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### MULTIREGIONAL ANALYSIS WITH USE OF REGIONAL ACCOUNTS AND INPUT-OUTPUT TABLES

#### Abstract

Authors construct Regional input-output tables (11 products of goods and services) on the basis of regional accounts and National input-output table (120 products) by 79 subjects of the Russian Federation.

Information of the Regional input-output tables is used for three types of multiregional models (size 79 x 11): a) input-output model; b) optimization model with vector criterion function; c) model of economic equilibrium.

Multiregional economic analysis is conducted by the following directions: 1) export-import impact on the regional economy; 2) possibilities of decreasing of regional trade deficit; 3) possibilities of levelling of regions by the level of final consumption of households per head.

#### **1. Introduction**

On the 40 Congress of ERSA (Barcelona, 2000) was presented the paper «Comparative regional analysis on the base of the System of aggregated input-output tables». It contained the results of research by the construction of 79 Regional Input-Output tables for 1997.

Regional Input-Output tables (RIOT) were compiled on the base of the National Input-Output table (NIOT) at producers' prices for 1997 (product by product, dimension 93 x 120), the Regional accounts data (on that moment had been accessed the production account and some elements of the use of income account) and other regional data (Granberg, Zaitseva 2000).

Two types of administrative division of the Russian Federation were used: a) by subjects of federation, b) by federal districts. RIOTs were constructed by 79 subjects of federation from 89.<sup>1)</sup> Calculations by interregional models were conducted by 7 federal districts.

The paper consists of three parts. In the first part is presented the analysis of net export by 79 RIOTs. In the second part – analysis of Multiregional Input-Output model by 7 federal districts. In the third part - described optimisation model and analysed possibilities of decreasing of regional trade balance deficits.

#### 2. Impact of net export on the economy of regions

The main feature of the technique of the regional input-output tables construction is evaluation of net export by products as difference between output and sum of intermediate consumption and final domestic demand. Using of the balancing method for estimation of net export is caused by unavailable or unreliable information.

Sum of net export by regions must be equal to net export of the country because sum of trade balances between all regions of the country is equal to zero. As a result of assumptions, which were made for construction of regional input-output tables and related with lack of statistical data and features of national technique of gross regional product estimation, this rule is failed (Granberg, Zaitseva 2000, 1999, 1998). Sum of net regional exports exceeds net export of Russia nearly in 2 times.

46 regions have positive net export (export surplus) and 33 regions have negative net export (import surplus). As sum of net regional exports is a few overstated, the number of regions with import surplus may be greater in fact. Comparison of net exports by regional and the produced Gross regional Product (GRP) shows that ratio of net export to GRP is in interval  $\pm 20\%$  in the most regions (66). This ratio amounts +50% only in one region (Tumen oblast). In 3 regions (Northern Osetija, Tyva, Ingushetija) import surplus amounts more than 50% to GRP.

Table 1.

Ratio of net export to GRP	Number of regions
40% - 50%	1
30% - 40%	_
20% - 30%	3
10% - 20%	16
0% - 10%	26
-10% - 0%	15
-20%10%	9
-30%20%	4
-40%30%	1
-50%40%	1
-50% and less	3
Total	79

Distribution of regions by Ratio of net export to GRP.

Regulating of regions by ratio of GRP per head to average (see chart 1) shows that the import surplus and maximum ration of import surplus to GRP are characteristic for the regions with the least level of GRP per head. These regions can be related to group of the recipients of the Russian economy.

In most cases, regions, where GRP per head amounts from 50% to 80% of average, have insignificant net export in comparison with GRP in these regions. Net export is positive in the most regions, where GRP per head exceeds 80% of average. These are the pronounced donor regions. The most interesting exception is Moscow city. On the one hand, Moscow city has the  $2^{nd}$  place in Russia by GRP per head, on the other hand, it has import surplus.

Total net export is calculated for showing up indirect influence of external links on economy of region. Calculation were conducted by formula  $X^v = (I - A)^{-1} V$ , where V – vector of net export (direct net export),  $X^v$  – vector of outputs induced by net export (total net export).



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		Number
		of re-
		gions
1. Direct and total net export is positive	total > direct	45
	total < direct	1
2. Direct net export negative (import surpl	us), total net export positive	4
3. Direct and total net export is negative	total > direct (by module)	28
	total < direct (by module)	1
Total		79

Grouping of regions by volume of direct and total net export.

The total net export by module essentially exceeds direct net export in the most regions of Russia. It is evidenced to the effect that indirect interregional and abroad exchanges strengthen orientation of direct exchange. Direct and indirect exchanges have opposite direction only in 6 regions of 79.

#### 3. Multiregional Input-Output model (MRIOM)

Unification of the Regional Input-Output tables in MRIOM is conducted with use of two coefficients:

 $d_j^r$  – share of import surplus in output of product *j* in region *r*,

 $c_i^r$  – share of export surplus of product *i* in region *r* in sum export surpluses of product *i*.

For calculation of such coefficients we made some assumption: if net export of product i in region r is positive, then farther it is considered as export of product i from region r, if net export of product i in region r is negative – it is considered as import of product i in region r.

Analog hypotheses had been applied in the Global Input-Output model of W. Leontief (UN World Model) (Leontief 1977).

Table of symbols:

 $X^r$  – vector of outputs in region r,

 $Y^r$  – vector of domestic final demand in region r,

 $V^r$  – vector of export from region r,

 $W^r$  – vector of import in region r,

 $A^{r}$  – matrix of direct input coefficients of region r,

 $C^r$  – diagonal matrix of export coefficients,

 $D^r$  – diagonal matrix of import coefficients,

 $S^{v}$  – vector of national export,

 $S^{w}$  – vector of national import,

I-identity matrix,

m – number of regions.

Then equations look like:

$$(I - A^{r}) X^{r} - V^{r} + W^{r} = Y^{r}, (r = 1, ..., m)$$
(1)

$$W^r = D^r X^r, \ (r = 1, ..., m)$$
 (2)

$$V^{r} = C^{r} \left( \Sigma W^{r} + S^{v} - S^{w} \right) \tag{3}$$

The main task: estimation of vectors  $X^r$ ,  $V^r$  and  $W^r$  on different variants of vector  $Y^r$  and matrixes  $C^r$  and  $D^r$ .

MRIOM is constructed by 7 federal districts, which were established by decree of President of Russia in May 2000: (1) Central, (2) Northwestern, (3) Southern, (4) Volga, (5) Ural, (6) Siberian and (7) Far-Eastern.

Matrix has dimension 154 (2x11x7).

The analytic calculations with use of inverse matrix are allowed to define:

- dependences of outputs, export and import of regions from final demand of different regions and national net export,
- outputs, export and import by different regions induced by final demand of each region.

Table 3.

(percent)

	On final demand of federal districts							On na-	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	tional net ex-	
								port	
Industry	96,1	0,0	0,3	0,5	0,4	0,5	0,1	2,1	100
Construction	99,1	0,0	0,1	0,1	0,1	0,1	0,0	0,4	100
Agriculture	98,3	0,0	0,2	0,3	0,2	0,2	0,0	0,8	100
Other activity by									
goods production	59,6	0,8	3,5	15,2	9,0	11,9	1,8	-1,8	100
Transport	95,2	0,1	0,5	0,8	0,5	0,8	0,1	2,1	100
Communication	58,2	0,1	0,3	1,7	2,3	0,5	0,1	36,8	100
Trade	89,1	0,0	2,3	3,0	1,2	3,2	0,2	1,0	100
Housing	97,3	0,1	0,2	0,3	0,2	0,3	0,1	1,6	100
Health, education, cul-								-	
ture	96,5	0,0	0,0	0,0	0,1	0,0	0,0	3,4	100
Science	20,5	0,1	0,2	0,3	4,1	3,0	1,6	70,4	100
Banking and manage-									
ment	85,9	1,7	0,8	2,3	2,1	0,5	0,8	5,8	100
Total	91,1	0,1	0,7	1,3	0,8	1,2	0,2	4,6	100

Distribution of Central federal district output

Output of Central federal district induced by domestic final demand of Central district is 91% and induced by national net export - 5%. Output of Central district induced by final demand of Volga and Siberian federal districts is also significant. Distribution of science output is very interesting: output induced by domestic final demand of Central region amounts only 20% and national net export - more than 70%. "Other activity by goods production" works for final demand of Volga district, 12% - Siberian district, 9% - Ural district.

Table 4.

(percent)												
Federal	On final demand											
districts	Industry	Construction	Agriculture	Other activity by goods pro- duction	Transport	Communication	Trade	Housing	Health, education, culture	Science	Banking and management	Total
Central	62,9	85,4	73,6	87,1	82,5	94,4	91,7	84,1	87,2	88,0	89,7	78,3
Northwest-												
ern	0,1	0,1	0,1	0,1	0,8	0,0	0,1	0,1	0,1	0,0	0,1	0,1
Southern	0,3	0,1	4,6	0,1	0,4	0,1	0,1	0,2	0,2	0,1	0,2	0,5
Volga	13,4	5,2	12,8	4,6	5,1	2,0	3,0	5,7	4,6	4,3	3,7	8,0
Ural	20,6	8,0	5,1	7,1	8,4	3,1	4,4	8,7	6,9	6,6	5,5	11,2
Siberian	2,6	1,1	3,8	0,9	1,6	0,4	0,6	1,1	0,9	0,9	0,8	1,7
Far-Eastern	0,1	0,1	0,1	0,1	1,1	0,0	0,1	0,1	0,1	0,1	0,1	0,1
Total	100	100	100	100	100	100	100	100	100	100	100	100

Outputs of federal districts induced by final demand of Central district

Central federal district basically works on itself and on national net export, others federal districts actively participate in provision of final demand of the Central federal district. Output of the Central district only on 78% provides the domestic final demand. Most actively in provision of domestic final demand of the Central district work Ural and Volga districts: 11% and 8% accordingly.

The participation of other federal districts in provision of final demand of the Central district on industrial products is especially great: on 21% it is provided for the output of Ural district and on 13% - Volga. Besides, the final demand of Central district on agriculture products more than on quarter is provided for the output of Volga, Ural, Southern and Siberian districts.

Northwestern and Far-Eastern districts practically do not participate in provision of final demand of Central district. Southern district works only on supplying the final demand of Central district on agriculture products.

#### 4. Multiregional optimization model (with vector criterion function)

Researching of possibilities of decreasing of regional trade deficit was conducted with use of Multiregional optimization model (Granberg 2000). Final demand of Russia as a whole (z) is maximized for different hypotheses about distribution of final demand between regions (Pareto-optimization). For estimation of constraints by output  $(M^r)$ , an assumption was made that actual volume of output may be increased only on 20%.

$$(I - A^{r}) X^{r} - \alpha^{r} z^{r} - V^{r} + W^{r} \ge 0,$$
(4)

$$e\left(V^{r}-W^{r}\right)\geq\varDelta^{r},\tag{5}$$

$$z^r - \lambda^r \, z^r \ge 0, \tag{6}$$

$$\sum_{r} V^{r} - \sum_{r} W^{r} \ge D, \qquad (7)$$

 $X^r \leq M^r$ ,

Where

 $z^{r}$  – domestic final demand of region r,

 $\alpha^{r}$  - vector of structure of domestic final demand in region r,  $\sum_{i} \alpha_{i}^{r} = 1$ ,

 $\lambda^r$  – share of domestic final demand of region *r* in national domestic final demand,  $\sum_r \lambda^r = 1$ ,

D – vector of national net export ( $S^{v} - S^{w}$ ),

 $\Delta^r$  – vector of regional trade balances,

e-identity vector,

 $V^r$  – vector of export from region r,

 $W^r$  – vector of import in region r,

 $X^r$  – vector of outputs in region r.

In table 5 is shown the actual net export (trade disbalance) by federal districts in percents of GRP.

Net export by	/ federal	districts	in	1997	$(\Delta')$	r actual)
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Central	-17,2
Northwestern	4,8
Southern	-5,0
Volga	14,2
Ural	33,2
Siberian	5,6
Far-Eastern	7,1

Five variants of adjustment of trade disbalance and their impact on final demand is examined:

• maximization of final demand in condition of lack of limitations on trade balance,

• maximization of final demand for actual trade disbalance,

• maximization of final demand in condition of proportional decreasing of trade disbalances on 20%,

• maximization of final demand in condition of proportional decreasing of trade disbalances on 40%,

• maximization of final demand in condition of proportional decreasing of trade disbalances on 50%.

Table 6.

	Lack of limi- tations on	ack of limi- tations on Variants of proportional decreasing of trade disbalances (coefficient of decreasing)						
	trade balance	1,0	0,8	0,6	0,5			
<b>Final demand</b>	120,1	116,8	113,5	110,3	108,6			
Output								
Central	119,2	119,6	119,2	118,9	118,7			
Northwestern	119,1	116,1	112,7	107,5	104,9			
Southern	118,9	118,1	115,9	113,7	112,4			
Volga	119,4	113,5	107,5	101,9	99,1			
Ural	118,2	112,1	105,0	101,5	98,8			
Siberian	119,7	116,8	112,5	107,8	105,3			
Far-Eastern	119,5	116,8	112,9	108,9	106,1			

Impact of trade disbalances on final demand and output by federal districts (% of actual level for 1997)

Final demand in Russia as a whole is increased on 20,1% and outputs in regions increase approximately on 19% in condition of lack of limitations on trade balance and possible of increase of output on 20%. Siberian and Far-Easte districts come to the con-

Table 5.

(% of GRP)

straint by output most close. In all other cases, only Central federal district comes to constraint by output.

Decreasing of trade disbalances reduce both final demand and output. Volga and Ural district are forced to reduce output on 0,9% and 1,2% in condition of decreasing of trade disbalances in two times. It is related with orientation of production in these districts on the external markets - both interregional and foreign.

The realization of searching of quasi-equilibriums in the multiregional system will provided.

#### Footnote:

1. The input-output table by Chechen is absent (there is not any information from this region) and data by 9 autonomous areas are included in data of the corresponding kraj and oblast. 9 Autonomous areas are included: Nenets - in Arkhangelsk oblast; Komi-Permyak - in Perm oblast; Khanty-Mansi and Yamal-Nenets - in Tumen oblast; Taimyr (Dolgan-Nenets) and Evenk - in Krasnojarsky kraj; Ust-Ordynsky Buryat - in Ikrutsk oblast; Aginsky-Buryat - in Chita oblast; Koryak – in Kamtchatka oblast.

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