Matrix representation of the Kaliningrad regional accounts system: experimental development and modelling prospects

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MATRIX REPRESENTATION OF THE KALININGRAD REGIONAL ACCOUNTS SYSTEM: EXPERIMENTAL DEVELOPMENT AND MODELLING PROSPECTS

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This article addresses the task of creating a regional Social Accounting Matrix (SAM) in the Kaliningrad region. Analyzing the behavior of economic systems of national and sub-national levels in the changing environment is one of the main objectives of macroeconomic research. Matrices are used in examining the flow of financial resources, which makes it possible to conduct a comprehensive analysis of commodity and cash flows at the regional level. The study identifies key data sources for matrix development and presents its main results: the data sources for the accounts development and filling the social accounting matrix are identified, regional accounts consolidated, the structure of regional matrix devised, and the multiplier of the regional social accounting matrix calculated. An important aspect of this approach is the set target, which determines the composition of matrix accounts representing different aspects of regional performance. The calculated multiplier suggests the possibility of modelling of a socioeconomic system for the region using a social accounting matrix. The regional modelling approach ensures the matrix compliance with the methodological requirements of the national system.

Key words: Social Accounting Matrix, region, multiplier, modeling

A full adaptation of the national accounting methodology to the regional level opens up new research opportunities for modelling and solving analytical and prognostic problems. A regional account system (RAS) is emerging. Among all the regional economic accounts, only goods and services production accounts are almost fully developed. Researchers are working towards an experimental assessment of a wider range of RAS indicators in view of available statistics and indirect and expert evaluations [5; 12; 13].

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To eliminate data deficit when developing a RAS and ensure data reliability, researchers use the techniques of matrix representations of economic flows [5; 6; 11]. A matrix structure makes it possible to balance resources and their uses for all accounts and gives an opportunity to rely on sparse data arrays. Matrix forms also increase the analytical value of regional account indicators, which create prerequisites for identifying the multiplication effect in the regional reproduction process.

A Social Accounting Matrix (SAM) is one of the promising tools to describe, analyse, and model income and expenditure flows of regional economic agents by reproduction, industrial, sectoral, and institutional parameters [4; 6; 11]. The SAM structure facilitates the revision and systematisation of data contained in numerous official and unofficial autonomous sources. Moreover, the need to balance income and expenditure flows encourages researchers to compensate for absent statistically identified indicators through calculations and indirect and expert evaluations. SAM developers do not innovate the methods and procedures of data collection. Their mission is to obtain maximum significant information from the available data array. The authors of this article when developing a SAM for the Kaliningrad region pursed this objective.

The research novelty of the study is accounted for by the selected method of presenting and interpreting indicators for analysing the income and expenditure of regional economic agents. Table 1 gives a general idea about the sources of these indicators.

Table 1

Data sources for developing regional accounts and creating a SAM

Group	List of SAM data	Source
'Expenditure/ Output' national system of tables	—	Federal Service for National Statistics
Individual regional account data	1. Household final consumption 2. Data on intermediate consumption 3. Regional procurement 4. Commodity procurement for investment 5. Wages fund by industry 6. Gross margin by industry. 7. Household income/expenditure (and transfers) 8. Savings of different agents 9. Savings of the regional government 10. Regional investment 11. Capital inflow/outflow from the region	Federal Service for National Statistics Kaliningrad Regional Statistics Service
Federal budget of the Russian Federation	1. Federal procurement for regional distribution 2. Federal expenditure/revenue in the region	1. Federal Treasury 2. Open data unavailable
Data on inter-budget transfer	1. Federal transfers to regions	Federal Treasury

The end of the table 1

Group	List of SAM data	Source
Data on taxation by industry	1. Taxes on manufacturing (VAT, excises, import duties) 2. Taxes on company property, payments for using natural resources, social transfers, and excises imposed on production 3. Sales tax, income tax, corporate tax 4. Taxes by budget levels 5. Taxes paid into the federal budget 6. Export/import duties	1—5. Federal Taxation Service 6. Calculated parameter
Data on international and interregional trade	1. Production to accommodate regional consumption 2. Regional consumption 3. Exports imports 4. Entry/exit	1—2. Kaliningrad Regional Statistics Service. 3. Federal Customs Service; North-Western Customs Agency 4. Open data unavailable

As a follow-up to the regional balance model calculations performed at IKBFU in 2013 [2; 3], one of the model's authors created a number of experimental consolidated accounts of the Kaliningrad region (table 2). These accounts' indicators served as a reference point for the SAM.

However, the first step to a SAM is developing its structure comprised of economic agents' accounts. On the one hand, each account is represented by both a row and a column. Matrix rows correspond to the economic agents' receipts and columns to expenditure. In line with the economic approach to completing SAMs, accounts are organised into groups corresponding to the stages of reproduction process. The first group of accounts — 'Goods' and 'Production' — is consistent with the process of creation of goods and resources for commodities and services. They are followed by factor accounts — labour and capital accounts corresponding to the generation of primary (factor) incomes. The third group brings together accounts representing the generation and use of disposable incomes of economic agents. The capital account is identified separately. The capital account row shows the savings of economic agents and the column investment. The last group is comprised of accounts of the rest of the world demonstrating the flows that are external to the region.

However, there is no detailed universal standard in SAM development. General economic requirements are specified in methodologies adapted to particular conditions and research problems. As a result, SAMs developed for individual Russian regions are very heterogeneous [4; 6; 10; 13].

The openness of the Kaliningrad economy, particularities of research problems, and available information resources encouraged the authors of the article to devise a technique for developing a regional SAM that would meet the above conditions. For more detail, see [7].

Table 2

Consolidated regional accounts of the Kaliningrad region as of 2012, thousand roubles

1. Goods and services account			
Use		**Resources**	
4. Interim consumption	460 084 227.00	1. Output in basic prices	724 705 900.00
5. Finland consumption expenditure	208 930 781.40	2. Entry of goods and services	31 396 159.60
6. Total accumulation	113 241 603.60	3. Imports of goods and services	376 563 704.00
7. Exit of goods and services	285 156 169.60		
8. Exports of goods and services	65 252 982.00		
Total:	1 132 665 763.60	Total:	1 132 665 763.60
2. Production account			
Use		**Resources**	
2. Interim consumption	460 084 227.00	1. Output in basic prices	724 705 900.00
3. GRP in market prices	264 621 673.00		
Total:	724 705 900.00	Total:	724 705 900.00
3. Generation of income account			
Use		**Resources**	
2. Remuneration	110 696 950.00	1. GRP in market prices	264 621 673.00
3. Other production taxes	9 689 869.00		
4. Other production subsidies	—		
5. Gross margin	144 234 854.00		
Total:	264 621 673.00	Total:	264 621 673.00

The end of the table

+4. Primary income distribution account			
Use		**Resources**	
7. Property income payable	4 716 711.45	1. Gross margin	144 234 854.00
8. Gross regional income	313 691 595.42	2. Remuneration	110 696 950.00
		including	
		balance of salary received abroad and paid to non-residents, including Russian regions	1 106 969.50
		4. Production and import taxes	55 652 894.43
		5. Production and import subsidies (-)	500 000.00
		6. Property income receivable	8 323 608.44
Total:	318 408 306.87	Total:	318 408 306.87
5. Secondary income distribution account			
Use		**Resources**	
3. Current transfers payable	163 476 080.36	1. Gross regional revenue	313 691 595.42
4. Gross disposable regional income	320 372 702.91	2. Current transfers receivable	170 157 187.85
Total:	483 848 783.27	Total:	483 848 783.27
6. Use of disposable income account			
Use		**Resources**	
2. Final consumption expenditure	208 930 781.40	1. Gross disposable regional income	320 372 702.91
3. Gross savings	111 441 921.51		
Total:	320 372 702.91	Total:	320 372 702.91
7. Capital and financial account			
Use		**Resources**	
3. Capital transfer payable	195 503.36	1. Gross savings	111 441 921.51
4. Total accumulation	113 241 603.60	2. Capital transfer receivable*	17 987 686.90
5. Net lending (+) / net borrowing (-)	15 992 501.45		
Total:	129 429 608.41	Total:	129 429 608.41

One of the key aspects of this technique is balancing the rows and columns with the same numbers, which, ideally, should be identical. General balance correlations serving as the basis for SAM development are described in [1; 5; 6; 11]. However, in practice, it is not easy to obtain a fully balanced SAM. Firstly, as an open system, a region is characterised by inconsistences in indicators related to external ties, as well as imbalances between savings and investment. At the same time, if a total of savings, entry, and imports equals a total of investment, exits, and exports, the balance is not distorted. Secondly, the imperfection of accumulation, processing, and interpretation of data and their incompleteness often result in a lack of correspondence between the other matrix accounts. This requires checking and correcting errors in the SAM for the Kaliningrad region.

The devised methodology suggests completing a 13×13 matrix table bringing together the indicators of income accounts (rows) and expenditure accounts (columns) of key regional economic agents (table 3).

Table 3

General structure of a SAM for the Kaliningrad region

Account number	Agent/ Account	Row result — column 13	Column result — row 13
1	Goods	Aggregate demand (internal and external)	Aggregate supply (external and internal)
2	Production	Producers' sales revenues	Gross industrial expenditure
3	Capital	Factor income	Factor expenditure
4	Labour	Factor income	Factor expenditure
5	Household	Household income	Total household expenditure
6	Companies/corporations	Corporate income	Total corporate expenditure
7	Regional government	Regional government's receipts	Regional government's expenditure
8	Federal government	Federal government's receipts	Federal government's expenditure in the region
9	Taxes	Collected in the region	Distributed by levels
10	Capital account: savings — row; investment — column	Total savings	Total capital accumulation
11	Other regions	Receipts of other regions	Expenditure of other regions
12	Other countries	Receipts of other countries	Expenditure of other countries

An important aspect of the SAM development technique is identifying the source of data and the means to calculate indicators for each matrix entry. Its key features employed in completing the SAM for the Kaliningrad region are shown in table 4. In the conditions of incomplete information, SAM development is not a routine task with a ready-made algorithm.

Table 4

Means to identify regional SAM paramters

Entry	Assessment method
1:2; 1:5; 1:7; 1:10; 1:12; 2:1; 3:2; 4:2; 5:3; 5:4; 8:9; 9:2; 10:6; 12:1;	Statistics: the 2012 data
1:11; 6:3; 6:7; 7:8; 7:9; 9:12; 11:1	Calculation: isolation from the aggregate regional parameter in proportion to the contribution of institutional sector to gross value added
6:12; 8:11; 9:12; 12:10	Balanced
Other	Indirect assessments using proportional parameters (for instance, the contribution of Kaliningrad regional GRP to the national parameter value)

Comment: The first number in the matrix entry label stands for the row and the second for the column (row : column)

The development of balanced matrices is the first step in modelling a regional economic system. Modelling includes the following stages: a) formulating and proving the hypothesis about a set of exogenous factors; b) dividing SAM accounts into exogenous (corresponding to impact factors) and endogenous ones; c) aggregating exogenous accounts — SAM is reduced through a decrease in the number of accounts; d) calculating the Leontief multiplier to reduce the SAM; e) performing analytical and prognostic calculations using the SAM multiplier.

The openness of the Kaliningrad regional economy encouraged the authors to put forward a hypothesis that the identification of external demand and financial flows as exogenous regional factors demonstrates an important cause-effect relation describing the emergence of multiplier effects throughout the regional reproduction chain.

Based on the proposed set of exogenous factors, the 8^{th}, 11^{th}, and 12^{th} accounts were aggregated in the regional SAM. Table 5 presents the 2012 Kaliningrad regional SAM developed by the authors as a research experiment. Here, a total of the 8^{th}, 11^{th}, and 12^{th} accounts is presented in the consolidated account No. 10 'The rest of the world, including the federal government'. Other accounts are presented in the order given in table 3 and are numbered 1-9. The last row and column contain total values.

Table 5

The 2012 regional SAM
after exogenous accounted aggregation, million roubles

	1	2	3	4	5	6	7	8	9	10	11
1		460084			151429	146	57335		113242	350409	1132646
2	724706										724706
3		144235									144235
4		110697								1107	111804
5			12128	110697		24313	292			40174	187603
6			130126				2950			–15194	117882
7			1410					30819		39772	72001
8		9690			12499	11166				45963	79317
9					22241	79706	9495			17792	129234
10	407960			1107				51731	15993	28215	505005
11	1132666	724706	143664	111804	186169	115331	70072	82550	129234	508239	3204433

After the standardisation of expenditure indicators in endogenous accounts (the Leontief model's coefficients of direct material input are calculated in a similar way), a matrix of average propensity to spend was developed. The matrix of average propensity to spend can be considered an analogue for the Leontief matrix of direct material input. In our case, it is a 9×9 matrix. It helps to calculate the SAM multiplier (table 6) reflecting the direct and indirect effect of a single change in exogenous accounts on the final receipt values for regional economic agents. By analogy, it was called the Leontief multiplier.

Table 6

Regional SAM multiplier

	1	2	3	4	5	6	7	8	9
1	2.5566	2.4329	2.175	2.3859	2.4097	2.1497	2.496	0.9318	2.2402
2	1.6358	2.5566	1.3916	1.5265	1.5418	1.3754	1.597	0.5962	1.4333
3	0.3256	0.5088	1.277	0.3038	0.3069	0.2737	0.3178	0.1187	0.2853
4	0.2499	0.3905	0.2126	1.2332	0.2355	0.2101	0.2439	0.0911	0.2189
5	0.3374	0.5274	0.5631	1.3053	1.3184	0.4951	0.3425	0.1279	0.2957
6	0.2962	0.4629	1.1598	0.2774	0.2802	1.2508	0.3313	0.1237	0.2595
7	0.0305	0.0477	0.0755	0.0533	0.0539	0.0672	1.0317	0.3852	0.0267
8	0.0732	0.1144	0.1687	0.1349	0.1363	0.1727	0.0764	1.0285	0.0641
9	0.2491	0.3894	0.8791	0.3549	0.3585	0.9327	0.4097	0.1529	1.2183

With predictive estimates of exogenous parameters at hand, a researcher can use the multiplier to model future states of a regional socioeconomic system through calculating predictive SAMs. The advantages of this approach to regional modelling include balancedness ensured through meeting the requirements of the national accounting system and reinforced through using the matrix principle included in the model's structure.

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