

Research Article

Simulation of Territorial Development Based on Fiscal Policy Tools

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Modern approaches to the development of a national economy are often characterized with an imbalanced inflation of some economic branches leading to a disproportional socioeconomic territories development (SETD). Such disproportions, together with other similar factors, frequently result in a lack of economic integrity, various regional crises, and a low rate of the economic and territorial growth. Those disproportions may also conduce to an inadequate degree of the interregional collaboration. This paper proposes the ways of regulating imbalances in the territorial development based upon the fiscal policy tools. The latter can immediately reduce the amplitude of economic cycle fluctuations and provide for a stable development of the economic state system. The same approach is applied to control the processes of transformation of the tax legislation and tax relations, as well as the levying and redistribution of the recollected taxes among the territories' budgets (this approach is also known as a tax policy). To resume, this paper describes comprehensive models of financial regulation of the socioeconomic territorial development that can help in estimating and choosing the right financial policy parameters. These provide the stable rates of the growth of national economies along with a simultaneous decrease in interregional socioeconomic disproportions.

1. Introduction

This study will expose the issue of the socioeconomic development of the nonuniformity of regional socioeconomic systems, which is one of the most commonly occurring issues in the world today. Political leaders, economists, and sociologists will often present asymmetry of regional development and growth in the variability of the territory's development, divergence, differentiation, and unbalanced development of some areas and regions. All of these terms are used to describe the situation of dissimilar growth of the separate elements, which forms the socioeconomic system of the region or country and also of the world which lead to negative trends that threaten the integrity of the whole economic system. This situation is the cause of the nonuniformity of development and is regarded as a major factor in the destabilization of, and fundamental changes in, regional policy. The dominant theories of unbalanced development highlight that without government regulation the market objectively increases the regional disparities into a force of cyclicality and market mechanism self-organization, thus establishing the higher development of the economy in some regions and a weakness in others.

Socially oriented strategies of economic space determine development following global priorities for a state's regional policy as a provision of unified social standards and reduction of the interregional economic differentiation. Among the state regulation territorial development tools are, for example, creation of special economic zones, infrastructure development, preparation of the territories for industrial mastering, stimulation for attracting investments, and so forth. This study shows the practice of regional economic management, with the most effective being the financial tools, such as financial support of the regional funds formation, separate economic budget financing developed for sectors within regions, and tax policy. This study presents an existing fiscal (or tax) policy, which highlights some of the redistribution of financial resources, leading to the inevitable infringement of the interests of regional donors, a slowdown in economic growth rates, absence of stimulus for less developed regions, a reduction in subsidization levels, and an increase in competitiveness. Some economic imbalances induce political imbalances and consequently a growth of social intensity, the forming of threats in border regions, an absence of any motivation of interregional collaboration, and a strengthening of centrifugal tendencies. A current situation or event leads to the need for a correction of regional policy, in particular, financial policy. One of the directions for the improvement of regional financial policy includes a model basis development for state financial regulation of the territory's development.

In modern scientific and economic publications, approaches to the simulation of the regional policy are considered [1–15]. In such publications [1, 2] it is considered that such simulation methods of the budget regulation mechanisms are at different hierarchical levels, as well as econometric methods and panel data. The research is presented in [3, 4] and considers some of the questions using the space-lagged models for testing an available overflow effect and the possibility of costs decreasing, which are linked with a stimulation of regional development. In publications [5-10], some of the fundamentals of the socioeconomic system dynamic models and the simulation models of the region are considered. Publications [11-13] consider questions of optimization method development for regional development strategies and analysis of the interregional economic collaboration based on a complex (or a set) of optimization interregional and interbranch models. The works [14, 15] offer a complex (or a set) of models, which give the possibility of determining the state regulation priority of ability to vital spheres of the regional systems and improve the effectiveness of target coordination based upon a multidimensional analysis and adaptive filtration methods.

Enough interest can be recognized in the development of the models to form an effective regional policy. However, some approaches remain unstudied, which allow to obtain an estimate of consistency for tax, budget policy, and dynamics if the investment processes have its influence on the convergence processes of regional development.

The management tool for simulation is based upon the balanced tax policy of the scenario simulation. This allows for research into some of the cause-and-effect factor links, which have an implicit structure. This model also allows the formation of a spectrum of development strategies and implements an estimation of some of the realization consequences for different variants of management actions, which are directed towards eliminating some of the imbalances in the regional systems development [16]. An adequate tool for the scenario realization approach is a simulation model, which provides some experimental possibilities and is linked with an estimation and different management scenario analysis of the region's socioeconomic development. The base conception for a simulation of the financial flows of territories is considered the advantages of the method of system dynamic [17], which give the possibility for an account of all structural relationships among some variables and time aspects of transformations.

In this research, a model development scenario was staged for the financial regulation territorial development, which is directed to form a multicomponent economic system and can provide an emergence of reverse interregional links and sustainable development of the common economy. These scenarios are shown as sequences of some states of the socioeconomic territorial system through the realization of different variants of the financial regional policy.

2. Scenario Elaboration Conceptual Scheme for Financial Regulation of the Territorial Development

The proposed conceptual scheme for the scenario elaboration of the financial regulation of the territorial development and the content for the stages of this scheme is shown in Figure 1.

In the first stage, the initial scenario of changes in the characteristics of territorial socioeconomic development (SED), due to the implementation of the adopted fiscal policy, is developed. Meeting the challenges of this phase is carried out using the model alignment imbalances using tax instruments and the proposed simulation model of regional financial regulatory [17]. The financial regulatory model of the territorial development has two main components: (1) the unit of resource allocation and (2) the unit of socioeconomic characteristics of the region.

The purpose of the first block is to simulate the possible value of the regional investment of transfers, subventions, and grants. Targeting of the second block is to simulate the impact of the value of investment transfers, subventions, and grants to the regions for the socioeconomic development of regional systems. Therefore, a simulation model of financial territorial regulation allows conducting multivariate projections of regional and state economic development, depending on the adopted financial regulation state policy. Output data of this stage are inversion scenarios of SETD through accepted taxbudget policy realization.

In the second stage, the formation imbalances analysis in regional development will be performed in the following areas: estimation of the regional socioeconomic development, differentiation of the regional socioeconomic development, estimation of the imbalance of the SED in the regions, and identifying the sources of structural imbalances [18, 19].

Assessment of the level of socioeconomic development is conducted by using the reference object as a method of construction, taxonomic indicator of development. The estimation of the differentiation of SED is a dynamic analysis of regional cluster formations and the analysis of the individual propensity to migrate from regions with low levels of socioeconomic development into a group of regions with



FIGURE 1: Conceptual scheme of scenario elaboration of the financial regulation of the SETD.

a high level of socioeconomic development. Evaluation is focused on the analysis of the regional structure of the upward or downward trend of economic development. To estimate the irregularity the following data is used: coefficient of variation, coefficient of irregularity (differentiation), coefficient of imbalance, and Tail's index. Identifying the sources of structural imbalances is based upon the decomposition of Tail's index. Herewith, the following factors in increasing the regional imbalances are considered: the unbalanced development of groups of regions with a high level of SED (donor regions) and regions with low SED (recipient regions), the unbalanced development of regions with high levels of socioeconomic development, and the unbalanced development of regions with low levels of socioeconomic development.

At the third stage, the alternative scenarios of managing the development of the territories are formed, aimed at eliminating or preventing the identified structural imbalances whilst maintaining the overall positive trajectory of the national economy development. The objectives of this phase are to generate management decisions concerning the elimination of imbalances in regional development, the formation of alternative fiscal policy options, forecasting the dynamics of socioeconomic development, and selecting an option of fiscal policy. Solving the above tasks is performed by grouping the regions, considering parameters such as the level and rate of socioeconomic development. The following regions and groups were also allocated: *regions leaders* (i.e., regions with a high level and a high rate of socioeconomic development); *stagnant regions* (i.e., regions with the high level and the low rate of socioeconomic development); *developed regions* (i.e., regions with the low level and the high rate of socioeconomic development); and *problematic regions* (i.e., regions with the low level and the low rate of socioeconomic development); and problematic regions (i.e., regions with the low level and the low rate of socioeconomic development); and problematic regions (i.e., regions with the low level and the low rate of socioeconomic development); and problematic regions (i.e., regions with the low level and the low rate of socioeconomic development); and problematic regions (i.e., regions with the low level and the low rate of socioeconomic development); and problematic regions (i.e., regions with the low level and the low rate of socioeconomic development).

Formation of alternative fiscal policy options suggests changing the parameters of the distribution of investment transfers, in particular the regional development fund among the described groups of the regions. Since the cyclical downturn in the state investment policy is aimed at increasing the speed of investment flow, especially in the production of the high added value, then adjustment of the parameters of the distribution of investment transfers is based upon the research on the territories asset management ratio of the industrial and economic systems (PES) [20]. The predicted results of socioeconomic development of the regions as a result of implementation of the different options of fiscal policy underlie the formation of alternative management scenarios of SETD.

In considering the following scenarios, the alternative compensation scenario assumes an estimation of the aftermaths of the priority investment support of the regionsdonors with the implementation of pessimistic scenarios of tax revenues. The main target of the development of this scenario is to evaluate the possibility of forming a "compensatory" effect of reducing the depth of the economic crisis by changing the fiscal policy parameters. The alternative antirecessionary scenario is directed to modeling the results of the phased financial support of the recipient and donor regions. Financial support of the recipient regions allows a reduction in the level of subsidization and in the depth of the economic crisis at the beginning of the implementation of the state stabilization policy. The financial support of the donor regions is aimed at promoting an inward investment in the production of high additional value and preventing the effect of a "deferred" cyclical downturn in the forecast period. Selecting an option of the fiscal policy based on the analysis of the parameters of the regional financial policy offers the alignment of the regional socioeconomic development while maintaining the positive trend in the economy.

Thus, the proposed scheme (Figure 1) of the socioeconomic development scenarios of the regions makes it possible to assess the consistency of fiscal, monetary, and investment policies and to increase the quality of information-analytical basis for decision-making and concerning the elimination of territorial imbalances.

3. Financial Regulation Model of the Territorial Development

Developing the scenarios of socioeconomic development of the territories is based on the financial regulation model, which includes simulation models of budget system, indicators, and socioeconomic characteristics of the regions. Together with other similar traditional approaches, such as a method of system dynamics, the proposed simulation models include some other dynamic econometric models, which is a feature of those models. The structurally determined equations are using the panel data models [1], which allow researching the space-dynamic effects of a realization of the fiscal policy.

In general, the panel data model cab will be presented as follows: $y_{it} = \alpha + x'_{it} \times \beta_{it} + u_{it}$, where y_{it} is a value of the researched indicator for *i*th region in *t*th time period, $i = \overline{1, n}, t = \overline{1, T}$; x'_{it} is a vector of the explaining variables (factors); u_{it} is a disturbance for the *i*th region (object) in *t*th time period; β_{it} is the model parameters (indicators). This model is a general model, so it is suggested that a standard presentation is used for constancy of the parameters (indicators) β_{it} for the all values indexed by *t* and *i*. The panel data specific model can give a possibility for additional division of disturbances on some of the components (parts): $u_{it} = \mu_i + \varepsilon_{it}$, where μ_i is the unobservable specific and individual effects and ε_{it} is the residual "noises."

Models with a fixed or random effect depend on suggestions of a property (or character) regarding the value μ_i . If the value μ_i is *n*th unknown fixed parameters, then this model is one from a set of panel data standard models with fixed effects and it can be presented as follows: $y_{it} = \mu_i + x'_{it} \times \beta + \varepsilon_{it}$. It is suggested that the average level of a dependent variable for the *i*th region can differentiate from an average level of dependent variable *j*th and is also a permanent variable for a different time period and is implemented into this model with the help of different cross-section values μ_i . Different constant values μ_i will be estimated for different objects. At the same time, these estimated parameters β_i would be similar to all the objects and for all time periods. Besides, the general (common) cross-section α will be absent in this case because if it exists, then this cross-section α in this model will raise an effect of multicollinearity.

If it is possible that μ_{it} is explained as a realization of independent values from X_{it} random variables, then this model belongs to a type of standard panel data model with random effects. In some models with a random crosssection effect, μ_{it} is defined as a random value, which has a zero expectation, but the perturbations u_{it} are unrelated for different time periods. The model with random effects has the following type: $y_{it} = \alpha + x'_{it} \times \beta + \mu_s + \varepsilon_{it}$, where α is a general cross-section. In these models with random effects, in contrast to those models with a fixed effect, the general crosssection can be identified and separately estimated.

The main contrast among panel data models with fixed and random effects is shown by the cross-section of those models. In the models with a random effect, the crosssections are considered as random values, whereas the models with a fixed effect—as the fixed values—exhibit differences in some objects.

The model with fixed effects $y_{it} = \mu_i + x'_{it} \times \beta + \varepsilon_{it}$ can be considered as a model with an individual fictitious value; that is, for each region, a variable is introduced which has an individual character. Implying the existence of the same parameters for all regions for all time moments, the availability of heterogeneity among some observation objects with the invariant objects with respect to time, but with a specific location parameter for each object, can be researched. By introducing fictitious variables,

$$d_{ij} = \begin{cases} 1, & i = j, \\ 0, & i \neq j \end{cases}$$
(1)

for each object, this model can be presented as a standard model: $y_{it} = \sum_{j=1}^{n} \mu_j d_{ij} + x'_{it} \beta + \varepsilon_{it}$. For an estimation of these parameters the intragroup transformation is used— $y_{it} - \overline{y}_i = (x_{it} - \overline{x}_i)'\beta + \varepsilon_{it} - \overline{\varepsilon_i}$. If the ordinary least squares- (OLS-) method is used, leading to a regression through the beginning

of the origin of coordinates, a consistent estimate will be obtained:

$$\widehat{\beta}_{\text{FE}} = \left(\sum_{i=1}^{n} \sum_{t=1}^{T} (x_{it} - \overline{x}_i) (x_{it} - \overline{x}_i)'\right)^{-1}$$

$$\cdot \sum_{i=1}^{n} \sum_{t=1}^{T} (x_{it} - \overline{x}_i) (y_{it} - \overline{y}_i).$$
(2)

Due to the subtraction of the time average of the data, this estimation is accountable with a variation in the borders of the object of observation. The estimations of individual effects can be used as $\mu_i = \dot{y}_i - \dot{x}'_i \cdot \hat{\beta}_{FE}$. These estimations are unbiased and consistent estimations for fixed *n* at $t \rightarrow \infty$. A formula for a covariance matrix has the following type: $V(\hat{\beta}_{FE}) = \sigma_{\varepsilon}^2 (\sum_{i=1}^n \sum_{t=1}^T (x_{it} - \overline{x}_i)(x_{it} - \overline{x}_i)')^{-1}$. As a dispersion estimation, σ_{ε}^2 can use $\hat{\sigma}_{\varepsilon}^2 = (1/(nT - n - k)) \sum_{i=1}^n \sum_{t=1}^T (y_{it} - \overline{y}_i - (x_{it} - \overline{x}_i)'\hat{\beta}_{FE})^2$. Here a bilevel procedure was used, whereby at first a calculated estimation was made with an account of the variation among the objects of observation and, afterwards, a calculation of the individual effects is provided.

The model with random effects cannot effectively be estimated either, with the help of the OLS-method, because some mistakes in suggestions for this model are correlated between them due to the presence of a specific summa for each object of observation. Therefore, the bisteps procedure FGLS is used:

$$\widehat{\beta}_{\text{RE}} = W\widehat{\beta}_{\text{FE}} + (I_k - W)\,\widehat{\beta}_b,\tag{3}$$

where

$$\widehat{\beta}_{B} = \left(\sum_{i=1}^{n} T(\overline{x}_{i} - \overline{x})(\overline{x}_{i} - \overline{x})'\right)^{-1} \sum_{i=1}^{n} T\left(\overline{x}_{i} - \overline{x}\right) \left(\overline{y}_{i} - \overline{y}\right),$$
$$W = \left(S_{xx}^{w} + (1 - \theta)^{2} S_{xx}^{b}\right)^{-1} S_{xx}^{w}, \tag{4}$$

$$S_{xx}^{w} = \sum_{i=1}^{n} \sum_{t=1}^{1} (x_{it} - \overline{x}_{i}) (x_{it} - \overline{x}_{i})',$$

where I_k is the identity matrix with dimension k (the explanatory variables). The parameter θ is selected as follows in order that the mistakes in the model will not be interrelated at any time for different values t. Then the parameter θ assumes the following form:

$$\theta = 1 - \frac{\widehat{\sigma}_{\varepsilon}}{\sqrt{\widehat{\sigma}_{\varepsilon}^2 + T\widehat{\sigma}_M^2}}; \qquad \widehat{\sigma}_M^2 = \frac{\sum_{i=1}^n u_i^2}{n-k-1} - \frac{1}{T}\widehat{\sigma}_{\varepsilon}^2, \quad (5)$$

where u_i is the remains, which received with the help of the OLS-method in a regression with accounting a variation among objects of observation $\overline{y}_i = \mu + \overline{x}'_i \beta + u_i + \overline{\varepsilon}_i$, $i = \overline{1, n}$.

It should be noted that one of the problems of using panel data is that of choosing a model type (usual regression, fixed, or random effect). In the above models, a definite hierarchy exists. The usual regression model is a special case of the model with fixed effects, when in this model we have $\mu_i = 0$, $i = \overline{1, n}$. In addition, this model can be used as the model with a random effect (when the mistakes are absent) or the model with fixed effects (when a correlation between μ_{it} and X_{it} is absent). Therefore, with statistical tests using a null hypothesis, there is a possibility of using a particular model, but the use of alternative tests of a null hypothesis means the possibility to use a common (general) model. The choice of model specification exists and is based on the *F*-test, Breusch-Pagan's test, and Haussmann's test.

F-test. A null hypothesis is formed to check the statistical significance of cross parameters in a model H_0 where H_0 : $\mu_i = \mu_j$ for any *i*, *j*. It corresponds to a model with the same parameter μ for all objects sampled, that is, to an aggregated model. The alternative hypothesis consists of the following fact that $H_1: \mu_i \neq \mu_j$, at least for one pair *i*, includes of a model with fixed effects. The calculated criteria value is calculated as follows:

$$F = \frac{R_{\text{pool}}^2 - R_{\text{FE}}^2}{1 - R_{\text{FE}}^2} \frac{nT - n - k}{n - 1}$$

$$= \frac{Q_{\text{pool}} - Q_{\text{FE}}}{Q_{\text{FE}}} \cdot \frac{nT - n - k}{n - 1} \overset{H_0}{\sim} F(n - 1, nT - n - k).$$
(6)

Breusch-Pagan's Test. In order to check the statistical significance of the random effects, a calculation is made with the help of Lagrange's multiplier test:

$$LM = \frac{nT}{2(T-1)} \left(\frac{\sum_{i=1}^{n} \left(\sum_{t=1}^{T} e_{it} \right)^{2}}{\sum_{i=1}^{n} \sum_{t=1}^{T} e_{it}^{2}} - 1 \right)^{2}, \quad (7)$$

where e_{it} is the oddments of the aggregated regression model.

If the hypothesis H_0 is true, then the statistic LM has χ^2 distribution and is valid with a single degree of freedom.

Haussmann's Test. Due to the most important difference in the heterogeneity simulation approaches of observable objects, there is a relation among input effects with some regressors (undefined variables). In this case, the random effects are suggested as interrelated with these regressors, whereas the fixed effects can be correlated with them. In addition, the choice of model with fixed or random effects depends on whether these effects are correlated or not with those regressors. During the validity of the hypothesis H_1 , the model estimations with the fixed effects exist, but the model estimations with the random effects do not exist. In this case, some significant differences can be found between estimations of these two models. The value of Haussmann's statistic is calculated as follows:

$$H = \left(\widehat{\beta}_{\rm FE} - \widehat{\beta}_{\rm RE}\right)' \widehat{\Phi}^{-1} \left(\widehat{\beta}_{\rm FE} - \widehat{\beta}_{\rm RE}\right),\tag{8}$$

where the estimation $\widehat{\Phi}$ is for the covariance matrix $(D(\widehat{\beta}_{FE}) - D(\widehat{\beta}_{RE}))$.

Such modelling is based upon the consideration of information and data for building models of a budget system and data on the socioeconomic development of Ukraine in the last 15 years.

A simulation model of the dynamics of the budget system indicators, which includes such variables as revenues of the consolidated budget, health care expenses, educational expenses, social protection and social security expenses, economic activity expenses, state budget expenses, donations, grants, and investment transfers to the regions, is based on a system of 11 equations. Some of these are presented below.

Health Care Expenses

$$Zatr_oh_zd_t = 0.06704 \cdot Dohod_svodnogo_budgeta_t + 0.021184 \cdot VVP_{t-1},$$
(9)

where Zatr_oh_zd_t is the health care expenses (million UAH, is the ISO 4217 currency code of the Ukrainian hryvnia, the national currency of Ukraine), Dohod_svodnogo_budgeta_t (is the variable, which describes the revenue (income or profit) part of the aggregate budgets: operational, investment, and financial) is the revenues of the consolidated budget (million UAH), and VVP_{t-1} are the gross domestic product (GDP), with a lag equaling 1 (million UAH).

The determination coefficient of the dynamical model was 0,99573; the following calculated values of *t*-test 3,0658 and 2,75002 are greater than the table value, which allows the conclusion that estimates of the model parameters are statistically significant; the value of the Durbin-Watson statistic equal to 1,56 indicates the absence of autocorrelation in a number of residuals.

Educational Expense

$$Zatr_obbrazov_t = -4853.6 + 0.12$$

$$\cdot Dohod_svodnogo_budgeta_t \qquad (10)$$

$$+ 0.04 \cdot VVP_{t-1},$$

where $Zatr_obbrazov_t$ are the educational expenses (million UAH).

The determination coefficient of the dynamical model was 0,994; calculated values of *t*-test, 3,07, 3,56, and 3,88, are greater than the table value at a 1% level of significance, which leads to the conclusion that estimates of the model parameters are statistically significant.

The general (common) view of a simulation model of the budget system indicators is shown in Figure 2.

In the socioeconomic simulation model characteristics of the territory development, such variables are considered as gross regional product, total export volume, investment in fixed assets, level of employment, the total import volume, volume of innovative products, value of foreign investments, the average monthly wage, income, level of economically active population, and the provision of housing, bringing into service the apartments and the number of students at universities. A few equations are presented in Figure 2.

Gross Regional Product

$$VRP_{it} = \mu_i^1 + 2474.059 \cdot Export_{it} + 0.566316 \cdot IOK_{it} + 62.60181 \cdot Zan_nas_{it} + 0.888341 \cdot VRP_{it-1},$$
(11)

whereVRP_{*it*} is the gross regional product for the *i*th region per capita (UAH); is the fixed effect in the *i*th region; Export_{*it*} is the total export volume of the *i*th region per capita (thousand USD); IOK_{*it*} is the investments in fixed assets of the *i*th region per capita (UAH); Zan_nas_{*it*} is the level of employment of the *i*th region (% of population aged 15–70 years); VRP_{*it*-1} is the gross regional product for the *i*th region per capita with lag equaling 1 (UAH).

The coefficient of considered panel data model determination was 0,978; calculated values of *t*-test, 48,448; 2,899; 7,86; and 8,56, are greater than the table value, which leads to the conclusion that estimates of the model parameters are statistically significant.

The Total Export Volume

$$\begin{aligned} \text{Export}_{it} &= \mu_i^2 + 0.434655 \cdot \text{Export}_{it-1} + 0.132915 \cdot \text{Export}_{it-2} \\ &+ 0.0000054 \cdot \text{VRP}_{it-1} + 0.0000591 \cdot \text{OB}_{-}\text{IP}_{it}, \end{aligned}$$
(12)

where the fixed effect is in the *i*th region; $OB_{-}IP_{it}$ is the volume of innovative products of the *i*th region per capita (UAH); Export_{*it*-1} is the total export volume of the *i*th region per capita with lag equaling 1 (thousand USD); Export_{*it*-2} is the total export volume of the *i*th region per capita with lag equaling 2 (thousand USD).

The determination coefficient of the considered panel data model was 0,854491; calculated values of *t*-test, 2,7167; 2,7494; 6,02; and 1,77, are greater than the table value, which leads to the conclusion that estimates of the model parameters are statistically significant.

The Total Import Volume

$$Import_{it} = \mu_i^3 + 0.4263 \cdot Import_{it-1} + 0.0000886 \cdot OB_{it}$$
$$- 0.0000499 \cdot OB_{it-1} + 0.0000054 \cdot VRP_{it-1},$$
(13)

where the fixed effect is in the *i*th region; Import_{*it*} is the total import volume of the *i*th region per capita (thousand USD); $OB_{-}IP_{it-1}$ is the volume of innovative products of the *i*th region per capita with lag equaling 1 (UAH); Import_{*it*-1} is the total import volume of the *i*th region per capita with lag equaling 1 (thousand USD).

The determination coefficient of the considered panel data model was 0,7117; calculated values of *t*-test, 5,81; -2,39; 4,58; and 4,69, are greater than the table value, which leads



FIGURE 2: Simulation model for budget system indicators.

to the conclusion that estimates of the model parameters are statistically significant.

The Average Monthly Wage

$$Sr_ZP_{it} = \mu_i^4 + 22.44544 \cdot Zan_nas_{i,t-1} + 0.097669 \cdot VRP_{it},$$
(14)

where Sr_ZP_{it} is the average monthly wage in the *i*th region (UAH); is the volume for a fixed effect for the *i*th region; Zan_nas_{*it*-1} is the level of employment in the *i*th region with lag equaling 1 (% of population aged 15–70 years).

The general (common) type of the simulation model of a dynamic of the socioeconomic region indicators is shown in Figure 3.

The determination coefficient of the considered panel data model was 0,9727; calculated values of t-test, 5,39 and 56,609, are greater than the table value, which leads to the conclusion that estimates of the model parameters are statistically significant.

The list of exogenous simulation model parameters sets is presented in Table 1.

The comprehensive country financial regulatory model of the socioeconomic region development includes a simulation

model of the budget system indicators and 25 simulation models of the socioeconomic region indicators (characteristics).

With analysis of some results, which were received by these simulation models, it is possible to make a highly precise forecast of economic value and confirm the necessity for use of scenario development. The comparison results for the actual and calculated values of the socioeconomic regional development studied indicators are shown in Figures 4(a)-4(d). Other indicators received similar results.

Analysis of the findings leads to the conclusion that the simulation model provides the highest accuracy in forecasting such indicators as GDP per capita, the interest rate on the loan, the level of employment, and the provision of housing. The prediction error for these parameters varies from 0,412% to 8,8649%. Similar results were also obtained for the other indicators.

Generally, the prediction error of the simulation model of financial regulation for the regional development does not exceed 11%, which proves the possibility of its utilization for the socioeconomic development of the territories of the characteristic change scenarios due to the implementation of different fiscal policy variants.



FIGURE 3: Dynamic simulation model of the socioeconomic region indicators.

TABLE 1: The values of exogenous parameters set.

Symbol	$\operatorname{Szdr}_i i = \overline{1,25}$	$\operatorname{Sobr}_i i = \overline{1,25}$	$\mathrm{Scosz}_i \ i = \overline{1,25}$	$It_i \ i = \overline{1,25}$	$\text{Inv}_i \ i = \overline{1,25}$	$D_V_i i = \overline{1,25}$	$\operatorname{Fid}_i i = \overline{1,25}$
Symbol		Coefficients of the subventions distribution			Coefficients distribution		
Description	For health	For education	For the social protection and security	For the investment transfers	Public investment	Equalization grants	Funding innovation

4. Forming of the Inertial Scenarios and Analysis of the Imbalances for the Regional Development

According to the demonstration in the scheme in Figure 1 at the first stage of the formation, the inertial scenarios were performed, which assumes the study of the dynamic changes of the characteristics of the socioeconomic development territories due to the adopted fiscal policy implementation. In the scenario development, an account was made of tax reforms, regarding the reduction of a tax burden on legal persons, reduction of value-added tax, an increase in the tax burden on physical persons with a high-level income, and an increase in the excise tax for such goods groups as alcohol, tobacco, fuel, and cars to increase of the import customs duties.

Calculating the value for the interbudget transfer changes in the budget policy, with respect to forming of a regional development fund, was taken into account. Also, two inertial scenarios were developed: (1) the optimistic inertial scenario, which is accounted for as an extension of the tax base owing to a change of parameters of the tax policy, and (2) the pessimistic inertial scenario, which is based upon the availability of a time lag indicating the positive "feedback" in an economy and, as a result, informing of the budget deficiency.

An estimation of the socioeconomic regional development level dictates a realization of the accepted fiscal policy, which existed with the help of the development level method [8]. The choice of this method is due to the following advantages: absences of some limits for a number of signs for the information space (a number of indicators can be included in an indicator system, a positive dynamic of which is confirmed by a reduction in the growth of the SER level); an original indicator system can include some signs which have a different dimension, some values of an integral indicator which have a normative range of changes that provides an interpretation of the received results. The level development indicator is calculated by the formula $d_i^* = 1 - (c_{i0}/c_0)$, where $c_0 = \overline{c}_0 + 2S_0, \, \overline{c}_0 = (1/n) \sum_{i=1}^n c_{i0}, \, S_0 = (1/n) \sqrt{\sum_{i=1}^n (c_{i0} - \overline{c}_0)^2},$ and $c_{io} = \sqrt{\sum_{j=1}^{m} (Z_{ij} - Z_{0j})^2}$ is the Euclidean distance among points-units (regions) and the point P_0 ($z_{01}, z_{02}, \ldots, z_{0m}$),

which is a developed etalon. Fundamentals for the building of



(c) Actual and forecast values of specific gravity for the number of specialists who are doing the scientific and technical works by Ukraine's regions (%)

(d) Actual and forecast values of number of students in the universities (high schools) (students on 10,000 population) by Ukraine's regions

FIGURE 4: Compared actual and forecasted values of the indicators of the socioeconomic regional development.

a developed etalon are using a sign separation on a stimulant and destimulant. Some signs, which provide a positive and stimulating influence on the level of the socioeconomic regional development, are called stimulants, in contrast to the sign-destimulants. The coordinates of the developed etalon are calculated as follows:

$$z_{0j} = \begin{cases} \max_{i} z_{ij}, & \text{если } j \in I, \\ \min_{i} z_{ij}, & \text{если } j \notin I, \end{cases}$$
(15)

where *I* is the set of stimulants. Due to the sign-destimulants having different dimensions, then at the formation of the matrix of the distances $C = (d_{i0})$, $i = \overline{1, n}$, is existing their standardization based on the following formulas: $z_{ij} =$

 $(x_{ij} - \overline{x}_i)/S_j$, $S_j = \sqrt{\sum_{i=1}^n (x_{ij} - \overline{x}_j)^2/(n-1)}$. The values of the integral indicator change in the range from 0 to 1. The nearer values to 1 of this indicator mean the higher level of socioeconomic region development.

The results of the integral indicator calculation on the level of the socioeconomic region development, received and based on average values of socioeconomic development indicators for 25 regions in the forecast period and characterized by a tendency for the development of a national economy in general, are shown in Figure 5.

From Figure 5, the stabilization policy is available, and positive effects are obtained in the medium perspective by two developed scenarios. This fact is confirmed by a dynamic value for the integral indicator for 2013-2014. Due to the reduction of integral indicator values in 2015 the possibility



FIGURE 5: Integral indicator dynamic on the level of socioeconomic regional development.

of creating a conclusion about the forming of a descending developed tendency and occurrence of the "differed" cyclical downturn was obtained.

The economic space proportions were studied with the help of the cluster analysis methods [8, 9, 16]. Classification consists of the decomposition of an initial set of regional points to make a comparison of a small number of classes $Q = \{Q_1, Q_2, ..., Q_n\}$. As for the regions which are owned by one class (or group), these would be placed at comparatively small distances from each other.

The established similarity or differences among regions (or among classified objects) are dependent on the metric distance between them. The following distances are used to measure among objects (Table 2).

The final conclusions confirm the necessity of a distribution parameter correction for interbudget transfers with the purpose of saving positive developed tendencies of a national economy. In this connection, a forecasted dynamic analysis was made of the socioeconomic region development during 2013–2015. An analysis was made of the structure of the region's cluster formations, a tendency of separated regions of migration of a group with a low level of socioeconomic development to a group with a high level of SETD.

For the building of the group of the hierarchical agglomerative and iterative methods were used. The hierarchical agglomerative methods can only give a conditionally optimal solution in a subset of a local portion (or cluster). However, an advantage of these methods is the calculated simplicity and interpretation of the results received. An entity of the hierarchical agglomerative method is included in the fact that, on the first step, each selected object is considered as a separated cluster. The combining clustering process occurs successively; the most similar objects unite which are based on the distance matrix or the similarity matrix. Clusterization results, which are presented as a dendrogram, allow the presentation of a hypothesis about the number of clusters. This number of clusters is used for choosing initial conditions for the iteration algorithm, which is based on the method of "k-means" [14]. The algorithm of this method includes the following fundamental steps: k points (or regions) are randomly selected or are indicated from n regions by a researcher based on some prior considerations.

These points are like etalons; a sequence number, which at the same time is a cluster number, is assigned to each etalon; from the remaining (n-k) regions the point X_i is retrieved with the coordinates (x_{i1}, \ldots, x_{im}) and it is checked for which etalons (or centers) it is closest to. The checked region joins that center (or etalon), to which $d_l = \min d_{il}$ $(l = 1, \ldots, k)$ matches. This etalon is replaced by the new one, which was recalculated with an account of a jointed point, and its weight (a number of regions are included in this cluster) is increased by one. If there are two or more minimal distances, then *i*th region is attached to a center with the smallest sequence number; afterwards, the point X_{i+1} will be selected and all the steps (procedures) are repeated.

Thus, via (n-k) steps, all points (regions) of a set will be assimilated to one of the k clusters, but the partition process is not finished with this step. In order for the stability of a partition to be received according to a similar rule, then all points X_1, X_2, \ldots, X_n are connected to received clusters again, whilst at the same time the weights continue to accumulate. The new partition is compared with a previous portion and they are the same; then this algorithm is completed. In another case, this cycle is repeated. The final partition may have some gravity centers, which do not match with the etalons, so they can be classified as C_1, C_2, \ldots, C_n . At the same time, each point X_i $(i = 1, 2, \ldots, n)$ will relate to that cluster (or class), for which the following $D(x_j, c_l) =$ min $d(x_i, c_i)$ pertains.

After finishing the classification procedures, there is a need to estimate the received results. For this, a measure of a classification quality can be used, a so-called "the functional of a quality." The best partition should be considered as such a partition by selecting the functional, of which an extreme value of the objective function, the functional of a quality, can be achieved. The following functionals of a quality were considered in the partition analysis: $F_1 = \sum_{l=1}^{k} \sum_{i \in S_l} d^2(x_i, \overline{x}_l), F_2 = \sum_{l=1}^{k} \sum_{i,j \in S_l} d^2_{ij}, F_3 = \sum_{l=1}^{k} \sum_{j=1}^{p} \sigma_{lj}^2$. Optimal partition is a partition where we have $F_i \to \min_{S \in A}$ and where A is the set of all allowable partitions.

For determining a cluster number, which is needed to split the original region set, the hierarchical agglomerative methods were used. As a distance, the Euclidean distance measure was considered. For determining the distances among a random cluster pair, Ward's method was used, which allowed the minimization of the sum of squared deviations among each region (object) and a cluster center, which was included in this region. A graphical analysis of the grouped results, which were presented as a dendrogram (Figure 6), allowed the conclusion to be made that the researched regions set could be split into two objects, or groups, similar to the socioeconomic developmental characteristics.

The method of "*k*-means" was used as a stable analysis for receiving classification. The results obtained allowed a conclusion to be made regarding the saving of a socioeconomic territories development differentiation in a forecast period. Region clusters with a high and low level of socioeconomic development are sustained by their own structure.

Distances measure among objects	Calculated formula	Conditions of using
The common Mahalanobis distance	$d_{ij} = \sqrt{(X_i - X_j)' \Lambda' S^{-1} \Lambda (X_i - X_j)}$, where d_{ij} is the distance between <i>i</i> th and <i>j</i> th regions (or objects); X_i, X_j are the value vectors of the SETD indicators for <i>i</i> th and <i>j</i> th objects; <i>S</i> is the common covariation matrix; Λ is the matrix of weighting coefficients	Is used in case of dependent vector components x_1, x_2, \ldots, x_n and their different significance at classification
Euclidean's distance	$d_{ij} = \sqrt{\sum_{k=1}^{m} (x_{ik} - x_{jk})^2}$, where x_{ik} , x_{jk} are the values for <i>k</i> th indicator, respectively, for <i>i</i> th and <i>j</i> th objects	Is used in case if the vector observation components <i>X</i> are homogeneous by physical sense and are equally important for classification
Weighted Euclidean's distance	$d_{ij} = \sqrt{\sum_{k=1}^{m} w_k (x_{ik} - x_{jk})^2}, \text{ where } w_k \text{ is the weight,}$ which can be used for <i>k</i> th indicator	Is used in case when for each vector component <i>X</i> can be used as a weight, which is proportional for a degree of a sign important $0 \le w_k \le 1$
Hamming's distance	$d_{ij} = \sum_{k=1}^{m} \left x_{ik} - x_{jk} \right $	Is used as a difference measure of the objects, which can be defined by dichotomous signs

TABLE 2: Distances measures among objects (regions).



FIGURE 6: Classification dendrogram.

For example, 15 regions, which are included in a group with low developed levels in the preforecast classification and in the forecast period, are saving their own position. A tendency to migrate from one cluster to another is observed in just two regions. A specific regional weight, with a high and low level of SETD, is shown in Table 3.

The results obtained allow the conclusion to be made that in the forecast period a convergence in regional development levels was observed. A value of one of the nonuniform indicators (variation coefficient) for the end of the forecast period in the first development scenario is 18,043% and in the second development scenario is 22,707%. Consequently, we can explain the decrease in the financial possibilities for an uneven smoothing of the territorial development. However, some uneven indicators, which were received from the end of the forecast period, are confirmed as a decrease in interregional differentiation on account of allowed regional policy. The final direction for an analysis of the socioeconomic territorial development is the detection of some "factorssources" of structural imbalances, which are based on a decomposition of Tail's index. At the same time, the following amplification factors of the regional imbalances are considered: the imbalance of a development among the groups by region-donors and regional-recipients and imbalanced development into a region's group with a high and low level of socioeconomic development.

As is shown by the analysis that was carried out, one of the general factors which formed was from an imbalance based upon intergroup socioeconomic differentiation. However, some minor decreases in the forecast period of this differentiation can be seen. Unfortunately, some divergent processes are characterized by a group of regional-donors; this is a source of the occurrence for an effect of "deferred" cyclical downturn (shown in Figure 5). Rates comparable to the economic region's growth, with high and low developed levels in the preforecast and forecast periods, show that the preforecast period of outstripping rates was characterized for the first regional group, when the forecast period of the economic growth rates for this group is significantly slowed down.

Therefore, the regions-donors are one of the primary sources for the formation of regional imbalances; they are also confirming the necessity for a correction of the tax-budget policy.

5. Forming and Analysis of Alternative Scenarios of Socioeconomic Regional Development

In forming the alternative scenarios of regional policy, the regions were grouped by level and rated according to the socioeconomic region development. The research regions, selected by classification variables, will allow the following

Smarife marian variabt	Preforecast classification	The period of feed forward			
Specific region weight		1	2	3	4
With the low level of SETD	64%	72%	64%	64%	64%
With the high level of SETD	36%	28%	36%	36%	36%

TABLE 3: Specific regional weight with a high and low level of SETD.



FIGURE 7: The specific weight of an investment transfer, which was selected from the region's groups.

groups: region-"leaders" (regions with a high level and rate of SETD); stagnant regions (regions with a high level and low rate of SETD); developing regions (regions with a low level and high rate of SETD), and "problematic" regions (regions with the lowest level and a low rate of SETD). An analysis of the specific weight of investment transfers, which was selected from these groups of regions (as is shown in Figure 7), allows the conclusion that an accepted financial and regional policy is directed, at least, to supporting the stagnant and problematic regions.

It can be concluded that the accepted policy levels, for alignment of socioeconomic regional development, lead on one side to an imbalance and decrease in regional development on account of a level reduction of regional depression and accelerated regional growth with a low level of socioeconomic regional development. However, it leads to a significant slowdown in the rate of growth for a region's group with a high level of socioeconomic regional development.

As a result of the above, the priority of the countrywide investment policy, under some conditions of cyclical downturn, is an increase in the investment and innovation activity of the enterprises, which are making products with high added value. A parameter correction is necessary if the fiscal policy is based on analysis of the impacts of resources in regional systems. Research methods, which analyze the impact of resources, are production functions, based on panel data without accounting for a factor of scientific progress. The variants of the panel data model were considered and are defined as

$$\ln \text{VDS}_{it} = \ln \beta_{0i} + \rho_i t + \beta_{1i} \ln \text{Zan}_{it} + \beta_{2i} \ln \text{IOK}_{it} + \varepsilon_{it},$$
$$\ln \text{VDS}_{it} = \ln \beta_{0i} + \beta_{1i} \ln \text{Zan}_{it} + \beta_{2i} \ln \text{IOK}_{it} + \varepsilon_{it},$$
(16)

where VDS_{*it*} is the gross value added per capita (in UAH) for *i*th region in *t*th time period:

Zan_{*it*} is the employed population (thousand populations per one thousand people) for *i*th region in *i*th time period;

IOK_{*it*} is the rate of investment in fixed capital per capita (in UAH) for *i*th region in *i*th time period;

 ε_{it} is the random component; β_{0i} , β_{1i} , β_{2i} , and ρ_i are unknown parameters, which need to be quantitatively estimated.

Moreover, some hypotheses were tested for the fact of separated regions with the parameter estimations β_{0i} , β_{1i} , β_{2i} , and ρ_i having no significant regional differences, that is, $\beta_{o1} = \beta_{02} = \cdots = \beta_{025} = \beta_0$; $\beta_{11} = \beta_{12} = \cdots = \beta_{1,25} = \beta_1$; $\beta_{21} = \beta_{22} = \cdots = \beta_{2,25} = \beta_2$; $\rho_1 = \rho_2 = \cdots = \rho_{25} = \rho_2$.

Due to the scientific progress being differentiated by some types of economic activity (in particular, the higher rates are observed in such industry sectors as mechanical engineering, the communications industry, and instrument making), research and detection were carried out on some types of economic activity that were characterized using the most effective technologies, which formed a "regional profile" of the impact of industry resources.

Similarly, as with the model variants presented above, which account for some regional differences in investment activity effectiveness for a dependence specification, accounting for some industry differences, the model variance was considered and is defined as

$$\ln \text{VDS(ED)}_{it} = \ln \beta_{0i} + \rho_i t + \beta_{1i} \ln \text{Zan} (\text{ED})_{it} + \beta_{2i} \ln \text{OF} (\text{ED})_{it} + \varepsilon_{it},$$

$$\ln \text{VDS(ED)}_{it} = \ln \beta_{0i} + \beta_{1i} \ln \text{Zan} (\text{ED})_{it} + \beta_{2i} \ln \text{OF} (\text{ED})_{it} + \varepsilon_{it},$$
(17)

where VDS (ED)_{*it*} is the gross value added (in million UAH) for *i*th kind of economic activity in the *t*th time period per capita":

 $Zan(ED)_{it}$ is the number of population (thousand people) who are engaged in *i*th kind of economic activity in the *t*th time period;

 $OF(ED)_{it}$ is the value of fixed assets (in million UAH) for *i*th kind of economic activity in the *t*th time period; ε_{it} is the random component;

 β_{0i} , β_{1i} , β_{2i} , and ρ_i are unknown parameters, which need to be quantitatively estimated.

The original data for model building data for 15 kinds of economic activity was used: agriculture; forestry and interlinked services; fishery (E1_E2); extractive industry; reprocessing industry; energy, gas, and water production and distribution (E3_E4_E5); construction (E6); trade, car maintenance, and household goods; hotel and restaurant activities (E7_E8); transport and communication activities (E9); financial activity (E10); real estate operations, leasing, and engineering (E11); state or government management (E12); education (E13); health care and provision of social aid (E14); provision of communal and individual services (E15).

In addition, an analysis of the regional differences of effectiveness was performed for the investments into a type of economic activity for a determination of regional priorities for a distribution of the investment transfers. The model variants of panel data were considered and are defined as

$$\ln \text{ VDS (ED)}_{it}^{j} = \ln \beta_{0i}^{j} + \rho_{i}^{j}t + \beta_{1i}^{j}\ln \text{ Zan (ED)}_{it}^{j} + \beta_{2i}^{j}\ln \text{ IOK (ED)}_{it}^{j} + \varepsilon_{it}^{j}$$

$$\ln \text{ VDS (ED)}_{it}^{j} = \ln \beta_{0i}^{j} + \beta_{1i}^{j}\ln \text{ Zan(ED)}_{it}^{j} + \beta_{2i}^{j}\ln \text{ IOK (ED)}_{it}^{j} + \varepsilon_{it}^{j},$$
(18)
(19)

where $VDS(ED)_{it}^{j}$ is the gross value added per capita (in million UAH) for *j*th kind of economic activity for the *i*th region in the *t*th time period:

 $Zan(ED)_{it}^{j}$ is the number of population (thousand people) who are engaged in *j*th kind of economic activity for the *i*th region in the *t*th time period;

 $IOK(ED)_{it}^{j}$ is the rate of investment in fixed capital per capita (UAH) for *j*th kind of economic activity for the *i*th region in the *t*th time period;

 ε_{it} is the random component; β_{0i}^{j} , β_{1i}^{j} , β_{2i}^{j} , and ρ_{i}^{j} are unknown parameters, which need to be quantitatively estimated.

The received industry functions will provide the possibility for an estimation of the technology effectively in some production investment and a potential growth in the gross added value.

From some alternative scenarios of financial regional policy, the compensating scenario (scenario 3) was considered, which provides a stimulation of economic growth for "problem" and stagnation regions and also for the region-"leaders," which have a slowdown of economic growth rates. At the same time, a transformation was being considered as the possibility for using of the distribution mechanisms from 2013. The original data for a scenario-form was being also considered for the forecast of some tax revenues, which were received based on a model of the imbalanced alignment of socio economic systems by use of tax levies. A pessimistic developed scenario also conducted this analysis, since this scenario allows an estimation of possibility for the formation of a "compensating" effect based upon a change of budget policy parameters.

In the alternative anticrisis scenario (scenario 4) a systematic financial support for the regions-recipients and regions-donors was considered. In the simulation some



FIGURE 8: The integral indicator values of socioeconomic regional development.

investment transfers values in 2013 were accounted for, which were accepted as distribution parameters for the regionaldevelopment fund in the budget codecs and are oriented to the priority financial support for "problematic" territories. Correction of the distribution parameters of the investment transfers was carried out in 2014 with the purpose of warning of a cyclic recession in a dynamic of macroeconomic indicators (this recession is forecast in 2015), which is directed to financial support not only for "problem" territories, but also for the region-"leaders," for which a significant recession of the economic growth rates is observed.

The values of the integral indicator of the socioeconomic regional development, which are characterized by a developmental tendency of national economy in general, at the different scenarios of a fiscal policy, are shown in Figure 8.

Figure 8 shows that the realization of scenario 3 is formed by a forecast stagnation phase in a dynamic of the macroeconomic indicators, which is confirmed by the effectiveness of the accepted stabilization policy, allowing a rolling over of a growth phase for 2013-2014. Change of the budget policy parameters in 2014 can provide the possibility of decreasing the crisis depth in comparison with a base pessimistic scenario of budget insufficiency. The integral dynamic indicator for realization of scenario 4 is matched with a dynamic of an integral indicator in realization of scenario 1, accounted for with an optimistic forecast for tax revenues in a budget.

6. Results of the Research

The research highlights the following conclusions: analysis of the predictive dynamics of socioeconomic development territories, in the case of the implementation of an optimistic scenario of tax revenue, demonstrates the effectiveness of the adopted stabilization policy. The research serves to prevent the establishment of a crisis in the dynamics of macroeconomic indicators and indexes of regional development, to sustain a development phase. In addition, this research allows forming the "compensatory" effect of cutting the capacity of financial regulation of the developmental territories based on varying the parameters of the regional financial policy, which should be addressed to support "problematic" areas during the pessimistic scenario development of indicators of a budget system. As well as the results of this research allow to use the "basic" policy of levelling socioeconomic development of the regions "leaders," which are a significant slowdown for the economic growth tempos. The analysis of the coefficients of the instability of socioeconomic development shows a convergence trend of the stages of economic development territories, with different scenarios of development and a reduction in intergroup socioeconomic differentiation.

7. Conclusion

The developed scenario models offer the possibility for estimating the consistency for tax, budget, and investment policy. It also allows an increase in the quality of the dataanalytical base for management decision-making with regard to the financial stability policy for regions and for the state. However, one promising direction of distribution of this inquiry is the structural and parametric adaptation of the proposed complex of the models. At the same, this complex can be used for estimation of a potential of the interregional collaboration and interaction. In addition, some other directions of this study will be able to detect of some possibilities for minimization of monetary values, which are re-connected with a stimulation of the territories development.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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