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Technology for Forecasting the Region Economy and Budget Revenues Development on the Basis of Interindustry Balance

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***Abstract*— The objective of the work is to develop the technology for forecasting the region economy and budget revenues development on the basis of interindustry balance. The forecasting was done taking into account the dynamics of the interindustry balance, investments, resource expenses and capacities restrictions. As the result of the forecasting the budget revenues were developed for three years. The relevance of the work is due to the proper management system development and the region social and economic development forecasting (subject of the Russian Federation). The mathematical model of the region economy development as a vector task of mathematical programming was created. The model was developed on the basis of interindustry balance and by considering the investments into each sector of the region economy. Methods for the vector tasks solution are based on the criteria and the max-min principle (the guaranteed result) normalization. Practical realization of the model is shown on statistical data of the certain region (Primorskiy Krai). As a result the forecast for the region economy key indicators development as well as the budget revenues were drawn in dynamics (for several years). The authors imply the directions of further researches in the development of more perfect software and its application for each subject of the Russian Federation forecasting.**

Keywords*— management, modeling, forecasting, economics region, vector optimization

I. INTRODUCTION

Modern methods of management and the regional economy sector development are based on the new methods of mathematical modeling. The actual sector includes first of all the production branches of the economy which interact among themselves, define strategy, dynamics of the region economy development and the state in general [1 - 14].

II. DISCRETELY - DYNAMIC MODEL OF REGIONAL ECONOMY

Mathematical model of the region economy will be properly presented [6 - 13]. The model considers the requirements first, of the "Methodical recommendations for drawing up the social and economic development forecast indices for the subjects of the Russian Federation" [14], and second, the requirements for the strategic planning in the Russian Federation [4].

The goal of the regional economy development is to improve the welfare of the region population, i.e. to increase (maximize) the end-use production - demand for all types of the region economic activity (OKVED [18]). This focus is presented as a vector task of the linear programming which is solved in dynamics for the discrete time terms:

$$Opt\ F(X, I, Y) = \{Y(t) = \{\max y_j(t), j = \overline{1,n}\}, \quad (1)$$

$$\max\ Y^{val}(t) = \sum_{j=1}^{n} y_j(t),\ X^{val}(t) = \sum_{j=1}^{n} x_j(t)\}, \quad (2)$$

$$\text{under constraints}\quad (I-A)X(t) - VI(t) \geq Y(t), \quad (3)$$

$$X(t) = (1-k^{изн})X(t^0) + \varphi I(t), \quad (4)$$

$$RX(t) \leq b(t^0+\Delta t) + \Delta b(t), \quad (5)$$

$$T^{\varepsilon min} \leq R^{trud} X(t) \leq T^{\varepsilon max}, \quad (6)$$

$$X(t^0) \leq X(t) \leq X(t^0+\Delta t), \quad X(t^0+\Delta t) = KX * X(t^0), \quad (7)$$

$$I^{inv}(t^0) \leq I(t) \leq I^{inv}(t^0+\Delta t), \quad I^{inv}(t^0+\Delta t) = K^{inv} * I^{inv}(t^0), \quad (8)$$

$$Y^{min}(t^0) \leq Y(t) \leq Y^{max}(t^0+\Delta t), \quad Y^{max}(t^0+\Delta t) = KY * Y^{max}(t^0), \quad (9)$$

$$t^0+\Delta t = t^0, t^0+1, \ldots, t^0+T, \quad (10)$$

where the $\boldsymbol{X(t)} = \{X(t) = \{x_j(t), j = \overline{1,n}\}, I(t) = \{I_j(t), j = \overline{1,n}\}, Y(t) = \{y_j(t), j = \overline{1,n}\}\}$ is the vector of unknowns (the operating variables) including $X(t)$ - gross issues, $I(t)$ - investments for all branches (types of activity) and $Y(t)$ - end use of the region for the planning period of $t \in T$;

in (1) $F(X, I, Y)$ – the vector criterion having a set of $\boldsymbol{K} = n+2$ of criteria, consisting of $Y(t)$ criteria for all kinds of activity final demand maximizing as well as criteria for composite (gross) final demand and the regional product output in (2) respectively..

III. TECHNOLOGY OF THE MODEL DEVELOPMENT AND THE REGIONAL ECONOMY FORECASTING

The technology of the mathematical model development (the 1st part) and the region economy development forecasting (the 2nd part) using the model (1)-(10) includes seven blocks.

The region economy mathematical model development (blocks 1-3):

1) the analysis of the statistical data for a year and development of the inter-industry balance on their basis;

2) target setting: the aim of the economic development and the region economy dynamic model coefficients calculation ;

3) definition of a numerical mathematical model for the region economy development as a vector task of the linear programming;

Modelling and prediction of the region economy development (blocks 4-7)

4) modelling process (the linear programming vector task solution), as a result volumes of gross output, end use of the region branches production for a year will be obtained;

5) the region economy indicators development which show the total financial plan of the region;

6) forecasting the region economy dynamic development (for the three-years financial plan of the region, including the tax liabilities defining the budget revenues of the region for the three-years period;

7) the management decision making, final for the region economy development, administrative impact (regulation) [14].

A. The region economy mathematical model development (blocks 1-3)

The analysis of the statistical data will be carried out according to the key economic indicators in [19] which, first, characterize the region economy totally and, second, serve as the basis for the balance development for a number of steps. For creation of interindustry balance we use statistical data "The line of business activities account in 2015", table 1.

TABLE 1. THE LINE OF BUSINESS ACTIVITIES ACCOUNT IN 2015 (MIL RUB.)

Indicators (types of economic activity)	Resource	The intermediate Use		
	Output	*The intermediate*	*Gross va-lueadded*	*Man-power*
1. Agriculture	56915	24433	32482	74,4
2. Fishing	72539	32547	39992	20,6
3. Mining operation	16866	8986	7880	10,3
4. Manufacturing	208065	149181	58884	99,9
5. Production of electric energy, gas, wate	80741	63374	17367	33,8
6. Construction	90254	49893	40361	28,1
7. Wholesale and retail trade	222383	77754	144629	66,2
8. Hotels and restaurants	17963	6789	11174	11,9
9. Transport and communication	274170	111774	162396	75,9
10. Financial activity	4775	2522	2253	12,9
11. Operations with real estate	106034	34576	71458	54,0
12. Public administration and security	79468	23600	55868	71,0
13. Education	31661	8042	23619	62,0
14. Health care, social services	53461	16219	37242	55,2
15. Commercial, social services rendering	17335	6290	11045	18,8

The line of business activities account in 2015, adequate to table1 calculated for six sectors [14]. The region inter-industry balance for six sectors developed on the basis of the six sectors table {the case of the Primorskiy Krai (PK)) is demonstrated in table 2. The interindustry balance of the region shown in table 2 is used for the PK economy numerical model development as a vector task of mathematical programming (1)-(10). To solve the task (1)-(10) the methods of the vector tasks solution based on the criteria normalization and the principle of the guaranteed result, [14] are used.

TABLE 2. INTERINDUSTRY BALANCE OF ECONOMY OF EDGE FOR 2015, ML. RUB

Release Expenses	The intermediate consumption -AX							End use - Y					In total
	Indus-try	Agri-cul-ture	Build-ing	Fi-shery	The services	Trans-port	Total AX	Final consum	Gross capital	Com-modity stocks	Export	Total-Y	
Industry	116984	15265	18627	2887	100696	32732	287192	10195	1800	4472	2014	18480	305672
Agriculture	3074	1469	779	2939	7945	5598	21804	27280	2165	5665	0	35111	56915
Building	5814	2187	2423	3369	9217	7724	30735	30903	10249	16546	1820	59518	90254
Fishery	218	131	106	173	195	150	974	49590	5411	1900	14663	71565	72539
The services	72142	3025	12120	14361	47029	57505	206183	229058	8184	45349	44304	326895	533079
Transport	23309	2355	15838	8818	10708	8063	69091	75962	53040	39296	36780	205078	274170
Total A'X	221541	24433	49893	32547	175792	111774	615980	422988	80849	113228	99581	716649	1332629
Work pay-ment–Z_1	53966	23164	30946	29246	224923	94329	456616						
Taxes –Z_2	6957	8718	8611	7472	26364	12495	70618						
Amortization–Z_3	13746	72	81	1174	86250	41275	142299						
Прибыль–Z_4	9460	527	722	2099	19748	14255	46814						
VDS – Z	84131	32482	40361	39992	357287	162396	716649						
Total re-source	305672	56915	90254	72539	533079	274170	1332629	$X_j, j=\overline{1,n}$				AX+Y = A'X+Z	
busy th people	144	74	28	20,6	352	76	974,6						

The interindustry balance of the region shown in table 2 is used for the PK economy numerical model development as a vector task of mathematical programming (1)-(10). To solve the task (1)-(10) the methods of the vector tasks solution based on the criteria normalization and the principle of the guaranteed result, [14] are used.

As a result of the solution of the task (1)-(10) the following data were received:

$\lambda^o(t+1)$=L0 = 0.5050 – optimum level (criterion); $\boldsymbol{X^o(t+1)}$=X0=[λ^o(t+1)= 0.5050, X(t+1)={ 193800 36260 1.80480 40810 2.88540 1.84490}, Inv(t+1)={130 2230 16480 4080 15440 12710}, Yo(t+1)={1130 19040 140910 34910 132050 108660}],

where $\lambda^o(1)$ - the maximum relative estimate, $X(1)=\{x_j, j=\overline{1,n}\}$ is the gross regional product on each industry, $Inv(1)=\{I_j, j=\overline{1,n}\}$ is the investments, $Yo(1)=\{y_j, j=\overline{1,n}\}$ is the end use (demand) of the relevant industry. General economic indicators of the region economy development for the period of $(t+1)\in T$, t=2015 were also obtained.

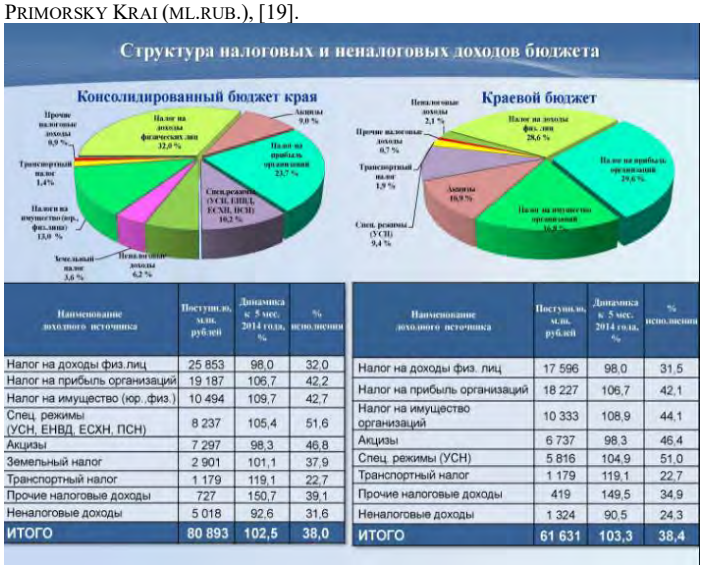
The similar calculations were carried out in dynamics for the (t+2), (t+3) year of planning. The results of the calculation were shown in the form of tables (for more details see [14]). The main table "The Forecast of the Gross Production Volume for the sectors of the Region for three years" is shown below.

TABLE 3. THE FORECAST OF THE GROSS PRODUCTION VOLUME FOR THE SECTORS OF THE REGION FOR THREE YEARS (mil rub.)

Industry	Base year	Forecast		
		t+1 year	*t+2 year*	*t+3 year*
Industry	305700	330400	331500	332100
Agricultural	569000	61800	61700	62100
Construction	90300	97500	97600	98000
Fishery	72500	78200	78200	78500
Service	533100	569600	572100	573900
Transport	274200	294100	294900	295800
Total A'X	1332700	1431600	1436000	1440400
Growth rate	1	1,07421	1,07751	1,08081

The structure of tax, non-tax revenues of the Primorskiy Krai budget according to the results of 2015 are demonstrated in table 4, [19].

TABLE 4. STRUCTURE OF TAX, NON-TAX RECEIPTS OF THE BUDGET OF THE PRIMORSKY KRAI (ML.RUB.), [19].



Наименование доходного источника	Поступило, млн. рублей	Динамика к 5 мес. 2014 года, %	% исполнения
Налог на доходы физ.лиц	25 853	98,0	32,0
Налог на прибыль организаций	19 187	106,7	42,2
Налог на имущество (юр. физ.)	10 494	109,7	42,7
Спец. режимы (УСН, ЕНВД, ЕСХН, ПСН)	8 237	105,4	51,6
Акцизы	7 297	98,3	46,8
Земельный налог	2 901	101,1	37,9
Транспортный налог	1 179	119,1	22,7
Прочие налоговые доходы	727	150,7	39,1
Неналоговые доходы	5 018	92,6	31,6
ИТОГО	80 893	102,5	38,0

Наименование доходного источника	Поступило, млн. рублей	Динамика к 5 мес. 2014 года, %	% исполнения
Налог на доходы физ. лиц	17 596	98,0	31,5
Налог на прибыль организаций	18 227	106,7	42,1
Налог на имущество организаций	10 333	108,9	44,1
Акцизы	6 737	98,3	46,4
Спец. режимы (УСН)	5 816	104,9	51,0
Транспортный налог	1 179	119,1	22,7
Прочие налоговые доходы	419	149,5	34,9
Неналоговые доходы	1 324	90,5	24,3
ИТОГО	61 631	103,3	38,4

The calculation in the six sections of the region was carried out on the basis of the coefficients shown in table 3 (the last line). The results of the tax revenues forecast calculations to the Primorskiy Krai for three years are shown in table 5.

TABLE 5. FORECAST OF TAX AND NON-TAX REVENUES OF THE BUDGET OF THE PERSONAL COMPUTER (MLN. RUBL).

Source of revenues	Receipt	Forecast		
	Base year ***t=2015***	***t+1*** *year*	***t+2*** *year*	***t+3*** *year*
Personal income tax	25853	27771,6	27856,9	27942,2
Profits tax	19187	20610,9	20674,2	20737,5
Property tax	10494	11272,8	11307,4	11342,0
Special modes	8237	8848,3	8875,4	8902,6
Excises	7297	7838,5	7862,6	7886,7
Land tax	2901	3116,3	3125,9	3135,4
Transport tax	1179	1266,5	1270,4	1274,3
Other tax revenues	727	781,0	783,3	785,7
Non-tax revenues	5018,0	5390,4	5406,9	5423,5
Total	80893	86896,1	87163,0	87430,0

The forecast of the non-tax revenues structure was calculated in the same way and the right side of table 4 is the basic (statistical) data . In general, the modeling results are the basis for various types of financial tasks and first of all for both the region budget revenues and spendings.

Thus, the mathematical model for the formation of the regional economy development and methods for vector tasks of mathematical programming solution allow for the gross volumes and optimum growth rate of the region economy to be calculated taking into consideration: first, interindustry balance, second, the investments into each sector of the region, third, resource facilities of the region and its production capacities. The growth rates of the region economy allow to c forecasting: tax and non-tax revenues in the budget of the region as well as to forecast the expenditure budget for three years. The developed model and the results of modeling can be the basis for the region economic policy development, defining the line of each sector conduct (i.e. of all enterprises of the relevant industry) in total. The authors are ready to participate in forecasting the region economy development on the basis of the developed software.

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