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## Economic growth outlooks in sub-federal development strategies: prospects and constraints

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# **Economic growth outlooks in sub-federal development strategies: prospects and constraints**

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- **Abstract**

*Inconsistencies in targeting and forecasting during the process of strategic planning in regions–subjects of Russian federation is atopic of the paper presented. It presents the results of analysis of regional strategies of long-term socio-economic development performed for federal subjects of Siberian and Far Eastern federal districts as well as for a group of largest federal subjects and macro-regions of Russia. The set of regional strategies may be considered as a unique sociological survey in which regions perform a role of interviewed subjects.*

*A method of testing strategic documents of federal subjects in terms of their consistency and availability of resources is presented. The method involves a) analysis of targeting in sub-federal strategies; b) aggregation of isolated forecasts of subjects of the same federal district; c) a comparison of the aggregate of independent sub-federal strategic forecasts with the complex long-term spatial forecast of socio-economic development of Russian economy.*

*The authors of regional forecasts have an advantage of local knowledge, of the economic situation, but they are not able to account all resource constraints that arise when intersectoral and interregional relations between production and exchange of goods in the economy (or within a larger macro-region) are analyzed. Such possibility is provided by the use of a national and spatial input-output models unified in the model complex. It provides forecasts in the cut of 8 federal districts (including Tyumen) and 40 economic activities.*

*This result confirms the assumption of a lack of validity of regional administrations' investment plans. According to the forecasts based on OIIM, in the years 2006–2020, the Russian economy is unable to provide investments stated in regional forecasts.*

*The results of a comparative analysis of the resource security of regional strategies and a verification of independent regional GDP growth forecasts by regions of Siberia, Far east and other macro-regions showed a potential of interregional competition for labor and investment resources. It is shown that a regional strategy is often used as a means of competition with other regions for federal resources. The basic problems are formulated that should be solved in order to make regional strategies actually important element of improving the system of regional governance and the document of public consensus between the government, business, and the population in respect of key issues of regional development.*

## **Introduction**

At present all 83 Russian administrative regions (subjects of Russian Federation) have developed their strategies of long-term socio-economic development for periods up to 2020, or-2030. These strategies are public documents: they are available on websites of regional administrations.

The need in the long-term strategic planning was recognized not long ago, in last decade. After the destruction of the socialist planning system, in the decade of 90-s, regional administrations were concentrated on current problems of surviving. Then, in early 2000s, they focused on developing the mid-term strategies of regional economic development up to 2010, which was stimulated by the requirements of the Ministry of Economic Development of the RF. Having the developed mid-term strategy was the necessary (but not sufficient) condition for granting from the Federal Fund for Financial Support of the Subjects of the Federation (FFPR). These strategies were elaborated according to the pattern approved by the Ministry. Later, having entered into the period of stable economic growth, regional administrations began to initiate the development of long-term strategies from their own.

This process culminated in early 2010s. Now the most advanced regions have sets of strategies including the long-term strategy of socio-economic development of a subject of the Federation, the strategy of innovation development, strategies of municipalities and rayions, etc. So, one may observe the formation of the spatial strategic planning system. In the context of this paper the most promising outcome of this process is that the set of 83 regional strategies may be considered as a unique sociological survey in which regions perform a role of interviewed subjects. The uniqueness of these documents is that they represent rare cases when a region is considered not as the set of industries in the frames of a territory, not as a number of inhabitants or voters in the same frames, not as a place of corporations location, but as an active actor, with its wishes, hopes, with its recognizing of its place among neighbours. The analysis of these self-presentations may allow adding more to our knowledge about horizontal relations between regions as well as about their relations with the federal government.

The paper represents some results of our analysis of strategies of subjects of Siberian and Far Eastern. The author aimed at testing sub-federal strategies of socio-economic development for compliance thereof with strategies of higher levels and for the consistency of the formulated goals, objectives and priorities.

The method of the comparative analysis of the strategies involved the following steps: (a) analysis of time horizons and the legal status and structure of strategies; (b) elementwise analysis of strategies; (c) consolidating the forecasted outcomes from the implementation of strategies in terms of the volume of gross regional product (GRP), investment in fixed assets, and the number

of employees; and (d) checking the consistency of consolidated forecasts for federal districts, formed on the basis of regional strategies, with similar forecasts, made at the IEIE SB RAS on the basis of spatial input-output model in the cut of federal districts and Tyumen oblast. Further the paper follows to this structure. The method will be demonstrated on the set of Siberian regions' strategies as of 2008, while the results will be presented for all regions considered.

### **1. Analysis of time horizons and the legal status and structure of strategies**

**The time horizons** of these documents are different: from 2017 in the long-term socioeconomic development programs of Altai and Krasnoyarsk krajs and the Republic of Buryatia to 2028 in the socioeconomic development program of the Republic of Altai. Five subjects reported long-term strategies in combination with medium-term programs (the Republic of Buryatia, Tyva, Kemerovo oblast, Altai and Krasnoyarsk krajs; in particular, in the long-term development program of Krasnoyarsk krai for 2007–2017, the medium term up to 2012 is highlighted). In the Republic of Khakassia, a socioeconomic development strategy for the period up to 2015 is valid, which is one of the subsections of the medium-term program “Socioeconomic Development of the Republic of Khakassia for 2006–2010.” A policy document titled “Strategic Development Directions of Chita oblast for the Period until 2020” is actually a part of the introduction to the region's socioeconomic development program in the medium term until 2010.

**The legal status** of the strategies also differed. Most of the considered regional strategies were approved by the local legislative or executive authorities. In five regions (the Republic of Altai, the Republic of Buryatia, the Republic of Khakassia, and Kemerovo and Chita oblasts), there were adopted regional laws on the approval of strategies. In two oblasts (Novosibirsk and Tomsk), strategies were approved by ordinances of legislative authorities. In three regions (the Republic of Tuva, Altai, and Omsk), strategies were approved by ordinances of the region's administration (government) or by a decree of the governor. In Irkutsk oblast and Krasnoyarsk krai, strategies have not been approved (they have no official status).

Thus, two subjects of the federation, namely, the Republic of Khakassia and Zabaykal'e krai (former Chita oblast), out of the 12 considered Siberian subjects did not have long-term strategies as of 2008. All subjects, included in the SiFD, had standard medium term programs for the period 2006–2010, made in accordance with the requirements of the “Standard Layout Program for the Socioeconomic Development of the Russian Federation,” approved by the act of the Ministry of Economic Development and Trade of the Russian Federation no. 170 as of July 17, 2002. An exception is the Republic of Altai, where the corresponding program was developed for the period 2006–2009.

The Ministry of Regional Development of the Russian Federation recommended that the

federation's subjects follow the "Requirements to the Socioeconomic Development Strategy of Subjects of the Russian Federation" when developing long-term strategies (according to this document, the long-term perspective should be at least 20 years). Only the strategies of the Republic of Buryatia, the Republic of Altai, Altai krai, and Novosibirsk and Kemerovo oblasts corresponded to these criteria.

Thus, the initial analysis showed a mismatch between the long term strategies and programs of Siberian regions in terms of the stated time frames of strategic planning.

## **2. Elementwise analysis of strategies**

In the presented strategies, developers used **basic elements of strategic analysis**: they described the image (vision) of the region's future, formulated the mission or motto of the region, highlighted the main strategic goal, and identified a set of strategic goals and corresponding objectives, as well as sectoral and spatial priorities. An analysis of the wordings of the "images of the future" in Siberian territories revealed some potential for interregional competition for human resources, since many of them positioned themselves in the future as "the most attractive places to live in Siberia." It is noteworthy that in the analysis of competitive advantages even the most remote regions (such as Tyva, Buryatia and Khakassia) stressed the merits of their geographic location, positioning themselves "in the centre of Siberia, on the crossroad of important trade routes".

Significant differences in the strategies of Siberian regions emerged in the understanding of **the objects of targeting**. So, in the strategies of the Altai Republic, the Republic of Khakassia, and Kemerovo oblast, the strategic goals are formulated with regard to the management policies of development in the region (for example, "socio economic policies of the government of the Republic of Khakassia"), but not with respect to the development of the region itself. The strategy of Tomsk oblast emphasized the coincidence of region-wide strategic objectives ("the most important and definite advantages for residents of Tomsk oblast") shared by the most active part of the population, with the goals of the regional administration.

All strategic goals in the analyzed documents have two components that are generally formulated as **a rise in living standards and formation of an effective regional economy**. Differences occur in the positioning of these goals. Thus, the Republic of Altai and Kemerovo and Omsk oblasts see improving the competitiveness of the region as a key strategic goal and, on this basis, increasing the prosperity of the population. In the Republic of Buryatia, the Republic of Khakassia, and Tomsk and Irkutsk oblasts, a higher living standard is put on the first place and the achievement of a certain level or dynamics of the regional economy is claimed as a means for implementing the main goal. The strategies of the Republic of Tuva and Altai give equal weights to the goals. In the strategy of Novosibirsk oblast, improved living standards are

caused by the formation of an appropriate socioeconomic policy.

The strategies of the Siberian regions used **different targeting hierarchies**, and the number of levels in these hierarchical systems varied from two to four. The first level of the hierarchy (strategic goal) was present in all strategies, except for Krasnoyarsk and Chita oblast. Objectives of the second level were formulated as “strategic objectives”, “strategic directions”, “strategic goals”, “basic objectives”, and “med-term and long term goals”. Objectives of the third level (tasks proper) were present in eight strategies out of twelve. The strategic development priorities were identified at the second level (in parallel with the strategic sub goals) in the strategies of five regions, and, as a rule, they were sectoral priorities. In other regions of the SiFD, the development priorities were indicated in the goals and objectives of the second and third levels.

Many of neighbouring regions tend to initiate investment projects in related or similar activities, which is expectable in similar geographic conditions. But this implies inevitably the competition for investments. However, a detailed **analysis of interregional competition** is only found in the strategy of the Republic of Buryatia, where the position of the region is compared with the positions of Irkutsk and Chita oblasts on the tourist and transport services markets, as well as in engineering, mining, and other activities. The interests of neighboring regions and the possibilities of interregional partnership are also addressed in the long-term strategies of Altai krai, Irkutsk and Novosibirsk oblasts, and the Altai Republic.

Problems regarding **the sufficiency of resources** for implementing strategies are worked out in the reviewed documents to varying degrees. Thus, a demographic outlook and an employment forecast are only presented in half of the strategies: in the strategies of the Republic of Buryatia, Republic of Tuva, Altai and Krasnoyarsk krais, and Kemerovo, Irkutsk, and Novosibirsk oblasts. It should be noted that only the marked republics have positive population projections. The strategies of Altai krai and Novosibirsk, Irkutsk, and Kemerovo oblasts consider two demographic scenarios, one of which involves population growth, while the other one envisages its reduction. Only in Krasnoyarsk krai, negative trends in both scenarios are expected. At the same time, the employment forecast is uniquely negative in all these regions, with the exception of the Republic of Buryatia and Novosibirsk oblast.

Overall, our analysis revealed the following. First, the strategies of Altai, Novosibirsk, Irkutsk, and Tomsk oblasts were structured most logically. Second, the strategic goals and objectives set out in the long-term strategies of the SFO regions did not contradict the goals and objectives set out in the “Strategy of the Socioeconomic Development of Siberia” and the “Concept of Long-Term Socioeconomic Development of the Russian Federation until 2020.” Third, the comparison of the proposed investments projects reveals the potential for interregional competition for resources. Fourth, demographic forecasts tend to underestimate the scale of

future shortages on regional labour markets, which may strengthen this competition

### **3. Consolidating the expected outcomes from the implementation of strategies**

Meanwhile, the **forecasts for GRP growth** in the regional strategies are unequivocally positive in all of the variants. These expectations suggest that the increase in production will be carried out by increasing the labor productivity, which, in turn, inevitably requires a significant increase in the regional capital to labor ratio. Respectively, in the regional strategic forecasts, capital investments grow at a faster pace. In order to attract the required volume of investments, public– private partnership, implementation of federal programs in their territories, as well as a direct appeal to the federal and regional budgets, are assumed in the strategies of the Siberian regions.

However, sufficient calculations of the need for investment, labor, and other resources to implement the strategy are rather exceptions from the rule. They only carried out in the socioeconomic development strategy of Novosibirsk oblast. The total need for capital investment for the entire period is also defined in the strategies of the Republic of Tyva and the Republic of Buryatia. In other documents, a forecast of capital investments was made in the consolidated economic forecast in terms of growth rates or volumes for certain years.

Subfederal forecast differ by the degree of reasonableness, of detail, by the level of the mathematical apparatus in use. They vary from designated rates of growth to the detailed systems of mutually coordinated indicators calculated on the base of economic-mathematical models. Thus, initially these forecasts are incompatible because they are presented in different terms (rates of growth or absolute values) for different years or periods. The number of variants also varied from 1 to 3.

The emendation required for a special procedure. In order to aggregate isolated GRP growth forecasts, presented in the regional strategies, it was necessary to implement their reduction, conversion to annual rates, and, in some cases, extrapolation to obtain the projected values of GRP for 2020 for by all subjects of the federation. Such a set is shown in Table 1. The forecast variants were reduced to 2 scenarios provisionally called “inertial” and “optimistic.” If there were no calculations for the inertial variant, parameters were approximately adjusted in the direction of a moderate decline. As a result we have obtained the consolidated forecast for Siberian federal district.

**Table 1.**

Set of independent forecasts of GDP growth rates in 2006–2020 (according to data from regional strategies), %

RF subject	Inertial scenario	Optimistic scenario
<b>SiFD (consolidated of</b>	<b>5.8</b>	<b>8.2</b>

<b>subfederal forecasts)</b>		
Republic of Altai	6.8	8.0
Republic of Buryatia	6.7	8.7
Republic of Tyva	4.6	12.4
Republic of Khakassia	3.8	4.8
Altai krai	5.0	7.7
Krasnoyarsk krai	3.9	5.9
Irkutsk oblast	2.8	7.1
Kemerovo oblast	5.4	6.8
Novosibirsk oblast	5.2	8.2
Omsk oblast	3.7	5.6
Tomsk oblast	4.7	5.7
Chita oblast	3.3	4.5

It is evident from the table 1 that “inertial” and “optimistic variants of regional forecasts differ significantly. The realization of “optimistic” scenario” could lead to the growth of interregional differentiation. But it is noteworthy that the smaller a region, the higher its optimistic expectations. This observation is valid not only for Siberia, but for other federal districts as well (See Supplement 1 for Far East). So the territorial pattern of the gross regional product of federal districts did not change significantly/Moreover, if some subject demonstrated the sharp change of its contribution to the federal-district GRP (like the decrease of the Krasnoyarsk krai share from 24.5% to 19.8% of Siberian GRP during the forecast period), this caused doubts in the quality of the forecast.

So, the mere procedure of “non-coordinated“ consolidation of subfederal forecast is very important for the verification of forecasts. Then, having such set of compatible individual forecasts for 2020 allows for estimating the rightness of expectations expressed in subfederal strategies.

#### **4. Checking the consistency of consolidated forecasts**

In their calculations, the authors of regional forecasts rely on the knowledge of the economic situation in a region, information on the real and long-term investment projects, and resource estimation and opportunities. Without a special toolkit, it is impossible to take into account all resource constraints that arise when intersectoral and interregional relations between production and exchange of goods in the economy (or within a larger macroregion) are analyzed. Therefore, the only available analysis method of the resource security of regional strategies and verification of independent regional forecasts of production growth at the moment is a comparison of

consolidated forecasts made on the basis of existing strategic regional forecasts and predictions obtained on the basis of an optimization of the multiregional input-output model (MIOM) of the Russian economy.

Based on this model, the calculations of which are conducted by federal districts and Tyumen oblast, a spatial forecast of parameters of the Russian economy in 2020 has been obtained at the IEIE SB RAS (2005 is used as a base year). The main forecast parameters are given in Table 1. A forecast of the economic growth in the Siberian federal district is obtained simultaneously with forecasts of other macroregions, taking into account the full range of cross-industry and interregional economic relations and restrictions on labor and investment resources. In accordance with the parameters in the macroeconomic forecast of the Ministry of Economic Development, three forecast variants were calculated: moderately optimistic, innovative, and inertial. As seen from Table 2, the SiFD shows the highest growth rates of GRP and capital investment in all variants in the forecast period.

**Table 2.**

Average annual growth rate of the main macroeconomic indicators of regional development forecasts by variants for the period 2006–2020, %

Indicator	RF	CFD	NWFD	SFD	VFD	UFD (minus Tyumen)	Tyumen	<b>SiFD</b>	FEFD
Optimistic scenario									
GRP	105.6	105.3	106.0	106.4	105.8	106.0	103.3	106.3	105.9
Investment in fixed assets	108.6	106.4	107.4	107.9	108.9	109.4	109.9	112.1	108.4
Inertial scenario									
GRP	104.7	104.6	105.0	105.6	104.8	104.9	102.6	105.3	105.0
Investment in fixed assets	106.9	104.8	105.8	106.0	107.0	107.5	108.9	110.2	106.4

The possibility of verifying subfederal forecasts is based on the experience of developing multiregional input-output models (OMIOM) for purposes of long-term forecasting. The active studies in the field of long-term forecasting with the use of the OMIOM apparatus were recommenced in the Institute of Economics and Industrial Engineering SB RAS (Novosibirsk) in 2002 and go on till now. (Ershov, 2007b)

#### **a. Design of IO models in use**

At present the OMIOM apparatus in use includes 2 basic models called as “point” (dynamic IO model) and “spatial”(multiregional IO model) models.(Ershov, 2007a) Forecasts for Russia as a whole are performed on the base of the optimization IO dynamic model. This model is used as an instrument for long-term forecasting in the cut of types of economic activities without taking spatial aspects of economic development into account. Spatial forecasts are performed on the base of the optimization multiregional IO model. Both models are constructed on the same database of 2010 in the cut of 40 sectors corresponding to the new nomenclature of economic activities developed with the Rosstat in 2004 and harmonized with Classification of Economic Activities in the European Community (NACE rev.1.1). (The list of sectors is attached in Supplement 2). Both models produce forecasts to 2030.

The “point model” has 2 forecasting periods: 2011-2020 and 2021-2030. The model contains of common IO balances: the balances of production and distribution of outputs, the balances of labour resources, the balances of gross investments and constraints on foreign trade balances. The objective function maximizes the sum of final demand components such as the final demand of house holdings, of governmental institutions, of non-profit organizations attending to house holdings, and the accumulation (change in stocks) of circulating tangible assets. The realization of the dynamic IO model provides for the forecasted tables of distribution of goods and services in the economy for the last years of the forecast period as well as for all interim time points. The presence of the “point” model facilitates the subsequent statement and realization of the “spatial” model. The formal statement of the model is in Supplement 3

The “spatial” model consists of 9 regional blocks united with the conditions of interregional transportation-economic links and with the territorial pattern of final demand. Each region is presented with the semi-dynamic optimization IO model that provides for the calculation of the state of economy for the last year of a forecast period. The set of constraints in regional blocks duplicates the structure of the “point” model. The optimal solution of the model represents a consistent set of forecasted regional IO tables for the last year of a forecast period. The tables are produced in the cut of 8 federal districts and Tyumen oblast and 40 types of economic activities. (Regions are listed in Supplement 4, the formal statement of the model is written in Supplement 5, the conventional scheme is in Supplement 6 ) As distinct from the “point” IO model the “spatial” one is realized in the semi-dynamic statement, with the use of a forward recurrence: first the problem is solved for 2011-2020, and then it is solved for 2021-2030 from the base of 2020.

### **b. Comparing the aggregate of subfederal forecasts with MIOM forecast**

In the presence of a GRP growth rate forecast for the SiFD regions for 2020 in a comparable form (as the average annual growth rate), it is possible to assess the validity of the expectations expressed in the regional strategies. A comparison of the optimistic projection variants with the optimistic version of the forecast obtained on the basis of the MIOM clearly demonstrates an overestimated effect from the implementation of regional strategies and, as a result, insufficient attention to resource constraints. The summary GRP growth rates of the SiFD subjects are much higher even when compared with the best innovative option of spatial development forecast of the Russian economy. Over the period 2006–2020, total GRP of the SiFD subjects (as a result of synthesis of their autonomous forecasts) increases by a factor of 3.25, while in the forecast made on the basis of the MIOM, considering interregional interactions and interrelationships, it does not grow by more than a factor of 2.5 even under the best set of circumstances and successful innovative policy. The forecast growth rates of investment in Siberian regions were significantly higher (by 2%) compared to the estimates of the complex forecast made on the basis of MIOM.

So, it became possible to estimate appropriateness of expectations expressed in the strategies of regions-subjects of Siberian Federal District. As Table 3 demonstrates, in the case of “inertial” scenario” the authors of local strategies extrapolated existing trends in the future so that the results do not deviate too much of the forecast based on the MIOM – by 0,5 percentage points. At the same time, the mere aggregate of local forecasts yields in higher growth rates even under conditions of “inertial” scenario, that is in the absence of any regional policy.

The comparison of “optimistic” variants evidently reveals the over-estimation of probable positive effects of realization of local strategies caused and, as a consequence, inadequate taking resource constraints into account. The aggregated growth rates of the sum of Siberian regions appear to be much higher even in comparison with the most optimistic, “innovation” scenario of our spatial forecast, exceeding the last by 1 percentage point. This implies that the total gross regional product of Siberian regions increases by a factor of 3,25 for the period of 2006-2020 while after consideration of interregional interactions and inter-industry links, it cannot rise more than by a factor of 2.5 even under the most favourable circumstances and successful realization of regional policy.

Table 3

Forecasts of average annual growth rates of the GRP of Siberian federal District  
in 2006-2020 (in percents)

	Scenarios		
	Inertial	Energy-raw materials	Innovation
Forecast on the base of the OMIOM	5,3%	6,3%	7,2%
	Inertial	Optimistic	
The aggregate of isolated regional forecasts	5,8%	8,2%	

The same procedure of compilation was performed for forecasted estimates of volumes of fixed investments. The aggregated growth rates of investments in the sum of isolated forecasts of Siberian subjects of the RF turned out to be much higher – by 2 percentage points - in relation to the complex forecast based on the use of multiregional IO model (See Table 4)

Table 4

Forecasts of average annual growth rates of fixed investments of Siberian federal District  
in 2006-2020 (in percents)

	Scenarios		
	Inertial	Energy-raw materials	Innovation
Forecast on the base of the OMIOM	10,2%	12,1%	13,4%
	Inertial	Optimistic	
The aggregate of isolated regional forecasts	12,3%	14,3%	

The result obtained confirms our supposition about insufficient validity of investment plans of regional administrations. They are formulated in terms of realization of regional potential on the assumption of investment inflows from outside, especially from the federal government. But for the national economy as a whole such “external” investment resources are internal. According to the calculations on the base of the MIOM, the national economy of the RF will not be able to provide the volume of investments declared in local forecasts.

Nevertheless, local forecasts appear to be consistent with the national forecast at least in one aspect: they require for exceeding growth rates of investments over growth rates of production. Now strategies of the subjects of Russian Federation are used as additional tools for lobbying regional interests in the federal center, and from this point of view the development of regional strategies certainly improves the culture of investment decision-making on all federative levels.

## **Conclusion**

So, the subfederal strategic documents have the following peculiarities that characterize the current state of regional strategic planning in Russia.

The strategies of subjects of the Federation are different in their understanding of targeting hierarchies, of strategic goals, objectives and priorities of development.

Scenario calculations are not well established: there is a tendency to forecast the GRP growth at the background of the expected decline of population what contradicts to the economic theory, history and practice. The most of subfederal strategies does not contain the estimates of required labour resources and investments.

The existing practice of developing local forecast in isolation of the national forecast of spatial economic development results in their inconsistency, that is exceeding the aggregate demand for external resources over available size of national resources including foreign investments. According to the forecasts based on MIOM, in the years 2006–2020, the Russian economy is unable to provide investments stated in regional forecasts

Improving quality of regional forecasts would be possible if the national spatial forecast were the initial point in the procedure of development of local strategic documents. Our experience in testing 27 regional forecasts proved that the same procedure for 83 strategies will be much more complicated process, which requires for the use of multiregional IO modeling. This apparatus provides for possibilities of long-term forecasting the national economy and of verifying subfederal forecasts.

Moreover, the inconsistency of long-term subfederal forecasts implies that their estimates of perspective regional growth establish the basis for interregional competition for resources: labor, investments, federal funding. Such tendency implies inevitably especially because the subfederal strategies are used as tools for lobbying regional interests on the federal level. At the

same time the issues of interregional collaboration and arising potential of growth are elaborated not sufficiently.

Meanwhile, the regional growth is not limited with the administrative borders. Coordination of regional strategies and analysis of consolidated subfederal forecasts are necessary for the further development of the spatial system of strategic planning in Russia

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## Supplement 1

Forecasted average annual growth rates of the gross regional product in regions-subjects of Far Eastern Federal District in 2011-2020

	Variants of the forecast	
	Inertial	Innovative (“optimistic”)
<b>SiFD (consolidated of subfederal forecasts)</b>	<b>5.4%</b>	<b>9.9%</b>
Republic of Sakhs (Yakutia)	4,0%	7,2%
Kamchatka krai	6,0%	15,0%
Primorye krai	9,6%	12,9%
Khabarovsk krai	3,6%	7,4%
Amur oblast	6,0%	12,7%
Magadan oblast	4,7%	4,6%
Sakhalin oblast	3,0%	9,0%
Jewish autonomous oblast	2,0%	9,0%
Chukotka autonomous okrug	8,1%	10,5%

## Supplement 2

### List of sectors

№	Types of economic activities
1	Agriculture
2	Hunting and forestry
3	Fishing, fish-farming
4	Extraction of solid fuel
5	Oil extraction
6	Gas extraction
7	Ferrous ore extraction
8	Non-ferrous ore extraction
9	Other minerals extraction
10	Food industry
11	Light industry

12	Wood industry
13	Pulp and paper industry
14	Publishing and printing
15	Coke
16	Oil products
17	Chemical products
18	Other non-metallic mineral products
19	Ferrous metals
20	Non-ferrous metals
21	Fabricated metal products
22	Machinery
23	Other industries
24	Generating and distributing electric energy
25	Generating and distributing heat energy
26	Production and distribution of gas fuel
27	Gathering and distributing water
28	Construction
29	Trade, repair of vehicles and others
30	Hotels and catering
31	Railway transport
32	Pipeline transportation
33	Other transportation and auxiliary activity
34	Communication
35	Financial activities
36	Realty, lease and other services
37	Public administration and military protection, mandatory social insurance
38	Education
39	Health and social services
40	Other public, social and personal utilities

**Formal statement of optimization input-output dynamic model of the  
Russia's economy**

Balances of production and distribution of products

for 2010:

$$x_i^0 + x_i^1 - \sum_{j=1}^n a_{ij}^{01} x_j^0 - \sum_{j=1}^n a_{ij}^{11} x_j^1 - \alpha_i^1 z^1 - v_i^1 + w_i^1 \geq b_i^1; i = 1, \dots, n; \quad (1)$$

for 2015:

$$x_i^0 + x_i^1 + x_i^2 - \sum_{j=1}^n a_{ij}^{02} x_j^0 - \sum_{j=1}^n a_{ij}^{12} x_j^1 - \sum_{j=1}^n a_{ij}^{22} x_j^2 - \alpha_i^2 z^2 - v_i^2 + w_i^2 \geq b_i^2; i = 1, \dots, n; \quad (2)$$

for 2020:

$$x_i^0 + x_i^1 + x_i^2 + x_i^3 - \sum_{j=1}^n a_{ij}^{03} x_j^0 - \sum_{j=1}^n a_{ij}^{13} x_j^1 - \sum_{j=1}^n a_{ij}^{23} x_j^2 - \sum_{j=1}^n a_{ij}^{33} x_j^3 - \alpha_i^3 z^3 - v_i^3 + w_i^3 \geq b_i^3; i = 1, \dots, n; \quad (3)$$

for 2030:

$$x_i^0 + x_i^1 + x_i^2 + x_i^3 + x_i^4 - \sum_{j=1}^n a_{ij}^{04} x_j^0 - \sum_{j=1}^n a_{ij}^{14} x_j^1 - \sum_{j=1}^n a_{ij}^{24} x_j^2 - \sum_{j=1}^n a_{ij}^{34} x_j^3 - \sum_{j=1}^n a_{ij}^{44} x_j^4 - \alpha_i^4 z^4 - v_i^4 + w_i^4 \geq b_i^4; i = 1, \dots, m; \quad (4)$$

corresponding restrictions for capital-forming sectors:

$$x_g^0 + x_g^1 - \sum_{j=1}^n a_{gj}^{01} x_j^0 - \sum_{j=1}^n a_{gj}^{11} x_j^1 - u_g^1 - \alpha_g^1 z^1 - v_g^1 + w_g^1 \geq b_g^1; g \in G; \quad (5)$$

$$x_g^0 + x_g^1 + x_g^2 - \sum_{j=1}^n a_{gj}^{02} x_j^0 - \sum_{j=1}^n a_{gj}^{12} x_j^1 - \sum_{j=1}^n a_{gj}^{22} x_j^2 - u_g^2 - \alpha_g^2 z^2 - v_g^2 + w_g^2 \geq b_g^2; g \in G; \quad (6)$$

$$x_g^0 + x_g^1 + x_g^2 + x_g^3 - \sum_{j=1}^n a_{gj}^{03} x_j^0 - \sum_{j=1}^n a_{gj}^{13} x_j^1 - \sum_{j=1}^n a_{gj}^{23} x_j^2 - \sum_{j=1}^n a_{gj}^{33} x_j^3 - u_g^3 - \alpha_g^3 z^3 - v_g^3 + w_g^3 \geq b_g^3; g \in G; \quad (7)$$

$$x_g^0 + x_g^1 + x_g^2 + x_g^3 + x_g^4 - \sum_{j=1}^n a_{gj}^{04} x_j^0 - \sum_{j=1}^n a_{gj}^{14} x_j^1 - \sum_{j=1}^n a_{gj}^{24} x_j^2 - \sum_{j=1}^n a_{gj}^{34} x_j^3 - \sum_{j=1}^n a_{gj}^{44} x_j^4 - u_g^4 - \alpha_g^4 z^4 - v_g^4 + w_g^4 \geq b_g^4; g \in G; \quad (8)$$

corresponding restrictions for the sector of transport ( $i = \tau$ ):

$$x_\tau^0 + x_\tau^1 - \sum_{j=1}^n a_{\tau j}^{01} x_j^0 - \sum_{j=1}^n a_{\tau j}^{11} x_j^1 - \alpha_\tau^1 z^1 - \sum_{j=1}^n c_{\tau j}^{v1} v_j^1 - \sum_{j=1}^n c_{\tau j}^{w1} w_j^1 \geq b_\tau^1; \quad (9)$$

$$x_\tau^0 + x_\tau^1 + x_\tau^2 - \sum_{j=1}^n a_{\tau j}^{02} x_j^0 - \sum_{j=1}^n a_{\tau j}^{12} x_j^1 - \sum_{j=1}^n a_{\tau j}^{22} x_j^2 - \alpha_\tau^2 z^2 - \sum_{j=1}^n c_{\tau j}^{v2} v_j^2 - \sum_{j=1}^n c_{\tau j}^{w2} w_j^2 \geq b_\tau^2; \quad (10)$$

$$\begin{aligned}
& x_{\tau}^0 + x_{\tau}^1 + x_{\tau}^2 + x_{\tau}^3 - \sum_{j=1}^n a_{\tau j}^{03} x_j^0 - \sum_{j=1}^n a_{\tau j}^{13} x_j^1 - \sum_{j=1}^n a_{\tau j}^{23} x_j^2 - \sum_{j=1}^n a_{\tau j}^{33} x_j^3 - \alpha_{\tau}^3 z^3 - \\
& \sum_{j=1}^n c_{\tau j}^{v3} v_j^3 - \sum_{j=1}^n c_{\tau j}^{w3} w_j^3 \geq b_{\tau}^3;
\end{aligned} \tag{11}$$

$$\begin{aligned}
& x_{\tau}^0 + x_{\tau}^1 + x_{\tau}^2 + x_{\tau}^3 + x_{\tau}^4 - \sum_{j=1}^n a_{\tau j}^{04} x_j^0 - \sum_{j=1}^n a_{\tau j}^{14} x_j^1 - \sum_{j=1}^n a_{\tau j}^{24} x_j^2 - \sum_{j=1}^n a_{\tau j}^{34} x_j^3 - \sum_{j=1}^n a_{\tau j}^{44} x_j^4 - \alpha_{\tau}^4 z^4 - \\
& \sum_{j=1}^n c_{\tau j}^{v4} v_j^4 - \sum_{j=1}^n c_{\tau j}^{w4} w_j^4 \geq b_{\tau}^4;
\end{aligned} \tag{12}$$

Balances of labor resources:

for 2010:

$$\sum_{j=1}^n t_j^{01} x_j^0 + \sum_{j=1}^n t_j^{11} x_j^1 \leq T_1; \tag{13}$$

for 2015:

$$\sum_{j=1}^n t_j^{02} x_j^0 + \sum_{j=1}^n t_j^{12} x_j^1 + \sum_{j=1}^n t_j^{22} x_j^2 \leq T_2; \tag{14}$$

for 2020:

$$\sum_{j=1}^n t_j^{03} x_j^0 + \sum_{j=1}^n t_j^{13} x_j^1 + \sum_{j=1}^n t_j^{23} x_j^2 + \sum_{j=1}^n t_j^{33} x_j^3 \leq T_3; \tag{15}$$

for 2030:

$$\sum_{j=1}^n t_j^{04} x_j^0 + \sum_{j=1}^n t_j^{14} x_j^1 + \sum_{j=1}^n t_j^{24} x_j^2 + \sum_{j=1}^n t_j^{34} x_j^3 + \sum_{j=1}^n t_j^{44} x_j^4 \leq T_4; \tag{16}$$

Balances of investments:

at period 1 (2006-2010):

$$\sum_{j=1}^n k_{gj}^{01} x_j^0 + \sum_{j=1}^n k_{gj}^{11} x_j^1 - f_1(u_g^0, u_g^1) \leq 0; \quad g \in G; \tag{17}$$

at period 2 (2011-2020):

$$\sum_{j=1}^n k_{gj}^{02} x_j^0 + \sum_{j=1}^n k_{gj}^{12} x_j^1 + \sum_{j=1}^n k_{gj}^{22} x_j^2 - f_2(u_g^1, u_g^2) \leq 0; \quad g \in G; \tag{18}$$

at period 3 (2016-2020):

$$\sum_{j=1}^n k_{gj}^{03} x_j^0 + \sum_{j=1}^n k_{gj}^{13} x_j^1 + \sum_{j=1}^n k_{gj}^{23} x_j^2 + \sum_{j=1}^n k_{gj}^{33} x_j^3 - f_3(u_g^2, u_g^3) \leq 0; \quad g \in G; \tag{19}$$

at period 4 (2021-2030):

$$\sum_{j=1}^n k_{gj}^{04} x_j^0 + \sum_{j=1}^n k_{gj}^{14} x_j^1 + \sum_{j=1}^n k_{gj}^{24} x_j^2 + \sum_{j=1}^n k_{gj}^{34} x_j^3 + \sum_{j=1}^n k_{gj}^{44} x_j^4 - f_4(u_g^3, u_g^4) \leq 0; g \in G; \quad (20)$$

Foreign trade balances:

for 2010:

$$\sum_{j=1}^n \beta_j^1 v_j^1 - \sum_{j=1}^n \gamma_j^1 w_j^1 \geq Q_1; \quad (21)$$

for 2015:

$$\sum_{j=1}^n \beta_j^2 v_j^2 - \sum_{j=1}^n \gamma_j^2 w_j^2 \geq Q_2; \quad (22)$$

for 2020:

$$\sum_{j=1}^n \beta_j^3 v_j^3 - \sum_{j=1}^n \gamma_j^3 w_j^3 \geq Q^3; \quad (23)$$

for 2030:

$$\sum_{j=1}^n \beta_j^4 v_j^4 - \sum_{j=1}^n \gamma_j^4 w_j^4 \geq Q^4; \quad (24)$$

Restrictions on outputs and increases in outputs:

$$x_j^0 \leq d_j^0; x_j^1 \leq d_j^1; x_j^2 \leq d_j^2; x_j^3 \leq d_j^3; x_j^4 \leq d_j^4; j = 1, \dots, n; \quad (25)$$

Restrictions on maximum and minimum exports and imports:

$$q_j^1 \leq v_j^1 \leq \bar{q}_j^1; q_j^2 \leq v_j^2 \leq \bar{q}_j^2; x_j^3 \leq d_j^3; x_j^4 \leq d_j^4; p_j^1 \leq w_j^1 \leq \bar{p}_j^1; p_j^2 \leq w_j^2 \leq \bar{p}_j^2; p_j^3 \leq w_j^3 \leq \bar{p}_j^3; p_j^4 \leq w_j^4 \leq \bar{p}_j^4; j = 1, \dots, n; \quad (26)$$

Objective function:

$$z^1 + \delta^1 z^2 + \delta^2 z^3 + \delta^3 z^4 \rightarrow \max;$$

### **List of symbols:**

#### ***Variables:***

$x_i^0$  - base output in sector  $i$  (as of 2005);

$x_i^1$  - increase in output of sector  $i$  over a period 1 (2006 – 2010);

$x_i^2$  - increase in output of sector  $i$  over a period 2 (2011 – 2015);

$x_i^3$  - increase in output of sector  $i$  over a period 3 (2016 – 2020);

$x_i^4$  - increase in output of sector  $i$  over a period 4 (2021 – 2030);

$z^1$  - value of maximized part of final demand in 2010;

$z^2$  - value of maximized part of final demand in 2015;

$z^3$  - value of maximized part of final demand in 2020;

$z^4$  - value of maximized part of final demand in 2030;

$v_i^1$  - export of products of sector  $i$  in 2010;

$v_i^2$  - export of products of sector  $i$  in 2015;

$v_i^3$  - export of products of sector  $i$  in 2020;

$v_i^4$  - export of products of sector  $i$  in 2030;

$w_i^1$  - import of products of sector  $i$  in 2010;

$w_i^2$  - import of products of sector  $i$  in 2015;

$w_i^3$  - import of products of sector  $i$  in 2020;

$w_i^4$  - import of products of sector  $i$  in 2030;

$u_g^1$  - gross fixed investments in 2010 (in the part of capital-forming sector  $g$ );

$u_g^2$  - fixed investments in 2015 (in the part of capital-forming sector  $g$ );

$u_g^3$  - fixed investments in 2020 (in the part of capital-forming sector  $g$ );

$u_g^4$  - fixed investments in 2030 (in the part of capital-forming sector  $g$ );

***Parameters:***

$a_{ij}^{01}$  - input-output coefficients providing a value of output of sector  $j$  in 2010 not exceeding a base value;

$a_{ij}^{02}$  - input-output coefficients providing a value of output of sector  $j$  in 2015 not exceeding a base value;

$a_{ij}^{03}$  - input-output coefficients providing a value of output of sector  $j$  in 2020 not exceeding a base value;

$a_{ij}^{04}$  - input-output coefficients providing a value of output of sector  $j$  in 2030 not exceeding a base value;

$a_{ij}^{11}$  - input-output coefficients for 2010 that provide an increase in output in 2006-2010 ;

$a_{ij}^{12}$  - input-output coefficients for 2015 that provide an increase in the output attained over a period 1;

$a_{ij}^{13}$  - input-output coefficients for 2020 that provide an increase in the output attained over a period 1;

$a_{ij}^{14}$  - input-output coefficients for 2030 that provide an increase in the output attained over a period 1;

$a_{ij}^{22}$  - input-output coefficients for 2015 that provide an increase in output of sector  $j$  in 2011-2015;

$a_{ij}^{23}$  - input-output coefficients for 2020 that provide an increase in the output attained over a period 2;

$a_{ij}^{24}$  - input-output coefficients for 2030 that provide an increase in the output attained over a period 2;

$a_{ij}^{33}$  - input-output coefficients for 2020 that provide an increase in output of sector  $j$  in 2016-2020;

$a_{ij}^{34}$  - input-output coefficients for 2030 that provide an increase in output of sector  $j$  in 2016-2020;

$a_{ij}^{44}$  - input-output coefficients for 2030 that provide an increase in output of sector  $j$  in 2021-2030;

$\alpha_i^1, \alpha_i^2, \alpha_i^3$  - a share of products of sector  $i$  in the maximized part of final demand (correspondingly, in 2010, 2015 and 2020);

$c_{\tau j}^{v1}$  - transport costs of exporting a product unit of sector  $j$  in 2010;

$c_{\tau j}^{w1}$  - transport costs of importing a product unit of sector  $j$  in 2010;

$c_{\tau j}^{v2}$  - transport costs of exporting a product unit of sector  $j$  in 2015;

$c_{\tau j}^{w2}$  - transport costs of importing a product unit of sector  $j$  in 2015;

$c_{\tau j}^{v3}$  - transport costs of exporting a product unit of sector  $j$  in 2020;

$c_{\tau j}^{w3}$  - transport costs of importing a product unit of sector  $j$  in 2020;

$c_{\tau j}^{v4}$  - transport costs of exporting a product unit of sector  $j$  in 2030;

$c_{\tau j}^{w4}$  - transport costs of importing a product unit of sector  $j$  in 2030;

$t_j^{01}$  - labour coefficients providing a value of output of sector  $j$  in 2010 not exceeding a base value;

$t_j^{02}$  - labour coefficients providing a value of output of sector  $j$  in 2015 not exceeding a base value;

$t_j^{03}$  - labour coefficients providing a value of output of sector  $j$  in 2020 not exceeding a base value;

$t_j^{04}$  - labour coefficients providing a value of output of sector  $j$  in 2030 not exceeding a base value;

$t_j^{11}$  - labour coefficients for 2010 that provide an increase in output in 2006-2010 ;

$t_j^{12}$  - labour coefficients for 2015 that provide an increase in the output attained over a period 1;

$t_j^{13}$  - labour coefficients for 2020 that provide an increase in the output attained over a period 1;

$t_j^{14}$  - labour coefficients for 2030 that provide an increase in the output attained over a period 1;

$t_i^{22}$  - labour coefficients for 2015 that provide an increase in output of sector  $j$  in 2011-2015;

$t_j^{23}$  - labour coefficients for 2020 that provide an increase in the output attained over a period 2;

$t_j^{24}$  - labour coefficients for 2030 that provide an increase in the output attained over a period 2;

$t_i^{33}$  - labour coefficients for 2020 that provide an increase in output of sector  $j$  in 2016-2020;

$t_i^{34}$  - labour coefficients for 2030 that provide an increase in output of sector  $j$  in 2016-2020;

$t_i^{44}$  - labour coefficients for 2030 that provide an increase in output of sector  $j$  in 2021-2030;

$k_{gj}^{01}$  - capital coefficients that maintain an output of sector  $j$  on the base level in 2006-2010 (in the part of costs of capital-forming sector  $g$ );

$k_{gj}^{02}$  - capital coefficients that maintain an output of sector  $j$  on the base level in 2006-2015 (in the part of costs of capital-forming sector  $g$ );

$k_{gj}^{03}$  - capital coefficients that maintain an output of sector  $j$  on the base level in 2006-2020 (in the part of costs of capital-forming sector  $g$ );

$k_{gj}^{04}$  - capital coefficients that maintain an output of sector  $j$  on the base level in 2006-2030 (in the part of costs of capital-forming sector  $g$ );

$k_{gj}^{11}$  - capital coefficients that provide an increase in output of sector  $j$  in 2006-2010 (in the part of costs of capital-forming sector  $g$ );

$k_{gj}^{12}$  - capital coefficients that provide an increase in output of sector  $j$  in 2006-2010 and maintain the increase in 2006-2015 (in the part of costs of capital-forming sector  $g$ );

$k_{gj}^{13}$  - capital coefficients that provide an increase in output of sector  $j$  in 2006-2010 and maintain the increase in 2006-2020 (in the part of costs of capital-forming sector  $g$ );

$k_{gj}^{14}$  - capital coefficients that provide an increase in output of sector  $j$  in 2006-2010 and maintain the increase in 2006-2030 (in the part of costs of capital-forming sector  $g$ );

$k_{gj}^{22}$  - capital coefficients that provide an increase in output of sector  $j$  in 2011-2015 (in the part of costs of capital-forming sector  $g$ );

$k_{gj}^{23}$  - capital coefficients that provide an increase in output of sector  $j$  in 2011-2015 and maintain the increase in 2011-2020 (in the part of costs of capital-forming sector  $g$ );

$k_{gj}^{24}$  - capital coefficients that provide an increase in output of sector  $j$  in 2011-2015 and maintain the increase in 2011-2030 (in the part of costs of capital-forming sector  $g$ );

$k_{gj}^{33}$  - capital coefficients that provide an increase in output of sector  $j$  in 2016-2020 (in the part of costs of capital-forming sector  $g$ );

$k_{gj}^{34}$  - capital coefficients that provide an increase in output of sector  $j$  in 2016-2020 and maintain the increase in 2021-2030 (in the part of costs of capital-forming sector  $g$ );

$k_{gj}^{44}$  - capital coefficients that provide an increase in output of sector  $j$  in 2021-2030 (in the part of costs of capital-forming sector  $g$ );

$u_g^0$  - a base value (2005) of investments (in the part of costs of capital-forming sector  $g$ );

$f_1(u_g^0, u_g^1)$  - a dependence function of total investments for period 1 on their base values and on their values attained in the last year of period 1 (for a given law of growth);

$f_2(u_g^1, u_g^2)$  - a dependence function of total investments for period 2 on their values attained in the last year of period 1 and on their values attained in the last year of period 2 (for a given law of growth);

$f_3(u_g^2, u_g^3)$  - a dependence function of total investments for period 3 on their values attained in the last year of period 2 and on their values attained in the last year of period 3 (for a given law of growth);

$f_4(u_g^3, u_g^4)$  - a dependence function of total investments for period 4 on their values attained in the last year of period 3 and on their values attained in the last year of period 4 (for a given law of growth);

$\beta_j^1$  - coefficients converting domestic basic prices (in rubles) into foreign market prices (in dollars) for exported products of sector  $j$  in 2010;

$\gamma_j^1$  - coefficients converting domestic basic prices (in rubles) into foreign market prices (in dollars) for imported products of sector  $j$  in 2010;

$\beta_j^2$  - coefficients converting domestic basic prices (in rubles) into foreign market prices (in dollars) for exported products of sector  $j$  in 2015;

$\gamma_j^2$  - coefficients converting domestic basic prices (in rubles) into foreign market prices (in dollars) for imported products of sector  $j$  in 2015;

$\beta_j^3$  - coefficients converting domestic basic prices (in rubles) into foreign market prices (in dollars) for exported products of sector  $j$  in 2020;

$\gamma_j^3$  - coefficients converting domestic basic prices (in rubles) into foreign market prices (in dollars) for imported products of sector  $j$  in 2020;

$\beta_j^4$  - coefficients converting domestic basic prices (in rubles) into foreign market prices (in dollars) for exported products of sector  $j$  in 2030;

$\gamma_j^4$  - coefficients converting domestic basic prices (in rubles) into foreign market prices (in dollars) for imported products of sector  $j$  in 2030;

$d_j^0, d_j^1, d_j^2, d_j^3, d_j^4$  - restrictions on variables of output of sector  $j$  (increases in outputs);

$Q^1, Q^2, Q^3, Q^4$  - restrictions on values of trade balances (correspondingly, in 2010, 2015, 2020 and 2030);

$T^1, T^2, T^3, T^4$  - expected employment (correspondingly, in 2010, 2015, 2020 and 2030);

$q_j^1, q_j^2, q_j^3, q_j^4, \bar{q}_j^1, \bar{q}_j^2, \bar{q}_j^3, \bar{q}_j^4$  - maximum and minimum exports of products of sector  $j$  (in 2010, 2015, 2020 and 2030);

$p_j^1, p_j^2, p_j^3, p_j^4, \bar{p}_j^1, \bar{p}_j^2, \bar{p}_j^3, \bar{p}_j^4$  - maximum and minimum imports of products of sector  $j$  (in 2010, 2015, 2020 and 2030);

$\delta^1, \delta^2, \delta^3$  - discounting coefficients for final demand,  $0 < \delta^i \leq 1, i = 1, 3$

## Supplement 4

### List of regions and abbreviations

1. Central Federal District (CFD)
2. North-Western Federal District (NWFD)
3. Southern Federal District (SoFD)
4. Volga Federal District (VFD)
5. Urals Federal District excluding Tyumen oblast (UFD-T)
6. Tyumen oblast (Tyu)
7. Siberian Federal District (SiFD)
8. Far Eastern Federal District (FEFD)

**Formal statement of optimization multiregional input-output model of Russia's economy**  
**Regional blocks of the model**

Balances of production and distribution of products

$$x_i^{r0} + x_i^{r1} - \sum_{j=1}^n a_{ij}^{r0} x_j^0 - \sum_{j=1}^n a_{ij}^{r1} x_j^1 - \alpha_i^r z^r - \sum_{s \neq r} x_i^{rs} + \sum_{s \neq r} x_i^{sr} - \sum_{h=1}^3 v_i^{rh} + \sum_{h=1}^3 w_i^{rh} \geq b_i^r; i = 1, \dots, n; \quad (1)$$

corresponding restrictions for capital-forming sectors:

$$x_g^{r0} + x_g^{r1} - \sum_{j=1}^n a_{gj}^{r0} x_j^0 - \sum_{j=1}^n a_{gj}^{r1} x_j^1 - u_g^{r1} - \alpha_g^r z^r - \sum_{s \neq r} x_g^{rs} + \sum_{s \neq r} x_g^{sr} - \sum_{h=1}^3 v_g^{rh} + \sum_{h=1}^3 w_g^{rh} \geq b_g^r; g \in G; \quad (2)$$

corresponding restrictions for the sector of transport ( $i = \tau$ ):

$$x_\tau^{r0} + x_\tau^{r1} - \sum_{j=1}^n a_{\tau j}^{r0} x_j^0 - \sum_{j=1}^n a_{\tau j}^{r1} x_j^1 - \alpha_\tau^r z^r - \sum_{k,s: k \neq s} \sum_{j=1}^n a_{\tau kj}^{ks} x_j^{ks} - \sum_{h=1}^3 \sum_{j=1}^n c_{\tau j}^{rvh} v_j^{rh} - \sum_{h=1}^3 \sum_{j=1}^n c_{\tau j}^{rwh} w_j^{rh} \geq b_\tau^r; \quad (3)$$

Balances of labor resources:

$$\sum_{j=1}^n t_j^{r0} x_j^0 + \sum_{j=1}^n t_j^{r1} x_j^1 \leq T^r; \quad (4)$$

Balances of investments:

$$\sum_{j=1}^n k_{gj}^{r0} x_j^0 + \sum_{j=1}^n k_{ji}^{r1} x_i^1 - f_1(u_g^{r0}, u_g^{r1}) \leq 0; g \in G; \quad (5)$$

Regional foreign trade balances:

$$\sum_{j=1}^n \beta_j^r v_j^r - \sum_{j=1}^n \gamma_j^r w_j^r \geq Q^r; \quad (6)$$

Restrictions on outputs and increases in outputs:

$$x_j^{r0} \leq d_j^{r0}; x_j^{r1} \leq d_j^{r1}; j = 1, \dots, n; \quad (7)$$

Restrictions on maximum and minimum exports and imports (quotas on imports and exports):

$$q_j \leq \sum_r v_j^r \leq \bar{q}_j; p_j \leq \sum_r w_j^r \leq \bar{p}_j; j = 1, \dots, n; \quad (8)$$

## System-wide restrictions

Restrictions on territorial pattern of final demand

$$z^r - \alpha^r z \geq 0; r = 1, \dots, R \quad (9)$$

Restrictions on maximum and minimum exports and imports:

$$\sum_{r=1}^R \sum_{j=1}^n \beta_j^r v_j^r - \sum_{r=1}^R \sum_{j=1}^n \gamma_j^r w_j^r \geq Q; \quad (10)$$

**Objective function:**

$$z \rightarrow \max \quad (11)$$

### List of symbols:

#### **Variables:**

$x_i^{r0}$  - output of sector  $i$  of region  $r$  produced in the last year of forecasting period on production facilities that worked at the beginning of the period;

$x_i^{r1}$  - increase in output of sector  $i$  in region  $r$  for the period;

$x_i^{rs}$  - transportation of products of sector  $i$  from region  $r$  to region  $s$  in the last year of forecasting period;

$x_i^{sr}$  - transportation of products of sector  $i$  from region  $s$  to region  $r$  in the last year of forecasting period;

$z^r$  - value of final demand of region  $r$  in the last year of forecasting period;

$v_i^{rh}$  - export of products of sector  $i$  of region  $r$  in the last year of forecasting period in direction  $h$ ;

$w_i^{rh}$  - import of products of sector  $i$  of region  $r$  in the last year of forecasting period in direction  $h$ ;

$u_g^{r1}$  - gross investment of region  $r$  in the last year of the period (in the part of capital-forming sector  $g$ ) that are calculated as a sum of investments in the base year  $u_g^{r0}$  and increases in

investments  $\sum_{k=1}^T \Delta u_g^{rk}$  ( $T$  - length of the period);

$z$  - a value of maximized part of final demand in the last year of the period;

$\alpha^r$  - a share of region  $r$  in maximized part of final demand in the last year of the period.

#### **Parameters:**

$a_{ij}^{r0}$  - input-output coefficients providing a value of output of sector  $j$  of region  $r$  in the last year of the period not exceeding a base value;

$a_{ij}^{r1}$  - input-output coefficients providing an increase in output of sector  $j$  of region  $r$  over the period;

$\alpha_i^r$  - a share of products (services) of sector  $i$  of region  $r$  in maximized part of final demand in the last year of the period;

$a_{vrj}^{ks}$  - transport costs of region  $r$  for transportation of a product unit of sector  $j$  from region  $k$  to region  $s$  in the last year of the period;

$b_i^r$  - fixed part of final demand of sector  $i$  of region  $r$  in the last year of the period;

$c_{vj}^{r/h}$  - transport costs of exporting a product unit of sector  $j$  of region  $r$  in the last year of the period by direction  $h$ ;

$c_{vj}^{rwh}$  - transport costs of importing a product unit of sector  $j$  of region  $r$  in the last year of the period by direction  $h$ ;

$t_i^{r0}$  - labour coefficients providing a value of output of sector  $i$  of region  $r$  in the last year of the period not exceeding a base value;

$t_i^{r1}$  - labour coefficients in the last year of the period providing an increase in output of sector  $i$  of region  $r$  over the period;

$k_{gi}^{r0}$  - capital coefficients maintaining output of sector  $i$  of region  $r$  over the period on the level attained in the base year (in the part of costs of capital-forming sector  $g$ );

$k_{gi}^{r1}$  - capital coefficients providing an increase in output of sector  $i$  of region  $r$  for the period (in the part of costs of capital-forming sector  $g$ );

$u_g^{r0}$  - base value of investment in the part of costs of capital-forming sector  $g$  of region  $r$ ;

$f(u_g^{r0}, u_g^{r1})$  - dependence function of total investment of region  $r$  for the period on its base value and its value attained in the last year of the period (for a given law of growth);

$\beta_i^r$  - coefficients converting domestic basic prices (in rubles) into foreign market prices (in dollars) for products of sector  $i$  exported from region  $r$  in the last year of the period;

$\gamma_i^r$  - coefficients converting domestic basic prices (in rubles) into foreign market prices (in dollars) for products of sector  $i$  imported by region  $r$  in the last year of the period;

$T^r$  - restrictions on number of labour resources of region  $r$  in the last year of the period;

$Q^r$  - restrictions on trade balance of region  $r$  in the last year of the period;

$d_i^{r0}, d_i^{r1}$  - restrictions on values of output variables and on increases in outputs of region  $r$  in the last year of the period;

$q_i, \bar{q}_i$  - maximum and minimum exports of products of sector  $i$  in the last year of the period;

$p_i, \bar{p}_i$  - maximum and minimum imports of products of sector  $i$  in the last year of the period;

$Q$  - restriction on value of national trade balance in the last year of the period.

## Scheme of optimization multiregional input-output model (on the example of 3 regions)

	Restriction N	Region 1						Region 2						Region 3						$Z$		Right hand
		$x^{(1)}$	$x^{(12)}$	$x^{(13)}$	$v^{(1)}$	$w^{(1)}$	$z^{(1)}$	$x^{(2)}$	$x^{(21)}$	$x^{(23)}$	$v^{(2)}$	$w^{(2)}$	$z^{(2)}$	$x^{(3)}$	$x^{(31)}$	$x^{(32)}$	$v^{(3)}$	$w^{(3)}$	$z^{(3)}$			
Region 1	1-8																					
Region 2	1-8																					
Region 3	1-8																					
Regional pattern of	9																					
Foreign trade balance	10																					
Functional	11																					