
2013, 1	9511,26	9916,03	9882,421
2013, 2	10860,64	11181,32	11244,678
Approximation error		0,0069	0,0084

Table 4

Comparing of forecasts of local budget expenditures for Donetsk region for the period until 2016

Period	Additive model	Multiplicative model
2014, 1	10914,87	11108,767
2014, 2	11711,32	12023,861
2015, 1	11880,75	12225,008
2015, 2	12514,41	12862,257
2016, 1	12754,72	13094,455
2016, 2	13243,74	13454,115

Table 5

Share of budget expenditures of Donetsk region in GDP according to model of multivariate linear regression

Year	GDP of Ukraine, GDP, USD billion	Donetsk region	
		Budget expenditures, GDP, USD billion	Share of budget expenditures in GDP
2006	511,392	6,360	0,0124
2007	672,717	8,249	0,0123
2008	939,976	10,942	0,0116
2009	867,540	11,048	0,0127
2010	1032,045	15,049	0,0146
2011	1249,544	20,514	0,0164
2012	1379,537	21,714	0,0157
2013	1398,020	22,875	0,0164
2014	1595,749	25,050	0,0157
2015	1782,903	27,071	0,0152
2016	1940,266	29,187	0,0150

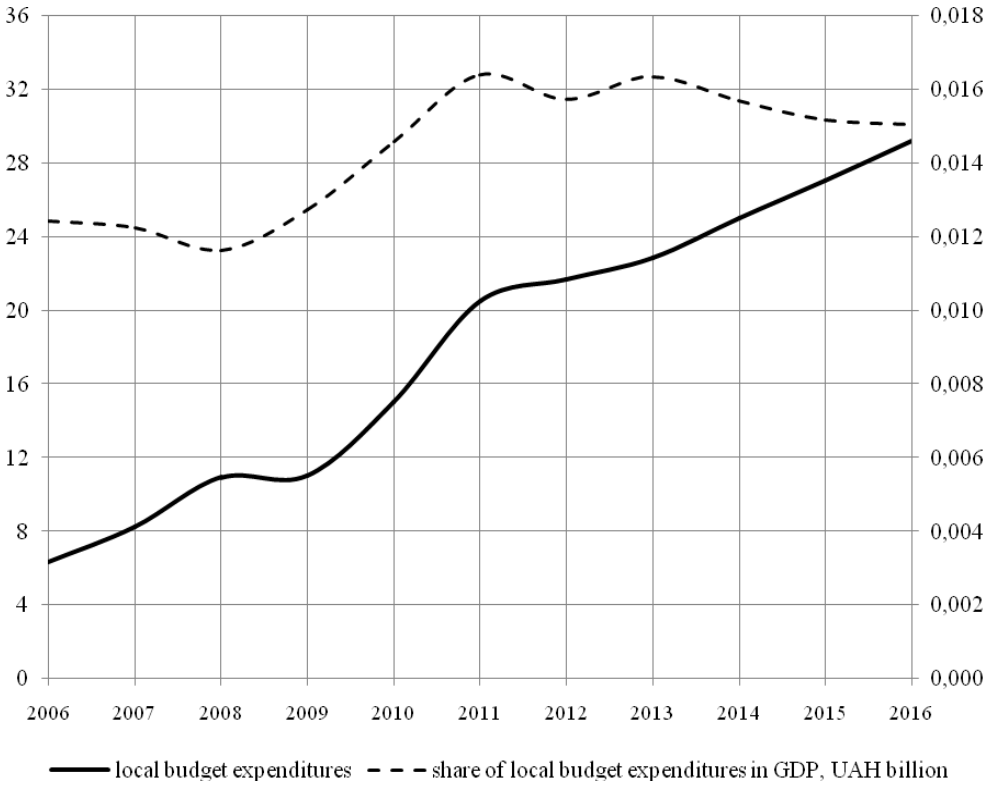

Fig. 2. Comparative dynamics of budget spending of Donetsk region and its share in Ukraine's GDP

Thus, in 2006-2009 the share of budget expenditures of Donetsk region in Ukraine's GDP stably reached the 1,23-1,27% and only in crisis year of 2008 it declined to 1,16%. Hereafter, most likely because of political factors, the value of this parameter has been increased to 1,46% in 2010; in 2011-2013 it ranged from 1,57-1,64%. According to forecast (made by means of multivariate linear regression), starting from 2014 this share should decrease nearly to 1,5% in 2016.

Such observations show on the one side the plausibility of developed model concerning its accordance to natural expectations and on the other side – the tendency of state policy in area of distribution of state funds.

Conclusions

According to findings we developed the theoretical and methodological basis of forecasting of local budget expenditures, particularly we explained the expediency of use the econometric methods and models, based on correlative factors, influencing directly in benchmark parameter – budget expenditures.

In order to forecast local budget expenditures we developed some mathematical economic models. Their further analysis allowed choosing two models satisfying in the best way to research goals: the additive model – the model of multivariate linear regression for initial data and the multiplicative (logarithmic) model for logarithms of initial data.

Further we made verification for those two models. The comparison of modeling results showed that both models sufficiently exactly approximated initial statistical data. At this, the multiplicative model occurred more exact for short-term forecasting, while the additive one is more stable at long-term forecasting.

This conclusion does not allow choosing either model for forecasting; thereat, it's advisable to made forecast as interval within predicted values of additive and multiplicative models

Modeling results showed that ratio between budget expenditures in Donets region and Ukraine's GDP is sufficiently stable, it changes continuously according to political and economical government decisions; the saccadic

changes can be naturally explained by hypothesis of external pulse effects (as it was in the second half of 2008). This confirms the adequacy of proposed model of expenditure forecast.

According to the model results for medium-term forecast in 2016 with the expected exchange rate 9,8 UAH/USD and expected inflation rate 0,5%, the budget expenditures of Donetsk region can be expected approximately as 26 UAH billion, that will be 1,5% of GDP. Forecast values are defined at the current prices.

It should be noted that modeling results should be defined more exactly in further, whereas only by means of broaden economic analysis one can improve accuracy of forecasting of local budget expenditure in Ukraine.

Results of forecasting, as well as analytical conclusions can be useful for budget management in Donetsk region. Developed mathematical economic models can be used to forecast spending of local budgets of Ukraine.

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