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Voloshenko, Ksenia; Kuznetsova, Anastasia

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THE BALANCE MODEL OF REGIONAL DEVELOPMENT MANAGEMENT IN CERTAIN TERRITORIAL CONDITIONS: DEVELOPMENT AND APPLICATION

K. Voloshenko^{*}

A. Kuznetsova^{**}



In this article the authors detail the methodology of regional development forecasting with the balance method. They provide with an overview and assessment of the existing models and systems, and their use for the purposes of public administration at the regional level. The article underlines the need to develop a balance approach models for specific territorial conditions. In particular, the authors identify the possibilities of studying the connections between the proportions of material and cash flows within the regional system, and reconciling the needs of a regional economy with the production and resource potentials. The long-term sustainability balance model — a simulation of event-based forecasting — has been developed for the Russian exclave. The authors provide a general description of the balance model, its elements and simulation algorithm. The results of calculations using the balance model for forecasting regional development are provided for three alternative scenarios for the Kaliningrad region for the period until 2018.

Key words: regional development, forecasting, exclave, balance model

Forecasting is one of the most important aspects in managing any territorial socioeconomic system, regardless of its complexity or the nature of its internal processes and conditions for development.

A need for scientifically justified forecasting is explained by the dynamic and uncertain nature of the decision-making environment. It holds true for both the internal structure of the regional socioeconomic system, which is shaped by general national trends, and the external environment, whose

^{*} Immanuel Kant Baltic Federal University
14 A. Nevski St., Kaliningrad,
236041, Russia.

^{**} Ministry of Economy. Government
of the Kaliningrad region.
1 Dmitry Donskoy St., Kaliningrad,
123600, Russia.

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impact is increasing as the global economy is becoming more internationalised. For example, internal variables include priorities of the national regional policy, measures of providing public support to the regions within the target programme mechanism (i. e., federal target programmes and state development programmes), as well as a package of institutional, financial, infrastructural, and other regional development tools created in the framework of the policy that is pursued by the federal centre. External conditions and their impact on the territorial system depend on the latter's openness and inclusion in global economic relations and the processes of international division of labour. In particular, the policies and development rates of the neighbouring EU countries are of special importance for the Russian exclave. Another factor to be taken into account is the regional economy's dependence on the developing interregional proportions and individual international processes. This can be illustrated by support for cluster initiatives and other forms of international integration, which are becoming increasingly relevant.

Under the impact of different processes and factors, development management and efficiency will depend on the quality of the forecasting, analysis, and understanding of the future image of the region. A system for forecasting regional development that is consistent with the actual conditions of its functioning and objectives in terms of scope and representation makes it possible to predict socioeconomic problems, justify the need for adjusting and changing the directions of development, identify the targets and objectives of the regional economy, and develop a package of priority actions and initiatives in the socially significant areas.

It is worth noting that the need for forecasting and analytical calculations has been increasing in the recent years, since the regional authorities are required to solve problems of strategic management in different spheres. Moreover there is a need for scenario planning aimed at reducing the environment uncertainty and the development of preventive measures relating to the high dependency of regional socioeconomic processes on the national economic situation and world market trends.

In the Russian and international practice of regional development management, the development of predictive and analytical systems of regional representation rests on the construction and application of special socioeconomic models, software tools, instruments and information computing platforms.

A large number of predictive models and information analytical products (forecasting software packages, decision support systems, automated information systems, etc.) have been developed for the purposes of regional development management. Most of them are hybrid forms that combine such model classes as balance and econometric ones as well as those of situation forecasting and simulation modelling technology. The best-known models used in managing regional development are listed below.

Balance models: RIM (Russian Interindustry Model) by the Institute of Economic Forecasting of the Russian Academy of Sciences [22] adjusted to regional conditions (G. R. Serebryakov, M. N. Uzyakov, A. A. Yantovsky);

the forecasting analytical system of economic growth by N. V. Suvorov, A. V. Suvorov, and V. N. Borisov [25]; the SIRENA and SIRENA-2 interregional cross-industry models [19; 26] developed by the Institute of Economics and Industrial Engineering of the Russian Academy of Sciences (S. A. Suspitsyn, Yu. S. Ershov, N. M. Ibragimov, L. V. Melnikova, etc.).

Econometric models: the regional econometric predictive model designed for the Republic of Dagestan by V. Z. Petrosyants, S. V. Dokholyan, and A. S. Kallaeva [16]; the econometric model of the impact of fixed investment on the sustainable growth of Russia's regions (E. A. Fedulova, T. A. Alabina, I. S. Volobuev, etc.) [27]; the econometric model of regional innovative development designed for Saint Petersburg (I. V. Romanenko) [21]; the econometric modelling and forecasting of the development of the Primorsky region (A. S. Velichko, I. A. Bazhin) [4]; the econometric model for forecasting gross regional product (for instance, those by R. M. Nizhegorodtsev, N. P. Goridko, and N. A. Petukhov [17], F. N. Klotsvog, and L. S. Chernova [12], A. G. Granbger and Yu. S. Zaitseva [6; 9], M. A. Latsheva [15], etc.).

Situation forecasting models: the "Region/Macro" AIS model developed at Samara State Academy of Economics (V. A. Tsybatov, D. V. Bubrovin, Kh. R. Khasaev, etc.), "Volgoinformset" company, Samara; the "Prognosis" AIS multivariable simulation model by Perm State University (the research team of the Department of Economic Cybernetics of Perm State University and the Institute of Economics of the Ural branch of the Russian Academy of Sciences led by D. L. Andrianov, a fellow of the Russian Academy of Natural Sciences), "Prognoz" company, Perm; A. L. Rinchino's model of the regional socioeconomic system [20], etc.

At the regional level, less attention is paid to trend models and the construction of general equilibrium models. Simulation models are being developed within the creation of software packages for situation forecasting models: the model of mid-term forecasting of the regional economic dynamics using the linear harmonic trends (E. N. Gribova) [10]; the "Russia: Centre — Federal Districts" model (A. R. Bakhtizin) [2; 3] — a follow-up of the well-known RUSEC (RUSSian ECOnomy) CGE (Computable General Equilibrium) model developed for the Russian economy in general without taking into account the regional component; the economic dynamics model based on the equilibrium of economic agents' forecasts by the Computing Centre of the Russian Academy of Sciences (A. A. Petrov, I. G. Pospelov, and A. A. Shanin) [18]; the economic dynamics model using a limited amount of statistical data (V. Yu. Solopov, and A. V. Koshkarov) [14; 23], etc.

Alongside the above-mentioned models that have gained widespread use at the regional level and are based on traditional forecasting and planning methods, new models adopting innovative solutions and approaches to regional management have been devised recently: the multivariable Regional Strategic Matrix (A. I. Ageev, B. V. Kuroedov, R. Matthews, and O. V. Sandarov) based on elements of fuzzy logic theory, graph theory, the scenario method, the hierarchy analysis method and other mathematical methods and expert evaluations [1]; the expert simulation model of a region based on

cognitive technologies and the computational experiment (I.V. Desyatov, G.G. Malinetsky, S.K. Manenkov, P.L. Ototsky, etc.) [13]; the socioeconomic and ecological model constructed by a computer cluster system by means of parallel algorithms of scenario calculation, and optimisation and improvement of approximate optimal control (V.I. Gurman, G.A. Marveev, E.A. Trushkova) [11], etc.

As to public governance, these models and related software packages exhibit certain limitations that lie in their content being unsuitable for meeting the needs of the development of specific mechanisms and tools to influence a region's socioeconomic system. Models often fail in ensuring the long-term sustainability of a region. It is a result of the initial research premise of modelling, which outweighs the orientation to supporting managerial decisions. On the one hand, it is explained by the development of information analytical systems adjusted to the conditions of certain Russian regions; thus specific conditions of, for example, the Kaliningrad region as an object of modelling are not taken into account. On the other hand, software packages include a standard representation of the regional economic system within various subsystems. In the case of the Russian exclave, the role of external trade in the functioning and development of the regional system shall be emphasised. For Kaliningrad, "external trade" includes not only foreign states but also mainland Russia. However, most models are limited to describing international economic activities only in the context of external transactions with the "rest of the world" based on forecasting the volume of exports and imports.

Therefore, there is a need to take into account the exclave's features of formation and distribution of money and commodity flows, high mobility and dependence of system changes on insignificant disturbances when modelling the development of the Kaliningrad region. The existing models and software packages cannot solve this problem due to their unification, i.e. the orientation towards developing standard solutions for all Russia's regions. Moreover, regional models disregard balance structures and methods.

When applied to a region, the balance method means forecasting and planning the development of a certain territory through using a calculation system that makes it possible to harmonise and balance the economy's need for different types of products with the opportunities for their production or importation and availability of different types of resources (physical, labour, financial and others).

One of the major reasons behind abandoning the idea of balance structures at the regional level is the quality of the statistical data system, whose integrity and accuracy are insufficient for balancing, which leads to significant discrepancies and errors. The level of the regional accounting system development is also rather low. In this connection, preference is often given to econometric models, despite their low reliability and accuracy, especially in the periods of instability and significant fluctuations in development.

At the same time, the targets and objectives of public governance of regional development impose certain requirements on tools and methods of regional studies as to the possibility of obtaining objective information on the structure and proportions of the regional system, the evaluation of the

internal potential of regional growth, the identification of current and prospective economic specialisations, and the forecasting of scenarios of territorial development under the impact of changing factors and conditions. These problems can be solved only in the framework of the balance approach, the more so in the case of a structural transformation of the socioeconomic system.

The need for and sufficiency of the balance approach in managing the development of the Kaliningrad region are explained by the possibility of creating an integral and systemic representation of the regional economy, a study into connections and proportions, an evaluation of physical and monetary flows in the regional system associated with the actual conditions of the system's development and functioning as well as the features of the mentioned proportions.

In the case of the Kaliningrad region, the major objectives of regional management attained through the balance method are as follows:

- a detailed industry-specific description of the regional economy's reproduction processes in terms of physical composition by the types of economic activities or enterprises, which makes it possible to evaluate the development, distribution, and redistribution of monetary flows within the regional economic system;

- the representation of the manufacturing and distribution of products created in the physical and non-physical spheres; the harmonisation of different types of economic activities or enterprises at the regional level, and the identification of dependences of regional processes on external markets, as well as their interrelations;

- the identification of the existing and prospective economic specialisations within the structure of the regional economy from the perspective of achieving macroeconomic equilibrium and ensuring the balance of all spheres of the regional economy;

- identification of the areas instrumental in increasing the efficiency of the region's participation in international and regional labour division (Russian regions), as well as labour productivity potential by the types of economic activities and enterprises;

- the application of an integral approach to managing regional development in terms of territorial sustainability based on harmonising different (physical, labour, and financial) balances.

We have formulated the key requirements for a model of the long-term sustainability of the Kaliningrad region. The requirements include scientific justification, integrity, systematicity, balance, minimisation of the criteria-dependence of the analysis, the optimisation of processes taking place within the regional system, variability, sufficiency, reliability, multistructurality, practical orientation, flexibility, adaptability, and the possibility of creating an automated information system based on the results obtained.

In view of the need for balanced development and the long-term sustainability, the modelling of the regional economy should be based on the balance approach as an efficient tool of establishing and maintaining regional proportions.

An assessment of different balances and their relevance to the objectives of public governance in the Kaliningrad region and the formulated

requirements for the model of the region's long-term sustainability made it possible to identify its class, as well as the types and models within it, and carry out the parametrisation and identification for the development of the necessary software shell (see Table).

**General characteristics of the balance model
of the long-term sustainability of the Kaliningrad region**

Basic characteristics	Model parameters
Model class	Simulation model and situation forecasting
Model types	Economic growth model
Types of constituent models	Constituent models within the balance model of long-term sustainability: — general balance model — international trade balance model — potential output model — model of economic agents' behaviour — demographic and labour resource forecasting models (an evaluation and forecasting of the demographic situation and labour resources)
Types of basic models and methods	Balance approach and balance structures
Types of secondary models and methods	Econometric methods and models, regression equations in the evaluation of individual elements of the regional economic system, endogenous and exogenous variables
Object to be modelled	Main sections of the regional accounting system (RAS) used in calculating GRP: — production — revenue turnover — final consumption — gross capital accumulations — external transactions ("the rest of the world" and Russia)
Modelling of sectors within the model	Household sector Public administration sector Corporation and NGO sector International trade sector
Major forecasting method	Changes in control parameters (observed variables), development of scenarios in view of expert evaluations
Planning and forecasting horizons	Mid- and long-term planning and forecasting of long-term sustainability
IT and software shells	Delphi/Visual Basic in Excel Microsoft Office/others

Source: compiled by the authors.

There are three main blocks in the model of long-term sustainability of the Kaliningrad region. Each of them is described by means of a system of constituent balances or balance equations.

The production balance model covers the process of value adding, its distribution and redistribution among the sectors, economic activity types, and enterprises within the regional economic system. It includes the indicators of the regional accounting system in terms of product manufacturing, income turnover and use.

The international trade balance model describes aggregated blocks relating to the formation of trade and monetary flows from or into the regional economic system as a necessary condition for production activities in the region (import of goods and flows) or its result (export of goods and flows).

The budget and taxation balance model demonstrates the formation of financial resources and their use in the budget and taxation system of a Russian region and at the federal level when distributing or redistributing income (generated in the course of production activities) through the public administration sector.

The underlying approach to the identification of an international trade sector within the regional economic system and to the development of an international trade model in the context of the general balance model exhibits both research and practical significance.

The further development of a model of the long-term sustainability of the Kaliningrad region is to be aimed at the formation of a system of decision-making support.

It is proposed to consider the solutions that were developed for balance description and regional economy modelling on the basis of the methodology of the “Region” AIS (Volgoinformset, Samara) and the “Prognoz” (Prognoz, Perm) software package as the best and most popular methodologically developed software packages on the Russian market from the perspective of meeting the needs of public administration. However, the balance model of the long-term sustainability of the Kaliningrad region can function independently of the considered software packages and be integrated into different regional complexes.

Alongside the obvious modelling opportunities used in public administration, the advantages of the balance model of the long-term sustainability of the Kaliningrad region are as follows:

- orientation towards developing alternative variants and choosing the desired control measures to achieve the long-term sustainability of the socioeconomic system under certain conditions;

- establishment of connections and cohesion between individual elements of the socioeconomic system, identification of stable dependences between different elements, their balancing at the level of economic sectors and types of economic activities according to the regional accounting system;

- harmonisation of internal monetary flows with commodity flows and transactions that are external to the system by economic sectors, types of economic activity, analysis of commodity flows in the Kaliningrad region as opposed to the “rest of the world” and “mainland Russia”;

- application of the multi-agent approach through considering the key sectors of the regional economy (households, public administration, corporations, and NGOs) and institutional units, and through the analysis of aggregated types of economic activities and enterprises;

— increased accuracy of calculations through using dedicated balances in the process of forecasting the region's demographic development, the formation and use of the region's labour potential;

— possibility of disaggregating and supplementing the model according to the needs and objectives of public administration, which is manifested in the specification of exogenous and endogenous parameters within balance blocks and equations so that they become indicative;

— taking into account the production capacities of the regional economic system and their changes within the forecasting horizon through modelling potential output in view of the available capital assets and labour resources;

— opportunity to evaluate the consequences and effect of the regional policy and the project initiatives of the Government of the Kaliningrad region on the socioeconomic system of the region. It is carried out through registering the values of the model's control parameters.

The authors participated in the project "Modelling regional long-term sustainability in the Kaliningrad region" initiated by the Ministry of Economy of the Kaliningrad region (2013). In the course of the project, the research team developed a basic aggregated balance model of the long-term sustainability of the Kaliningrad region and tested it for the purpose of further disaggregation and specification in line with the needs of public administration (Fig. 1 and 2). The general framework of the model and its application in the public governance of long-term sustainability were developed.

According to its key parameters, the balance model of long-term sustainability forecasts regional proportions and performances in the framework of the dedicated models that are aligned in the process of simulation modelling and situation forecasting:

— the general balance model (uses balance equations to describe the link between individual macroeconomic indicators and subsystems of the regional economic system. It is based on the regional accounting system and reflects the movement of physical and monetary flows in economic circulation that are balanced for a specific moment (t));

— the international trade model (focuses on the international trade balance of the Kaliningrad region within the blocks reflecting the formation and distribution of monetary flows in the relations with "the rest of the world" and "mainland Russia". The model balances inflow/outflow and exports/imports of goods, including transit flows via the Kaliningrad region);

— the demographic and labour resource forecast model (changes in the size of population, age and sex structure, migration flows and, as a result, an evaluation of the region's labour potential. A workforce assessment is carried out and a labour resource balance is prepared based on the current demand for workforce);

— the potential output model describes the changes in possible output by sectors (economic agents) depending on the processes of deployment and disposal of fixed assets, the influence of demographic factors, increases in labour productivity, and the impact of technological progress);

— the economic agent behaviour model (an aggregate of the dedicated models (accounts) of the activities of regional economic agents mobilising regional physical, labour, and financial resources.

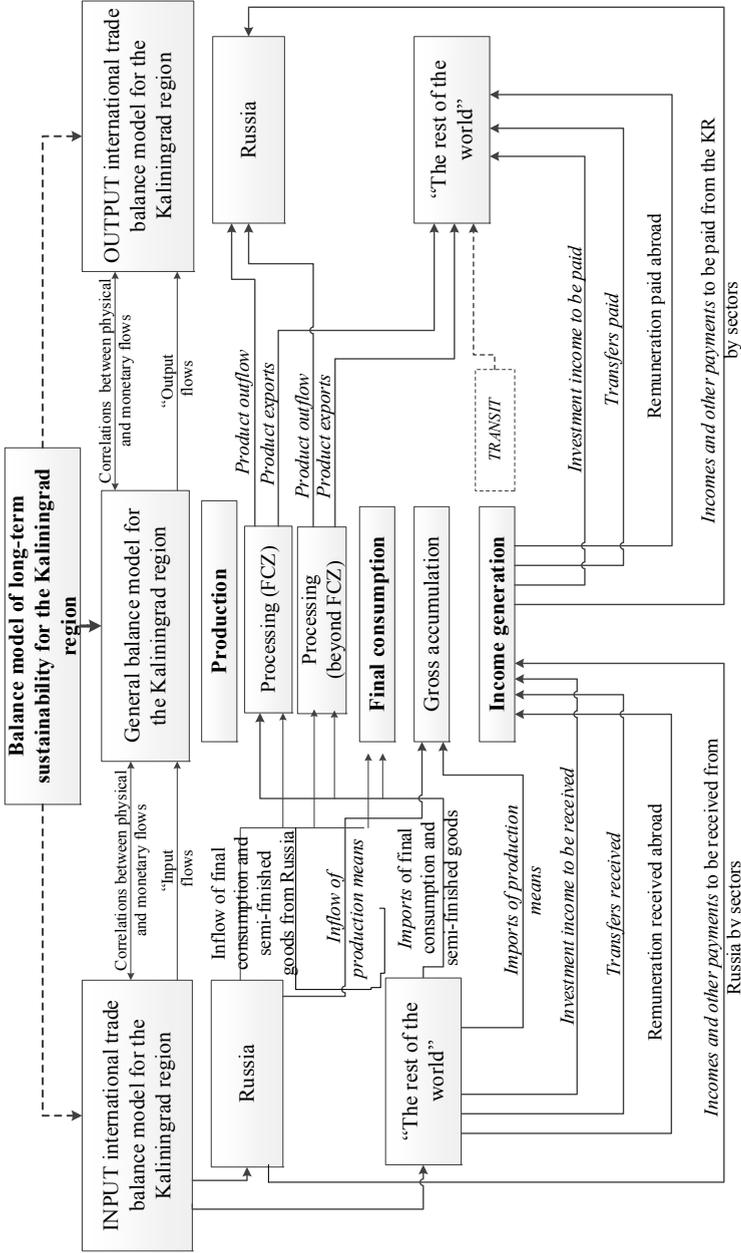


Fig. 1. Structure of the balance model of the long-term sustainability of the Kaliningrad region

Source: compiled by the authors.

The framework of the balance model of long-term sustainability includes manufacturing, income turnover, final consumption, gross accumulation, international trade sector, budget and tax calculations, demographic situation, and labour resources.

Here, the balance model comprises all elements of the regional accounting system and is capable of expanding each block in line with public governance needs.

A mathematical description of dependences and balance equations of the long-term sustainability model was prepared. It served as a basis for the development of a software package for the balance model of the long-term sustainability of the Kaliningrad region using Visual Basic Environment in MS Excel. An algorithm for creating balances and conducting calculations was developed; it was tested in the process of experimental calculations using the model in the framework of developing scenarios of the long-term sustainability of the Kaliningrad region in 2014—2018.

The balance algorithm is considered as an element of simulation modelling and situation forecasting and can be described in an aggregated form as a sequence of the following actions:

1. Scenario mapping (alternatives and scenarios of regional development are identified alongside the values of the model's exogenous parameters — gross output, labour productivity, intermediate consumption, investment accumulation rate, remuneration, etc.).

2. Model calculations and the simulation modelling of the socioeconomic system's behaviour in the framework of scenarios representing control measures. The result is the calculation of the model's endogenous parameters.

3. Establishing correlation between the target rates, and the region's potential and production capacities. It includes a comparison of gross figures with the regional potential output calculated on the basis of fixed capital and labour resources.

4. Interpretation of results, an assessment of achieved targets and public governance objectives in terms of the region's long-term sustainability. Repetition of the iterative cycle.

5. Presentation of the final results of model calculations in the framework of scenarios of the socioeconomic development of the region. Registration of control measures affecting the regional system. Development of tools and mechanisms for managing regional development.

The demographic and labour resource forecasting blocks, as well as the international trade model describing trade flows, which are presented in the model of the long-term sustainability of the Kaliningrad region, were developed independently of balances for the general models under the condition of the correspondence of calculation results.

The harmonisation of the international trade and general balance models was conducted as follows. In the framework of the general model, the target rates for internal flows are integrated into the international trade balance

model. Within the latter model, the desired endogenous variables (export, import, outflow, inflow, etc.) are calculated based on the economic and mathematical coefficients set for each commodity flow (as of 2011).

This work tests the balance model of the long-term sustainability of the Kaliningrad region for 2009—2011. It was concluded that the model was effective in terms of accurate representation and calculation of the rates describing the condition of individual elements and processes taking place in the regional economic system within the set planning horizon. Therefore, the difference between the estimated and actual values did not exceed 3—5%, which is permissible in numeric calculations.

To test the balance model and identify factors affecting the implementation of the chosen strategy, calculations were carried out for three scenarios of the development of the Kaliningrad region.

Scenario 1: Import substitution. An increase in value added at import substitution enterprises. The structure of the regional economy does not change, which is manifested in the persistence of certain types of economic activities and enterprises within macroeconomic indicators. However, gross value added is expected to increase in regional import substitution by types of economic activities; it is expected to double in 2018. Through the balancing of monetary flows, the following key control parameters of long-term sustainability were obtained:

- increase (duplication) of import substitution cost, which is manifested in a growing percentage of processing enterprises in the structure of GRP — from 22.03% in 2011 to 35.0% in 2018 (16.5% in 2009, 16.63% in 2010);

- an increase in gross output (105.0%);

- an increase in GRP (118.7%);

- a decrease in the percentage of intermediate consumption in gross output from 60.0% in 2011 to 54.8% in 2018;

- an increase in labour productivity per employee — from 483.4 thousand roubles in 2011 to 539.2 thousand roubles — at 111.6%;

- exports from the Kaliningrad region at 110.0%;

- transportation of goods from the Kaliningrad region at 115.0%.

Within the scenario's forecasting horizon (2014—2018), a 36% decrease in imports and a 1.8-fold increase in exports of goods from Russia are expected. Fig. 3 shows the results of scenario planning in the framework of the balance model.

Scenario 2: Economic modernisation. A transition from “partial import substitution” to an export-driven economy. The scenario's control parameters are the targets set in the “Economic Modernisation” state programme for the Kaliningrad region. The role of import substitution is decreasing dramatically in the structure of the regional economy; new enterprises are expected to emerge in the framework of innovative economic activities; services industries are developing rapidly — in particular, the percentage and contribution of tourism into GRP is growing.

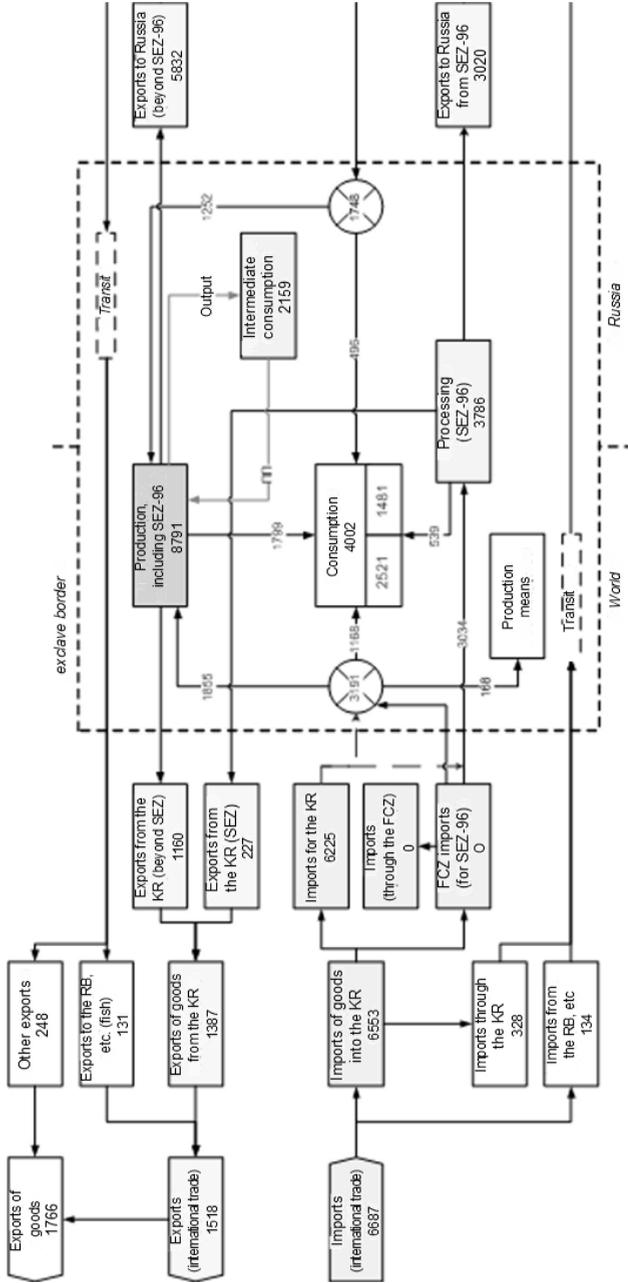


Fig. 3. Commodity flows according to the Import Substitution scenario, million USD

Legend: RB — Republic of Belarus, KR — Kaliningrad region, IC — intermediate consumption, FCZ — free customs zone, SEZ — special economic zone.

Source: [5; 6].

The scenario uses the following targets of the “Economic Modernisation” project:

- a 1.8-fold increase in GRP per capita by 2020 in comparison to 2013 in current prices. In 2018, GRP will amount to 139.4%;
- an increase in GRP (12.5%, an annual growth rate of 2.5%);
- a 1.9-fold increase of labour productivity per employee in current prices in comparison to 2013. In 2018, labour productivity will increase to 817.3 thousand roubles (569.9 thousand roubles in 2013), the rate will increase by 143,4%;
- an increase in gross output (150%; an annual growth rate of 10%);
- a 1.4-fold increase in investment in fixed capital per capita in current prices by 2020 in comparison to 2013.

It is worth stressing the extensive nature of the regional economy’s development, which becomes an obstacle to a transition to an innovation-based export model. In line with the targets of the state programme, an increase in GRP will be achieved through a 43.4% growth in labour productivity against a 21.5% reduction in workforce and an increase in the percentage of intermediate consumption by up to 70%. Thus, the GRP growth is supported by an increase in the amount of raw materials “pumped” through the region.

Scenario 3: “Local zone” export model. The preservation of the current model of regional economy (tax and customs privileges) within “local zones” against the background of a gradual increase in innovation by 2018. A growing value added standard for import substitution enterprises is accompanied by the improvement of major macroeconomic indicators through an increase in the efficiency of regional resources and industrial potential.

As a result of monetary flow balancing, the following control parameters of long-term sustainability were obtained:

- an increase in gross output (110.0%);
- an increase in GRP (115.0%);
- a decrease in intermediate consumption from 60% in 2011 to 58% in 2018;
- an increase in labour productivity per employee from 483.4 thousand roubles in 2011 to 522.6 thousand roubles (108.1%);
- exports of goods from the Kaliningrad region at 135.0%;
- transportation of goods from the Kaliningrad region at 119.0%.

In comparison to the previous scenario, a more favourable situation is attained in terms of intermediate consumption reduction and an increase in further processing up to 42%. It creates the necessary basis for a further increase in export potential and transportation of goods into other Russian regions. Compared to 2011, imports will decrease by 32.3%, inflow of goods from other Russian regions will increase 1.7-fold.

The data of the Kaliningrad Office of the Federal Statistics Service, Russian Ministry of Finance, Ministry of Finance of the Kaliningrad region, Federal Taxation Service, Kaliningrad Office of the Federal Taxation service, Russian Federal Treasury, and North-western Office of the Federal

Customs Service of Russia were used as sources of information on the endogenous and exogenous parameters of the balance model of long-term sustainability as of 2009—2011.

The balance model of long-term sustainability, its blocks, modules, and related software packages can be used in public governance in the Kaliningrad region in the following areas:

— evaluation of the balance and cohesion between individual elements and flows within the regional socioeconomic system in monitoring the current situation in the region. The achieved targets are to be integrated in the model; their balance requires analysis.

— forecasting of socioeconomic indicators of long-term sustainability by different areas and types of control measures. The degree and level of impact are identified based on assessing the changes in the region's socioeconomic system;

— development of new or the evaluation of the efficiency of the existing mechanisms and tools of managing regional development aimed at ensuring long-term sustainability;

— assessment of the results of certain programme or project solutions by areas of the socioeconomic system — efficiency of public administration in solving certain problems of regional sustainability (production, manufacturing and unemployment, social welfare, etc.).

During the test, the developed balance model of long-term sustainability showed good results in terms of accurate representation and calculation of the rates describing the condition of individual elements and processes taking place in the regional economic system within the set planning horizon. Thus, it is possible to expand selected blocks in line with the purposes of public governance. A fully developed model complex can be used in modelling regional development and forecasting targets and proportions of the regional economic system both in the Kaliningrad region and other regions with similar conditions and structure of the territorial socioeconomic system.

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About the authors

Dr Ksenia Voloshenko, Director of the Centre for the Modelling of Regional Socioeconomic Development, Science Park, Immanuel Kant Baltic Federal University, Russia.

E-mail: KVoloshenko@kantiana.ru

Anastasiya Kuznetsova, Minister of Economy of the Kaliningrad region, Russia.

E-mail: a.kuznetsova@gov39.ru