A.O. Baranov, V.N. Pavlov, V.I. Suslov

The System of Dynamic Input-output Models for Forecasting the Development of Russian Economy at the National and Regional Levels

Institute of Economics and Organization of Production Planning of SB RAN,
Novosibirsk State University

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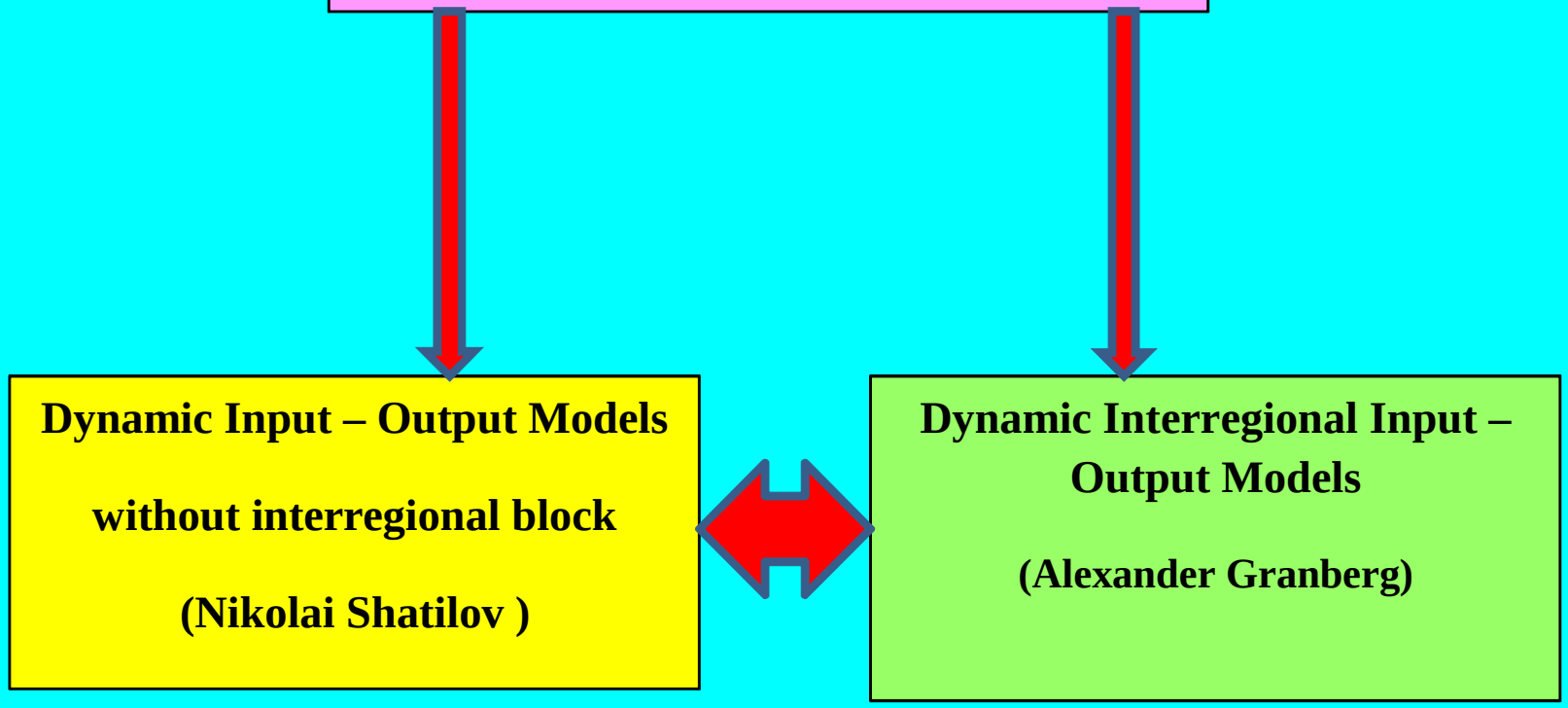
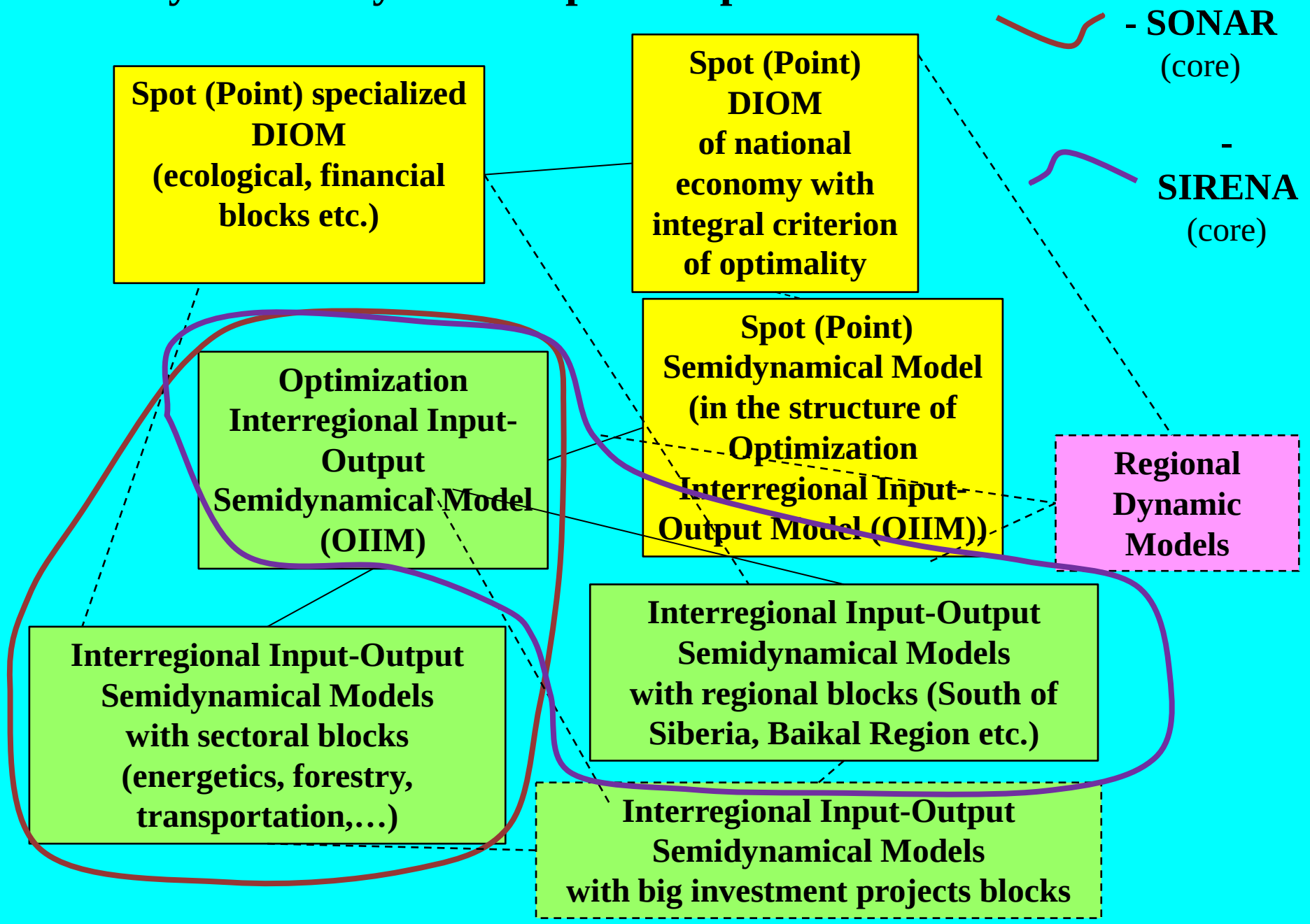
Dynamic Input – Output Models' Development at the Institute of Economics and Industrial Engineering of SB of RAS and at the Novosibirsk State University

since the middle of 60s of 20th century



The System of Dynamic Input-Output Models

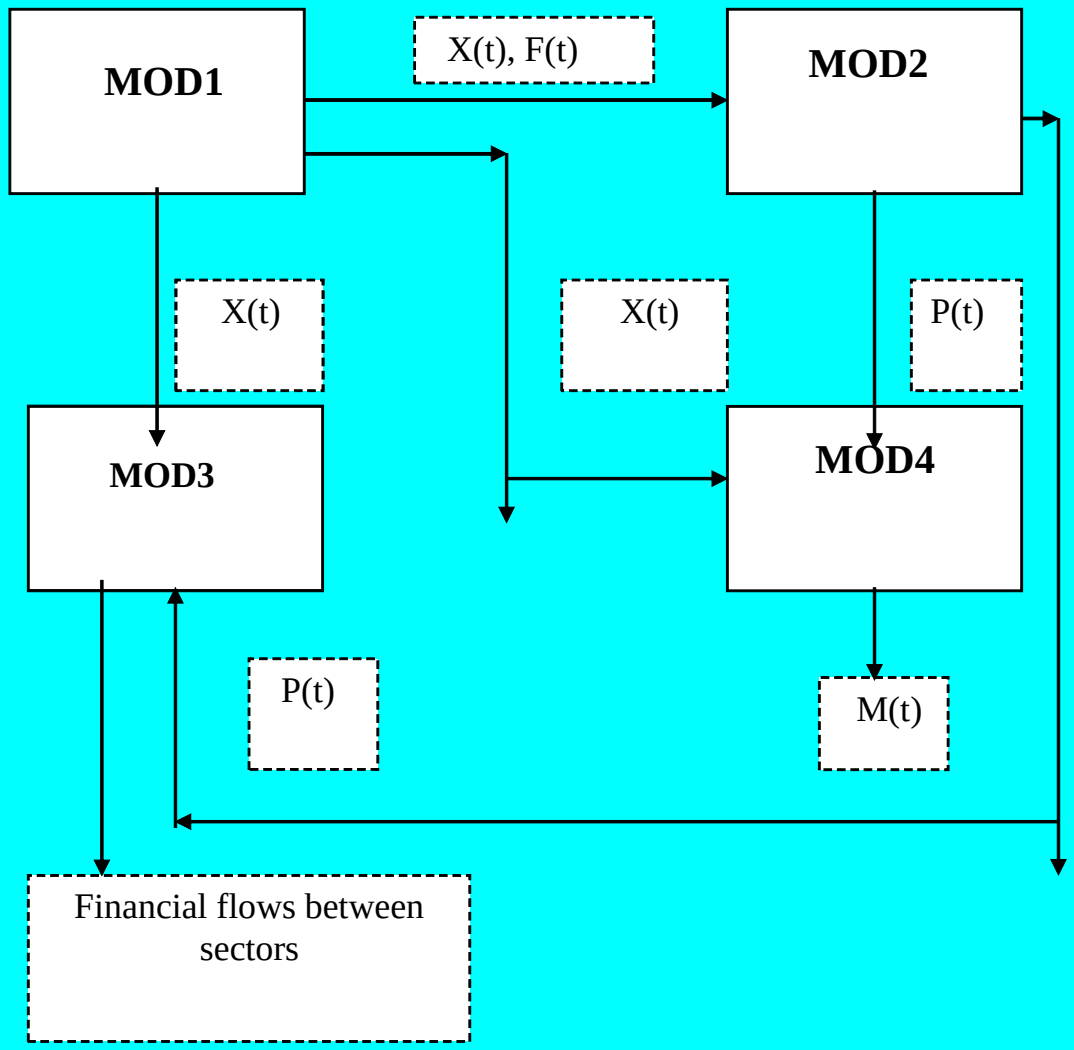


1. KAMIN System for forecasting the development of the economy at the national level

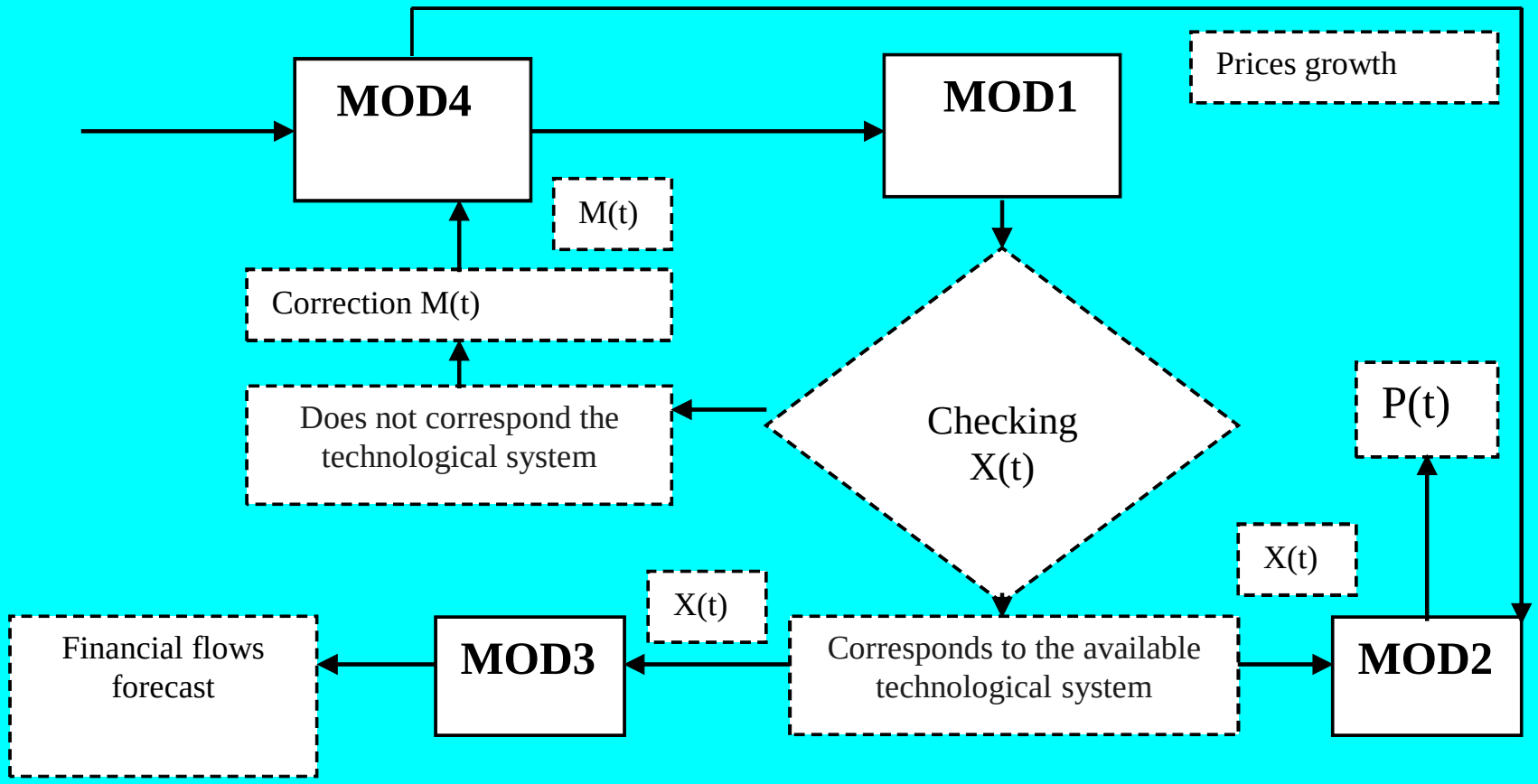
KAMIN System (the system for making a comprehensive analysis of intersectoral information) consists of the following main elements.

1. A dynamic input-output model for forecasting production and using the gross output of the national economy with a distributed construction lag (MODI).
2. A model for prices forecasting (MOD2).
3. A Model for forecasting financial flows between sectors of national economy (MOD3).
4. A Monetary Block Model (MOD4).
5. A Model for forecasting ecological processes (MOD5).
6. A model for forecasting incomes and expenditures of the federal and consolidated budgets (MOD6).
7. A dynamic input-output model with a balance-of-payments block (MOD 7).

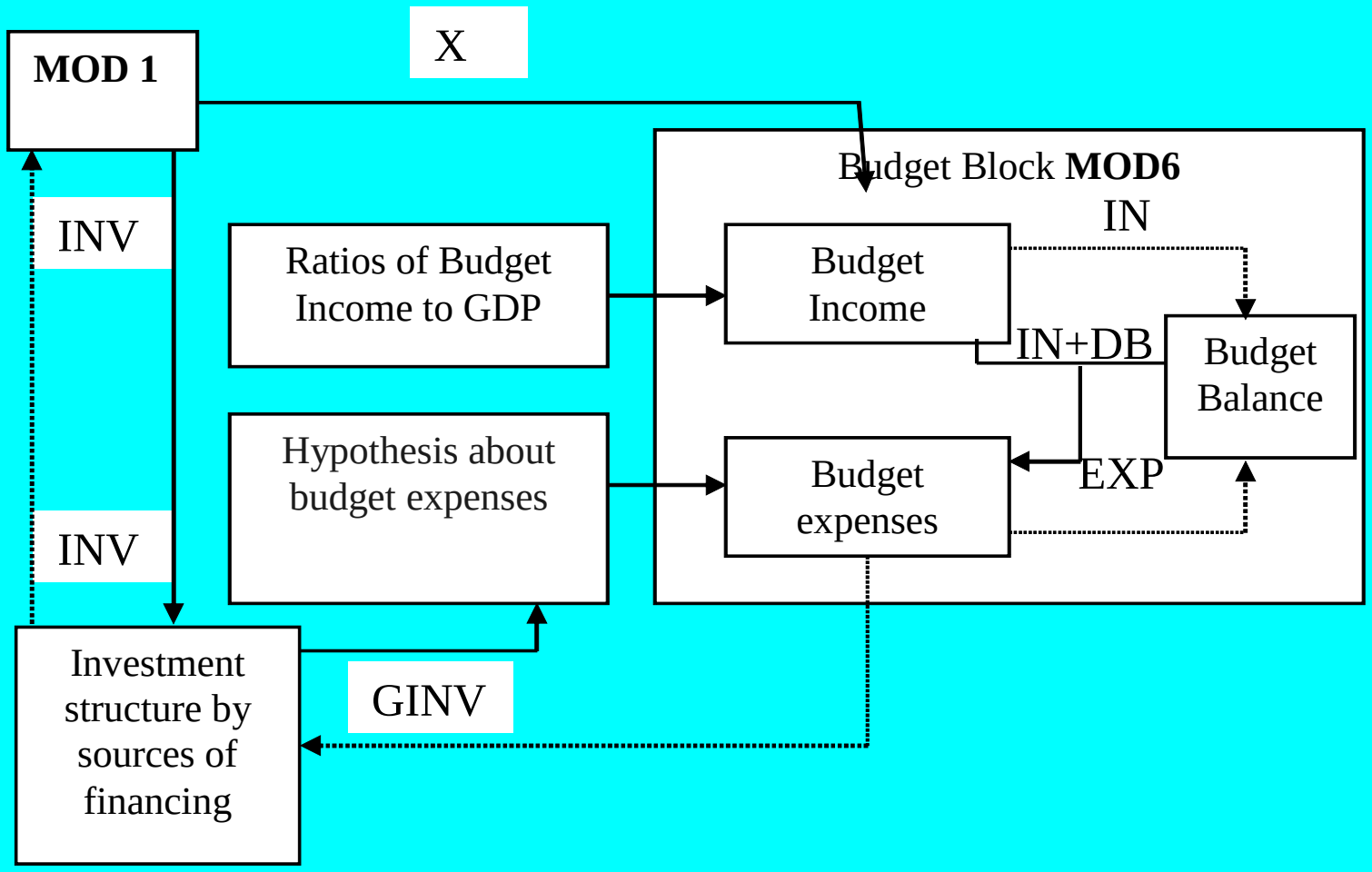
1st Version of calculations with monetary block



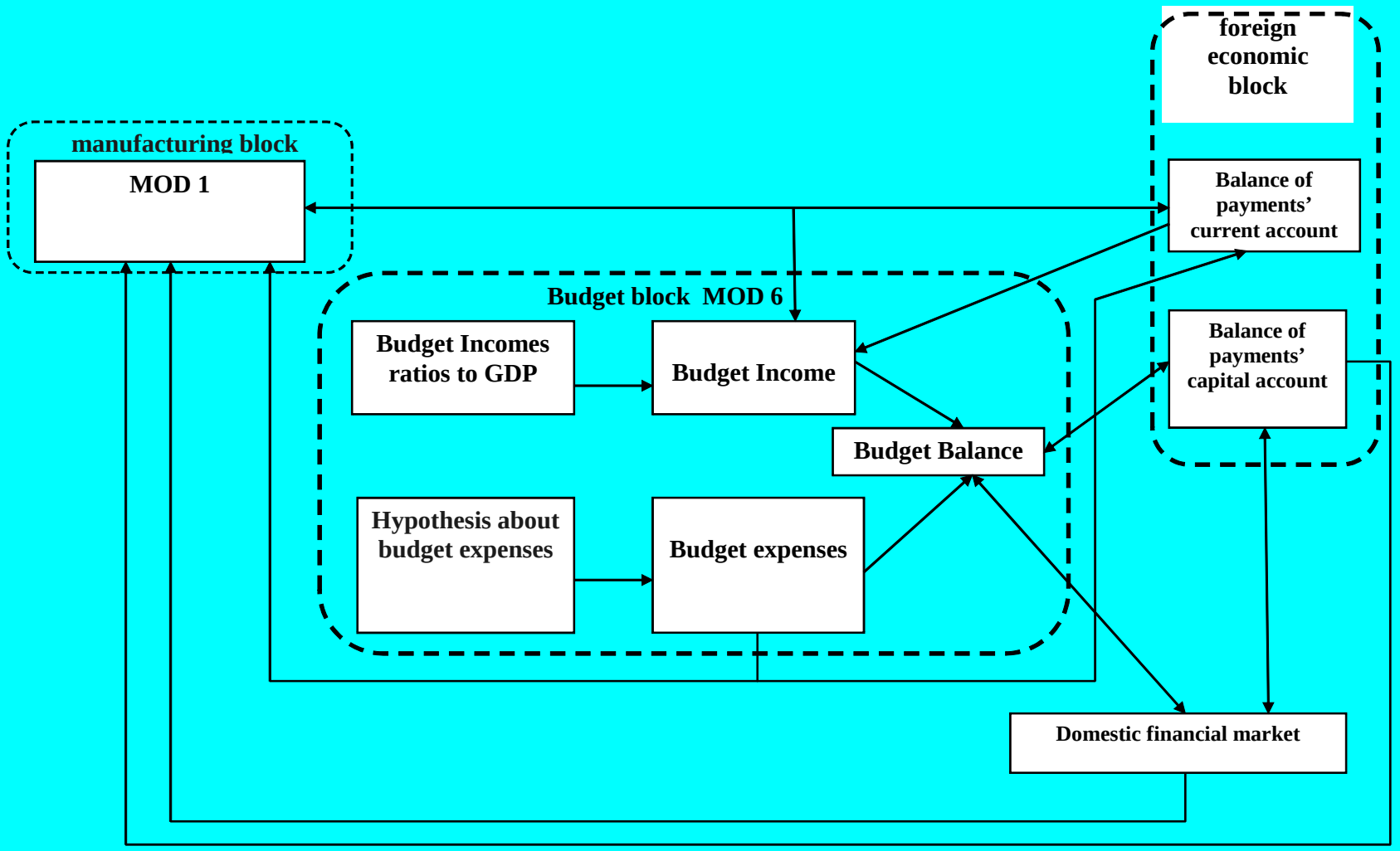
2nd Version of calculations with monetary block



Calculations with budget block



Interrelationships between foreign economic, manufacturing and budget blocks of the economic system.

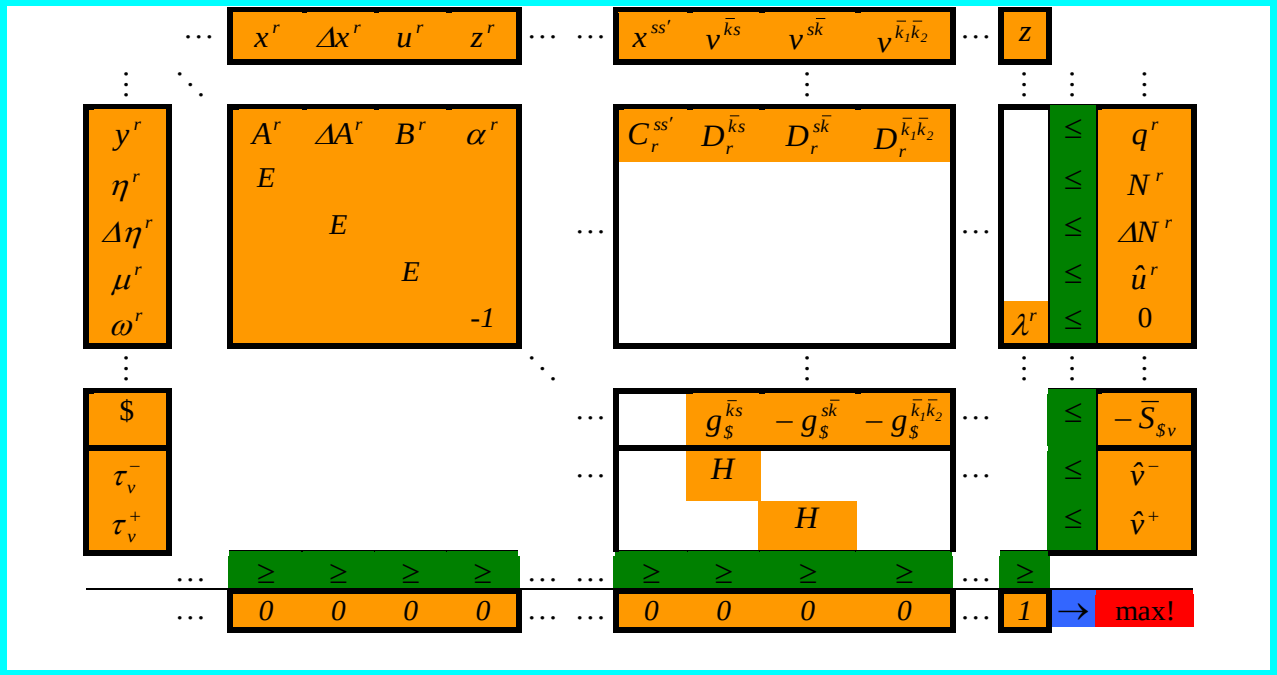


2. Optimization interregional input-output model and its modifications

Optimization multi-regional input-output models (OMIOM) were proposed by A. G. Granberg in the sixties of the XX century. In more than 40 years of their existence and application, their structure and application methods in the theoretical and applied analysis have been significantly changed. However, their essence has remained unchanged: regional input-output models are united into linear-programming constructions with the help of interregional relations (of the transportation problem type) and conditions for equalizing regional consumption levels of the population and state (scalarizing vector of regional goals).

In some separate segments, these constructions linearize non-linear dependencies. In this way, in modern modifications of the models, the dependence of the investments made in the last year of the forecasting period on total investments into fixed capital, the dependence of investments on production capacity growth, the dependence of world market prices on the size of export and import (It is natural for Russia as an important country on a world scale) and some other dependencies are non-linear.

Structure of the regional block of the model is represented on the following slide. Along with ordinary variables (size of production, capital investments, non-production consumption, interregional transportation, export, import, international transit) and constraints of the direct problem, special role is given to variables (prices of production and resources, tax rates on profit and turnover, exchange rates, export-import duties) and constraints of the dual problem.



In first row given the list of variables of the direct linear programming problem, in first column – list of variables of the the dual problem of linear programming

The constraints of the direct problems (in order of their presentation in this figure) are: the balances of production and resources (labour and investment ones), restrictions of available production capacities, of the growth of production capacity, restrictions of investment growth, of the territorial structure of consumer goods consumption, foreign trade balance, restrictions of export-import quotas. The constraints of the dual problem are: conditions of break-even production under the available capacities and under the available capacity growth, break-even of investments, consumer goods consumption, interregional product transportation, export-import delivery, and international transit.

The variables and constraints of the direct and dual problem of the optimization interregional input-output model create an integral theoretical-methodological concept of national spatial economy within the system of world economic relations. An important role in it is played by macro-financial aggregates that depend on variables of both direct and dual character and that create macro-financial balances. The latter show the dependence between “contributions” of particular regions into national consumption and actual regional consumption. These dependencies are balanced by surplus macro-aggregates of interregional and foreign trade exchange. The realization of these macro-financial balances is guaranteed by the characteristic of complementary non-rigidity of optimal designs of linear-programming problems.

Unfortunately, in essence, these models are “subjectless”, they represent the field of possibilities for economic games, but not the economic games themselves. In fact, they (the models) consist of strict limitations, i.e. “laws of economic matter conservation”: in the region it is impossible to use (products, services, resources) more than are available and all that is available should be somehow used (loss is also viewed as a form of use). The same shortcoming is inherent in the model discussed in part 1 of this report.

One direction of applying the models under study is building scenarios for socio-economic development of spatial economy (of the world economy, the economy of the USSR, Russia, and Siberia in applied works). In recent years, serious attempts have been made to increase the adequacy of applying the models to this and other problems (by introducing non-linearity into the dependencies of introducing production capacity on investment size and dependencies of world market prices on the volume of Russian export and import). Due to this, models begin to represent a real border of the area of acceptable states, and a change from one scenario to another is fulfilled by changing a small number of parameters rather than by a full rearrangement of many hundreds of borders into separate variables.

In constructing development scenarios, the main meaningful role in carrying out calculations is played by a group of experts in industrial and structural-functional problems.

Getting the forecast scenario development is a result of long work in the course of which the experts adjust (coordinate) their opinions (set goals and scenario conditions, i.e. local forecasts), while the model represented by the group of specialists “leading it” plays the role of some central expert council. In order to get coordinated decisions on the central scenario, the optimization input-output model is made up several thousand times, and dozens of expert brainstorming meetings of the “leading team” and “exploiters” are held.

In 2009-2010, research on medium-term and long-term post-crisis development of Siberia and the whole of Russia in a global context was carried out.

The ideas about a post-crisis world organization are still very vague. As the history of Genoese, Bretton-Woods and Jamaica agreements shows, the new order will be determined in five to ten years of post-crisis development, i. e. by the end of the 10^{s} - beginning of the 20^{s} of the XXI century. Oversimplifying the situation, all the multitude of possible development scenarios can be concentrated into two extreme ones: ***A*** scenario – the world will resume its "normal course"; ***B*** scenario – the world will become totally different.

The world order is determined by four major characteristics: the role of the dollar, oil, state and innovations. The "normal course" is: dollar is (almost) world currency, oil is the main good "managing" world financial flows, state is liberal, innovations are insufficient because decision makers focus on current tasks.

The Russian development scenario within the framework of world scenario ***A*** can be called inertial or energy and raw materials-dependent. This scenario will be carried out under the passive position of the Russian government that has existed until the present time: words about economic growth, innovations and development of the eastern part of the country are not supported with real actions.

Under this scenario, the economic development of Russia and Siberia assume a stable inertial character. In the long term, Russia will keep its position of an "average" country and will continue losing its national sovereignty.

The situation would be quite different under scenario ***B*.** Russia would appear in an unstable position. If adequate measures are not taken, in the long term it will “slide down” to destruction and disintegration (a catastrophic development scenario). Under this scenario, growth rates would fall and appear lower than the world average ones, macroeconomic rates would be suspended and the share of Siberia in total output would markedly decrease, with the share of the Far East being unchanged.

The Russian state, which in the XVI-XVII centuries expanded from the Volga to the Pacific Ocean and farther, can return to its previous size only in 20 to 40 years giving rise to a whole multitude of pseudo-states, which would, to varying degrees, depend on developed countries and transnational capital.

However, given Russia undertakes serious steps, the prospects for its development can be more than favourable (innovational scenario).

The opportunity for realizing the innovational scenario will appear only in case the Russian government comes from slogans to real actions that will stimulate 1) economic growth as a result of which the share of accumulation in GDP will grow from the present 18-19% to a minimum of 25-30% (in China this figure exceeds 40%); 2) research and development including corporate and technological update and innovations that would increase expenditures on research and development in relation to GDP up to 3-4% (3-4 times), the share of high technology research-intensive production, innovative enterprises in the range of 25-40%; 3) economic development and improvement of Asian and Arctic territories of Russia.

The models can also be applied for analyzing interregional economic relations. The analysis is based on two parts of mathematical economics: the theory of economic equilibrium and the theory of cooperative games. The first one (Valrus equilibrium) concerns an ordinary commodity-money market and equivalent interregional exchange, the second one (Nash equilibrium, the nucleus of the system) concerns contract market and mutually beneficial exchange.

According to Valrus market conception, each “subject” of the market (region) determines its demand and supply (export-import of products) by maximizing their target function under budget restriction in the current exchange prices. Meanwhile, s/he does not care about partners or any common goals.

According to Nash, the principal notion of the market mechanism is an agreement or contract, consensus. The market mechanism is a negotiation process where the market subjects (regions in this case) conclude agreements on cooperation, that is, enter into coalitions. The subjects focus on their own interests and leave old agreements or coalitions if they see more promising partners. The equilibrium according to Nash is reached when none of the subjects and none of the subjects’ coalitions is able to improve their position by changing the composition of partners.

One of the main results of the corporate games theory is that in the situation of equilibrium, all the subjects of the market enter into interaction and, if a subjects' coalition leaves the full system, it loses. The set of such equilibrium states is called the core of the system. This is a specific set – the set of mutually beneficial interregional exchange.

As an example of the applied analysis of interregional economic interrelation we will give the results of calculations for the system of the Soviet republics made before the disintegration of the Soviet Union (at that time 30 products and 15 regions model has been used).

Macro regions	Russia	Ukraine	Belo-russia	Kazakh stan	Middle Asia	Moldo-va	Cauca-sus	Baltic States	Total contribution
Russia	64,6	67,3	55,5	42,5	36,3	31,7	35,8	65,0	60,2 (+14,5)
Ukraine	1,2	14,8	16,5	4,9	18,0	52,1	7,4	8,1	6,3 (-9,8)
Belorussia	2,3	4,0	3,8	3,5	2,1	4,1	3,3	3,7	2,8 (-0,8)
Kazakhstan	1,7	0,6	-1,4	27,1	3,8	-0,6	6,7	-0,6	3,0 (-1,4)
Middle Asia	3,7	1,1	15,4	0,5	26,4	1,7	-0,0	2,8	4,8 (-1,5)
Moldova	0,8	-2,7	-0,3	0,7	0,3	0,0	0,6	0,9	0,1 (0,0)
Caucasus	2,6	1,7	0,5	4,5	3,9	0,2	25,7	0,7	3,4 (0,0)
Baltic States	1,9	1,5	4,3	3,3	2,5	1,9	2,7	8,0	2,2 (-1,0)
Internal effect	78,8 (45,7)	88,3 (16,1)	94,3 (3,6)	87,0 (4,4)	93,3 (6,3)	91,1 (0,1)	82,2 (3,4)	88,6 (3,2)	82,8 (0,0) (82,8)
External relationships	21,2	11,7	5,7	13,0	6,7	8,9	17,8	11,4	17,2
Total (consumption)	100 (58,1)	100 (18,5)	100 (3,8)	100 (5,1)	100 (6,7)	100 (0,1)	100 (4,2)	100 (3,6)	100 (100,0)

First, let us focus on the results of coalition analysis, calculations for all the possible coalitions of the former 15 Soviet republics. The share of the emergent (synergy) effect in the total final consumption by the Soviet republics accounted for about 55%. Only Russia, in the situation of total autarchy, could manage to keep the value of its target index at a rather high level. Moreover, the contribution of Russia into the total consumption of the system exceeded its own consumption, the balance of inter-republican interaction being positive. At the same time, the balance of the Ukraine was "indecently" negative.

Consumer goods consumption's regional structure (1987, percentage points)

Macro regions	Actual	Lower limit of the core	Equiva-lent exchange	Upper limit of the core
Russia	58,06	56,25	56,37	89,62
Ukraine and	18,58	19,21	19,42	19,82

A somewhat different picture was presented by the results of the equilibrium analysis (according to Val'rus and Nash). The zone of the core is strongly stretched in the direction of the increase of the share of Russia in the total consumer goods consumption of the system. It means that the consumer goods consumption of Russia could have been considerably increased at the expense of the other republics, but the inter-republican exchange would have still remained mutually beneficial because the coalitions of republics would have consumed less without Russia.

At the same time, the actual share of consumer goods consumption of Russia was higher than its share in the situation of an equivalent exchange because its consumption was overstated in comparison with that which would have existed under equivalent inter-republican exchange. The same situation, but to a greater degree, was true for Kazakhstan and Central Asia, while the consumption of the Ukraine, Transcaucasia, the Baltic Republics and especially Byelorussia was understated in comparison with the equilibrium equivalent one.

To develop interregional input-output models of space economy further it is planned a) to go beyond the borders of the paradigm of perfect competition and take into account innovational monopolism; b) to find a reasonable compromise between the continua and agent-oriented (subject) approaches including large investment projects as special subjects (along with large corporations, municipalities, cities and households) into the simulation; c) geo-informational and supercomputing technologies should be used together with traditional methods of mathematical programming, statistics, econometrics, simulation control and normative regulation.

Another direction for further research is harmonizing input-output models used in the Institute of Economics and Industrial Engineering of SB RAS. At present, several spot and multiregional models of different specializations are being applied, each of them exploited in isolation from each other. A task to coordinate the models has been posed and is beginning to be solved in three areas: informational (oriented to creating a common data base), simulational-methodological (making a “construction” of different models out of a small number of model units connected by formalized “adapters”), software and mathematical (creating a common software platform – the language of model construction). In other words, here we have some kind of a “mild variant of reincarnation” of the idea of coordinating a system of territorial and industrial planning models created in the 60s of the last century.

Thank you for your attention