Dynamic Model of Evaluation of Financial Sufficiency of Regional Social and Economic Systems Development Strategies

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Abstract[1]

The article deals with the problem of regional social and economic systems development strategies financial sufficiency. System dynamic modelling is suggested to be used for solving problem. Financial resources flow model in the system consisting of region, territorial administrative units, economic institutional sectors is developed. Optimization model of distribution of financial resources directed on regional social and economic systems development strategies realization is considered.

1. Introduction

Modern stage of Russian Federation development is characterized by increasing level of regional independence and strengthening importance of territorial management for achieving strategic purposes of state development. Consequently, the problem of territorial management efficiency increasing is in the focus of economic science in the last years. One of the methods of territorial management efficiency increasing is regional strategic planning. The procedure of regional strategic planning is explained in detail in economic literature [1]. The following methods are used for strategic plans development: system analysis, economic analysis, statistic methods, project management, method of intersectoral balance, methods of forecasting.

The most urgent problem of regional strategic planning is a problem of financial support of multilevel territorial units development strategies. Strategic documents are focused mainly on justification of development priorities. They don't pay much attention to the problem of financial resources sufficiency for realization of the strategy. Consequently, most of the strategies are nothing else but a set of declarations (intentions) of perspectives of development. Unreliable financial basis of the strategy decreases probability of its successful realization, especially in an unstable financial environment. The probability of fail increases sufficiently on lower levels of management, because they have less capacity of financial resources accumulation. Consequently, there is a serious problem of feasibility of strategies developed and accepted for realization. In a context of this problem, the following points are important:

- firstly, the insufficiency of financial resources makes it necessary to find additional financing sources and distribute available financial resources rationally between management levels and regional economy sectors;
- secondly, financial support of the strategy is not discussed in detail in the strategic documents. The analysis of financial resources for realization of the strategy is based on estimation of financial needs of large-scale investment projects included in the strategy. Consequently, the problem of rational distribution of financial resources between economic sectors and management levels is not even identified. The processes of accumulation and distribution of financial resources is not focused on idea of rationality, which means achieving strategic purposes by the most efficient use of available resources;
- thirdly, institutional sectors of regional economy are not fully taken into account. Strategic planning, as a

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rule, takes into consideration two institutional sectors, namely, government and business. Financial resources of households are left out of consideration. Nevertheless, households are one of the most important potential investors with significant savings.

The purpose of the research is a development of tools for multilevel territorial units development strategies financial support. In order to achieve the purpose, the following tasks should be solved:

1. Formalization of financial flows system supporting achievement of strategic priorities of regional development;
2. The development of mathematical model of accumulation and distribution of financial resources for realization of multilevel social and economic systems development strategy.

2 The formalization of regional economy financial flows system

The formalization of financial flows requires complex analysis of direction, intensity and other parameters of financial resources moving. The purpose of the analysis is determination of attributes and types of whose financial flows which are the most important as instruments of regulation and strategic planning. The traditional definition of a flow is "directed movement" (in economy, directed movement of goods, resources, information, etc.). Financial flow is a directed movement of financial resources reflecting the system of economic relations in the spheres of production, distribution, exchange and consumption. But different stages of regional economic development cause transformation of terminology of regional economics [2]. It means, each stage is characterized by unique structure of financial flows accumulation and distribution system. Economic environment criteria characteristics determine intensity and direction of financial flows. The most important of the characteristics mentioned are exterritoriality, high level of resource mobility, economic rationality and efficiency.

Consequently, in the context of the problem discussed and on the basis of spatial economy, financial flow is directed movement of financial resources reflecting economic relations for achieving strategically significant priorities of territorial development realized on principles of resource mobility, economic rationality and efficiency. The classification of financial flows can be performed on different classification criteria:

- on the basis of horizontal direction financial flows could be classified as direct of inverse; on the basis of vertical direction financial flows could be classified as ascending and descending;
- on the basis of hierarchy level financial flows could be attributed as macrolevel, mesolevel and microlevel financial flows;
- on the basis of composition elements financial flows could be classified as single and aggregated;
- on the basis on schemes of accumulation and splitting financial flows could be classified as split and integrated;
- on the basis of complexity level financial flows could be identified as particular and integrated;
- on the basis of dynamic properties financial flows could be classified as constant and variable;
- on the basis of association with economic subsystems inputs and outputs financial flows could be classified as incoming and outcoming;
- on the basis of mutual direction financial flows could be classified as unidirectional and opposite.

The systematization of financial flows described above was applied for modelling of financial flow system of regional economy. System dynamic modelling (SDM) methodology was chosen for regional economy financial flows system model development. The following advantages of SDM methodology were taken into account [3]:

1. SDM includes graphic language for visualization;
2. SDM is based on special types of variables (rates and levels), which are highly suitable for modelling financial flows accumulation and distribution processes.
3. SDM simplifies dynamic model development, system dynamics is simulated by the system of differential or finite difference equations;
4. There are a number of program tools supporting SDM methodology and facilitating model development, verification, simulation and interpretation.

The graphic model of financial flows in the system composed of region, territorial administrative units and institutional sectors is shown on figure 1.

3. The development of mathematical model of accumulation and distribution of financial resources for realization of multilevel social and economic systems development strategy

The following notations are used: n – a number of territorial administrative units in the region; i – an index for addressing particular territorial administrative unit; $i=1..n$; t – an index for addressing particular time point; t, $t+1$ – double index for addressing time interval $(t,t+1)$; K_t^i – fixed capital; LT_t^i – a number of taken in economy; L_t^i – population; $Y_{t,t+1}^i$ – added value; $I_{t,t+1}^i$ – fixed capital investments ; μ – fixed capital wear rate; $DN_{t,t+1}^i$– population income; $PA_{t,t+1}^i$ –business profit and amortization; $DGf_{t,t+1}^i$– a sum of taxes directed to federal budget; $DGR_{t,t+1}^i$ – a sum of taxes directed to region budget; $DGm_{t,t+1}^i$ – a sum of taxes directed to municipal; d_n^i – a share of salary paid by business in added value; d_B^i – a share of business profit

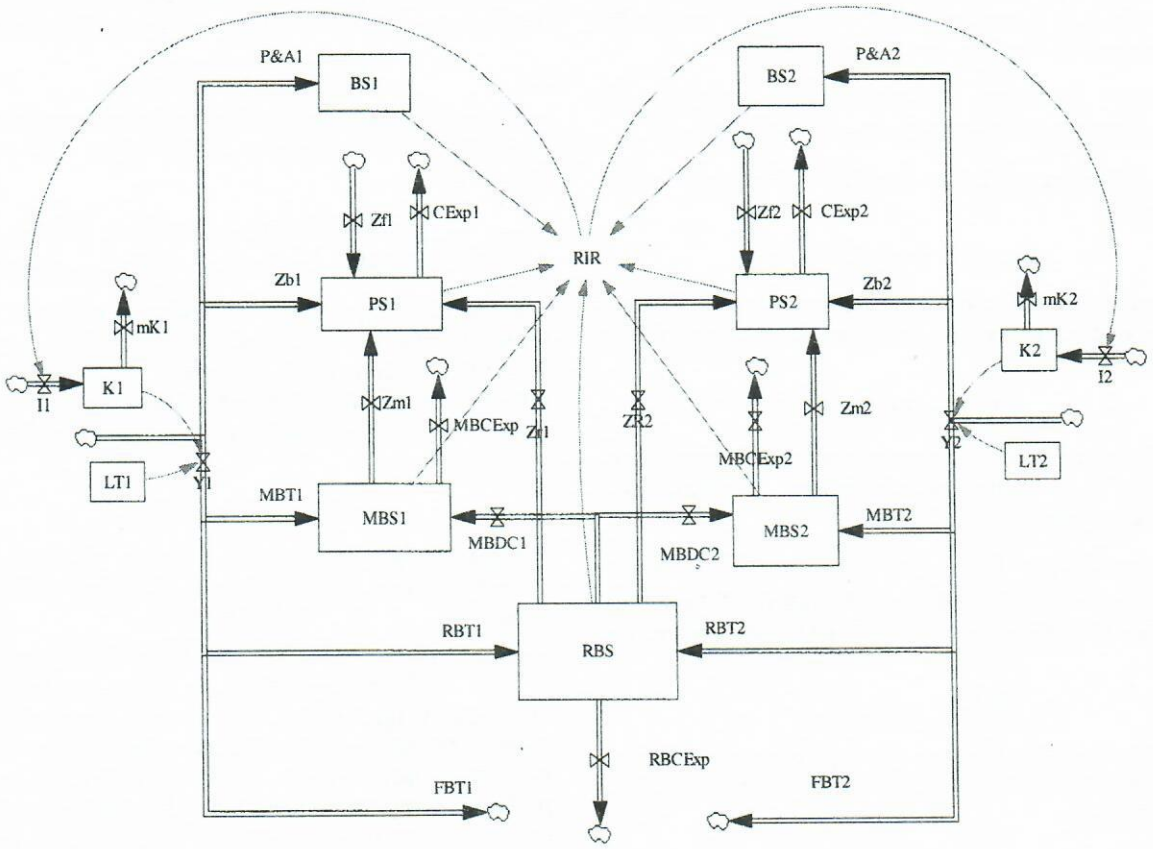

Fig. 1. Rate and level model of financial flows in the system composed of region, territorial administrative units and institutional sectors (notifications: Y- added value, Zf- total sum of salary and other payments from federal budget to population, Zm- total sum of salary and other payments from municipal budget to population, Zr- total sum of salary and other payments from region budget to population, FBT- federal budget taxes, RBT- region budget taxes, MBT-municipal budget taxes, MBS- municipal budget savings, PS- population savings, mK- fixed capital wear, P&A-profit and amortization, BS-business savings, CExp- customer expenses, MBCExp- municipal budget current expenses, RBCExp- regional budget current expenses, MBDC- municipal budget deficit covering, RBS- region budget savings, Zb- total sum of salaries paid by business, K-fixed capital, LT- population taken in economy, I- investments, RIR- region investment resources).

and amortization in added value; d_{Gf}^{i} – a share of taxes directed to federal budget in added value; d_{GR}^{i} – a share of taxes directed to region budget in added value; d_{Gm}^{i} – a share of taxes directed to municipal budget in added value; $Zb_{t,t+1}^{i}$- salaries paid by business; $Zf_{t,t+1}^{i}$- salaries and other payments, paid by federal budget to the population; $Zr_{t,t+1}^{i}$- salaries and other payments, paid by region budget to the population; $Zm_{t,t+1}^{i}$- salaries and other payments, paid by municipal budget to the population; $SN_{t,t+1}^{i}$ – population savings; c_{N}^{i} – specific customer expenses; gm^{i} – specific current costs of municipal budget; gR – region budget specific current costs; $RR_{t,t+1}$ – region budget total current costs; $RM_{t,t+1}^{i}$– municipal budget total current costs; $BD_{t,t+1}^{i}$- municipal budget deficit; $BP_{t,t+1}^{i}$– municipal budget surplus; $\gamma_{t,t+1}^{i}$ – a share of regional investment resources directed to i- indexed territorial administrative unit; d_t – discount rate, $RRD_{t,t+1}$- region budget expenses on covering budget deficits of municipal budgets; $BPR_{t,t+1}$- region budget surplus; $RIR_{t,t+1}$- region investment resources.

The following assumptions were accepted:

- Financial resources of all institutional sectors excluding current expenses are spent on investments.
- The dynamics of population and number of taken in economy are not researched, consequently, $L_t^i \equiv L_0^i$, $LT_t^i \equiv LT_0^i$.
- The region is considered as functioning in self-financing mode. The attention is concentrated on

accumulation, distribution, assumption of its own financial resources. The involvement of external financial resources is not considered.

- The following parameters are considered as constants: μ, d_n^i, d_B^i, d_{Gf}^i, d_{GR}^i, d_{Gm}^i, c_N^i, gm^i, gR.

The following equations simulate dynamics of model variables:

$$K_{t+1}^i = K_t^i - \mu \cdot K_t^i + I_{t,t+1}^i$$

- fixed capital increases due to investments from different sectors of economy and decreases due to fixed capital wear.

$$Y_{t,t+1}^i = F(K_t^i, LT_t^i)$$

- added value depends on main production factors levels, namely, fixed capital and labour force (measured by a number of taken in economy);

$Y_{t,t+1}^i = Zb_{t,t+1}^i + PA_{t,t+1}^i + DGf_{t,t+1}^i + DGR_{t,t+1}^i + DGm_{t,t+1}^i$ – added value could be calculated as sum of salaries paid by business, profit and amortization, and taxes.

$$Zb_{t,t+1}^i = d_n^i \cdot Y_{t,t+1}^i$$

– salaries paid by business is computed as multiplication of added value and share of salary paid by business in added value;

$$PA_{t,t+1}^i = d_B^i \cdot Y_{t,t+1}^i$$

– profit and amortization is computed as multiplication of added value and share of profit and amortization in added value;

$$DGf_{t,t+1}^i = d_{Gf}^i \cdot Y_{t,t+1}^i$$

– sum of taxes directed to federal budget is computed as multiplication of added value and a share of taxes directed to federal budget in added value;

$$DGR_{t,t+1}^i = d_{GR}^i \cdot Y_{t,t+1}^i$$

– sum of taxes directed to region budget is computed as multiplication of added value and a share of taxes directed to region budget in added value;

$$DGm_{t,t+1}^i = d_{Gm}^i \cdot Y_{t,t+1}^i$$

– sum of taxes directed to municipal budget is computed as multiplication of added value and a share of taxes directed to municipal budget in added value;

$$DN_{t,t+1}^i = Zb_{t,t+1}^i + Zm_{t,t+1}^i + Zr_{t,t+1}^i + Zf_{t,t+1}^i$$

– population income is computed as a sum of salaries and other payments of business and budgets;

$$SN_{t,t+1}^i = (1 - c_N^i) \cdot DN_{t,t+1}^i$$

– population savings is calculated as a difference between population income and population customer expenses;

$$RM_{t,t+1}^i = gm^i \cdot L_t^i$$

– municipal budget total current costs are computed as multiplication of specific current costs and population;

$$RR_{t,t+1} = gR \cdot \sum_{i=1}^m L_t^i$$

– regional budget total current costs are computed as multiplication of specific current costs and region population;

$$BD_{t,t+1}^i = \begin{cases} 0, \text{если } DGm_{t,t+1}^i \geq RM_{t,t+1}^i + Zm_{t,t+1}^i \\ RM_{t,t+1}^i + Zm_{t,t+1}^i - DGm_{t,t+1}^i \text{ иначе} \end{cases}$$

– municipal budget deficit is equal to 0, if sum of taxes directed to the municipal budget is more than a sum of municipal budget costs; otherwise municipal budget deficit is computed as a difference between sum of taxes directed to the municipal budget and municipal budget costs;

$$RRD_{t,t+1} = \sum_{i=1}^n BD_{t,t+1}^i$$

– region budget expenses on covering territorial units budget deficit is equal to a sum of budget deficits of territorial administrative units;

$$BP_{t,t+1}^i = \begin{cases} 0, \text{если } DGm_{t,t+1}^i \leq RM_{t,t+1}^i + Zm_{t,t+1}^i \\ DGm_{t,t+1}^i - RM_{t,t+1}^i - Zm_{t,t+1}^i \text{ иначе} \end{cases}$$ – municipal budget surplus is equal to 0, if sum of taxes directed to the municipal budget is less than a sum of municipal budget costs; otherwise municipal budget proficit is computed as a difference between sum of taxes directed to the municipal budget and municipal budget costs;

$BPR_{t,t+1} = \sum_{i=1}^n DGR_{t,t+1}^i - RR_{t,t+1} - RRD_{t,t+1} - \sum_{i=1}^n \mathrm{Zr}_{t,t+1}^i$ – region budget surplus is computed as sum of taxes directed to region budget minus region budget expenses including total current costs, salaries and other payments and covering territorial administrative units budget deficits;

$RIR_{t,t+1} = \sum_{i=1}^n SN_{t,t+1}^i + \sum_{i=1}^n PA_{t,t+1}^i + \sum_{i=1}^n BP_{t,t+1}^i + BPR_{t,t+1}$–region investment resources are calculated as a sum of population savings, profit and amortization, municipal and region budget surpluses.

$$I_{t,t+1}^i = \gamma_{t,t+1}^i \cdot RIR_{t,t+1}$$

– fixed capital investments are computed as a multiplication of region investment resources and a share of region investment resources directed to i- indexed territorial administrative unit.

Target function is determined according to requirements of modern stage of development of regional economies. The most important requirements are:

- increasing end results of regional social and economic system functioning;
- regional social and economic system functioning in optimal way realized in a system of accumulation, distribution and use of financial resources on different hierarchy levels and institutional sectors;

- model must include all institutional sectors and their financial resources.

Taking into account all the requirements mentioned above, the following target function and constraints were determined:

$$F = \sum_{t=1}^{T-1} d_t \sum_{i=1}^{n} Y_{t,t+1}^{i} \rightarrow max$$

– the sum of added values produced during T years, must be maximized.

Model operated parameters are:

$$\gamma_{t,t+1}^{i},\ i=1..n$$

– shares of regional investment resources directed to i-indexed territorial administrative units in time interval (t, t+1);

The following model constraints were determined:

1. Operated parameters constraints

$$\sum_{i=1}^{n} \gamma_{t,t+1}^{i} = 1,\ \forall \gamma_{t,t+1}^{i} \geq 0$$

– the sum of shares must be equal to 1, it means, all region investment resources must be invested.

2. No decrease of territorial units budget sufficiency

$$\forall i\ \frac{DGm_{t,t+1}^{i}}{L_{t+1}^{i}} \geq \frac{DGm_{-1,0}^{i}}{L_{0}^{i}}$$

–territorial budget specific income in each moment must be equal or more than its value in initial moment of time;

3. No decrease of population income

$$\forall i\ \frac{DN_{t,t+1}^{i}}{L_{t+1}^{i}} \geq \frac{DN_{-1,0}^{i}}{L_{0}^{i}}$$

– population specific income in each moment must be equal or more than its value in initial moment of time.

4. Conclusion

Model constructions discussed above, namely, rate and level model of financial flows in the system composed of region, territorial administrative units and institutional sectors and mathematical model of accumulation and distribution of financial resources for realization of multilevel social and economic systems development strategy, must be considered as initial attempts of formalization of problems researched. The approbation of the models is planned to be performed on information base of Republic of Bashkortostan, one of the largest regional economies of Russia, in order to continue development of tools for improving regional strategic planning procedure.

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