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Equilibrium, kernel, integration in the multiregional system under liberalization of external trade

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**Russian “Macro-regions”: economic integration and interaction
with the world economy**

A.Granberg, V.Suslov, L.Melnikova

1. Objectives of the study.

The project is dedicated to an analysis of interregional and foreign trade ties of large economic regions in Russia. In the project:

- Effects of economic interactions among the regions of Russia are estimated;
- Non-equivalence level of the actual interregional exchange is determined;
- Equilibrium of the system of regions, i.e., the state of an equivalent interregional exchange, is found;
- System core, i.e., a set of mutually beneficial exchanges, is estimated;
- Consequences of foreign trade liberalization are studied;
- Reasonable rate of export-import tariffs, providing an acceptable unemployment level and sufficient competition from the world market, is assessed;
- Volume of interregional financial transfers, maintaining a sufficient level of internal economic space homogeneity, is estimated.

2. Review of literature.

The Western regional science tackles similar problems within the framework of interregional trade and customs unions; conceptual basis of them are the classical studies of J.Thunen , A. Weber, A. Losch, W. Isard. Fundamental studies of these scholars were translated in Russia and, therefore, they are quite well known. In the theories of international trade, basic concepts are introduced, and trade opportunities under various conditions are explored. In particular, free trade zones, common markets, customs, monetary, and economic unions are

defined. In this field, the works of R. Caves, J. Frankel, R. Jones [11], P. Krugman [14], M. Obstfeld [13], could be noted. The most strict principles, statements and results were obtained in the framework of the customs unions theory where small-dimensional models (1-2 products and 2-3 regions) were applied, and consequences of customs union formation had been studied. In this area of research, the works of B. Balassa [7], M. Kreinin [12], P. Robson [15], E. Truman [17], R. Vickerman [18], could be mentioned. Studies on international trade and customs unions generalize rich empirical data; they widely use econometric methods and models. Among authors who applied such methods, are J. Tinbergen [16], J. Brada, J. Mendez [10] J. Bergstrand [8,9]. Theories of international trade and customs unions had been included in the macroeconomics textbooks long ago; advanced textbooks in this field do exist, too. Among the latter is the work of B. Soderstren, G. Reed [19].

Our approach to the problems formulated is based on classical parts of mathematical economics: theory of economic equilibrium, multi-objective optimization, and theory of cooperative games.

The theory of economic equilibrium goes back to the works of Walras who gave the first strict definition of economic equilibrium and put the mathematical problem of the equilibrium search. In the thirties of this century, a number of authors (H. Neisser, H. Stakelberg, F. Zeuthen, Schlesinger) had shown that the problem of equilibrium existence is deeper than Walras thought. It is not reduced only to the calculation of the number of equations and variables. A. Wald found the first evidence of the equilibrium existence for simple models in mid-thirties. However, a break in this field is connected with name of J. Von Neuman and further Kakutani, who proved the fixed-point theorem. Based on their results, in the early fifties L. W. McKenzie, K. Arrow and G. Debreu proved the existence of equilibrium for the economies of very general types. The further development of the theory of economic equilibrium is connected with the names of D. Gale, H. Nikaido, H. Uzawa, G. Debreu.

The works of F. Edgeworth's laid cooperative game theory fundamentals: he introduced the concepts of core, negotiations, contract curve. These works were forgotten for almost 80 years. In the early fifties J. Nash, L. Shapley and Gillies studied the solutions of a particular class of games and suggested the concept of the c-core, often called Nash's core afterwards. In late fifties, M. Shubik realized the connection of these results with the ideas of F. Edgeworth. In the next decade and in early seventies, the studies of H. Scarf, G. Debreu, R. Aumann, K. Vind, W. Hildenbrand, M. Khan, D. Brown and A. Robinson explored the accordance among various game theory models, the conformity of the core and the equilibrium of an economic system. K. Arrow and M. Khan introduced the concept of effective sharing. This concept and the explanation of the role of prices usually are connected with the name of V. Pareto and effective sharing is often called Pareto-optimum.

The book by W. Hildenbrand [1] can be regarded as a summarizing work on the theories in question.

3. Specific features of the approach used.

Theories of economic equilibrium and cooperative games form two different concepts of market relations. In accordance with the theory of economic equilibrium, a market of commodity-money relations is determined. Any player at the market is completely independent in the decision making. He selects his own supply and demand maximizing his utility function and taking into consideration only the prices and budget constraints. The prices, under which demand and supply are in balance, are called equilibrium prices and the corresponding state of the system is called equilibrium. In accordance with the game theory, the so-called contract market is determined. All participants of the market are independent, too. Anyone of them decides with whom and in which way to interact, in particular, to exchange products and resources. That is, in what coalition and under what conditions he enters the coalition. Any par-

ticipant chooses the coalition that provides the maximum utility function. The existence of the set of exchange options (contracts) when the most beneficial coalition for all market participants is a complete system is proved for rather general conditions. This set is called the core of the system.

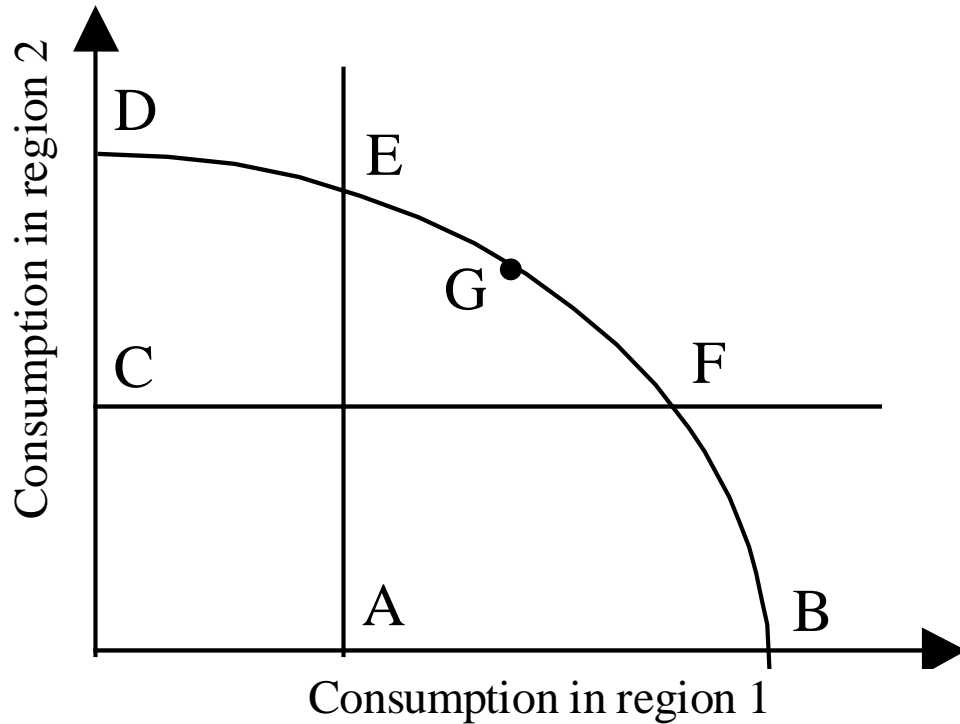
The natural field for the application of these mathematically advanced and quite abstract theories is a system of regions. Each region is regarded as the subject of the market relations; regions interact or enter into coalitions if there are no restrictions on the product exchange between them. When a region leaves the coalition (whole system), the exchange of goods with other regions in the coalition is terminated. In the framework of the above theories, the equivalent and mutually beneficial interregional exchange, the effects of interregional internal and external interactions are determined strictly; the ways of searching for the adequate state of exchange and the area of mutually beneficial exchange, are formulated; the methods of assessing the non-equivalency and levels of non-mutually beneficial exchange for the actual states of a regional system are constructed. All these problems were solved within the scope of our approach [3,6]. Illustrations of equilibrium and core for a two-region system are given in Fig1.

Fig.1

Economic equilibrium takes place under such exchange prices (prices of equivalent exchange) when each region maximizing the objective function, supplies a volume of export (supply) and demands a volume of import (demand) that are in equilibrium on the interregional market.

A set of sharings and corresponding states of the system, when there are no coalitions of regions that benefit from leaving it, is called the core of an economic system.

DEFB - set of Pareto-optimal values of consumption in regions 1 and 2;
 A - value of consumption in region 1 under autarky (in coalition);



C - same for region 2;
 EF - core of the system;
 G - system equilibrium.

There is no difference of principle between our approach and that of the Western theory of economic integration. In both cases, consequences of alteration of internal and external trade modes for a system of regions are studied. The differences lie in the tools and methodical schemes of the analysis. The approach of Western regional science is based on empirical evaluations of the consequences of changes in trade regimes and, therefore, is limited in its abilities. Our approach is based on the use of models of multi-region systems that allow to conduct various experiments, sometimes fantastic from a standpoint of reality. Lately, the provisions of Western theories have supplemented the approach in question. E.g., we can tell

that the system of Russian macro-regions in the project is regarded at the minimum as a free trade zone, at the maximum as a customs union. It makes sense to note that even within a customs union the participating regions are not completely independent in their decision making. This requires certain alteration of classical theories.

4. Multi-regional models.

A. Granberg proposed the multi-regional models used in this approach, in late sixties. W. Isard, L. Moses and Stevens suggested the idea of the above models that consist in joining the input-output conditions and transportation tasks, in the seventies. These are optimization models, but they are used as a tool for searching for specific states of a system of regions (e.g., equilibrium and core), which, in accordance with the theory, are supported by market mechanisms.

Structure of the 3-region model is presented in Fig 2.

Fig. 2

Multi-regional input-output model (example of three regions)

	Regional variables	Interregional Ties	Foreign trade ties (export-import)	
Regional balances of products and Resources	■	■ ■ ■	■ ■	■
Regional Foreign trade Constraints		■ ■ ■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■ ■ ■	■
State constraints			■ ■ ■ ■ ■ ■ ■ ■	■
Goal function		■		■

Columns:

- Regional variables;
- Final consumption;
- Interregional ties;
- Foreign trade ties (export-import)
- Fixed value of constraints.

Rows:

- Regional balances of products and resources;
- Regional foreign trade constraints (trade balance, customs restrictions)
- National foreign trade constraints;
- Goal function of the model (final consumption of the system)

5. Input data.

Input data of the model for every region envelops input-output matrix, volumes of production, employment and fixed capital by industries, investment and consumption of the population, internal and external export and import, dollar exchange rates for exported and imported goods. Based on official statistics and with minimum of expert estimations, input data for 1990 were obtained. The actualization of the data with the use of various indirect methods of the index evaluation has become a serious result of the pre-project work and the first stage of the project implementation. As of today, the basic solutions of the Russian model correspond to 1993. This model is presented in the context of five macro-regions (European part, the Urals, West Siberia, East Siberia and Russian Far East) and thirty industries of material production.

An important role in the model is played by the commodity exchange rate of the currency, which transform domestic prices into the world prices. Their values were obtained based on a Goskomstat report carried out in 1989, where export and import data from foreign

trade statistics were compared; namely, the world market prices measured in foreign currency rubles and domestic prices from the input-output balances. Actually, these indices are the ratios of commodity exchange rates of domestic ruble to the foreign currency one. In order to obtain the commodity exchange rate as related to the dollar, these indices were divided by the dollar exchange rate.

David Tarr has made an assessment of commodity exchange rates for countries of the former Soviet Union including Russia. His results are presented in Working Papers of the World Bank ([23]). Since David Tarr used Goskomstat information in his work, the differences are rather negligible (Table 1). Margins for the values of exchange rates are shown because D.Tarr used more detailed classification of products and made (as the USSR Goskomstat) the estimates for export and import separately. In fact, he adjusted the Goskomstat estimates by the price dynamics in the early 90s. However, since price changes in that period were very chaotic, it would be incorrect to draw an unambiguous conclusion in favor of D.Tarr's data.

The problem of actualization of the input data has not been solved completely. In the process of work errors in the input data were found; they will be corrected in the nearest future. Therefore, results presented below are of somewhat preliminary character.

6. Analysis of actual state.

Calculations were performed with the model including constraints **a, b, c, d, g** (see section 4), export and import variables were fixed on the actual values, right-hand portions of constraints on fixed capital, labor and production capacities ($\mathbf{C}^r, \mathbf{L}^r, \mathbf{N}^r$) were set (as in all main cases) at the actual level, as well.

Basic solutions of the model imitate the state of Russian economy in 1993, i.e., reproduce and, to some extent, remodel this situation. They remodel it, since actual information on the real situation is practically absent in the amount needed. To the most extent, this pertains to

Table 1

Various estimates of foreign-to-domestic price ratio

Industries	David Tarr's estimates (World Bank)	Goskomstat estimates
1. Power industry	1,500	1,490
2. Oil industry	3,540	3,310
3. Oil-processing industry	2,000	1,070
4. Gas industry	2,460	2,140
5. Ferrous ores	0,902	1,000
6. Ferrous metals	0,70-1,50	1,180
7. Non-ferrous ores	1,20-1,50	0,700
8. Non-ferrous metals	1,50-1,60	1,570
9. Basic chemistry	0,70-1,20	0,740
10. Petrochemistry	0,60-0,90	0,603
11. Machine building	0,90-1,40	1,200
12. Timber industry	0,700	0,790
13. Woodworking industry	0,75-0,80	0,720
14. Pulp and paper industry	0,78-0,81	0,760
15. Textile industry	0,25-0,33	0,390
16. Clothing industry	0,327	0,330
17. Meat and dairy industry	0,30-0,50	0,380
18. Fish industry	0,451	0,480
19. Other food processing industry	0,431	0,390
20. Flour-grinding and cereals industry	0,43 4	0,640
21. Plant-growing	0,500	0,440
22. Stock-raising	0,2-0,3	0,180

interregional exchange indicators. This exchange has plausible character for the basic solutions (Table 2): European part of Russia supplies products of engineering, consumer goods, food processing industries, agriculture; the Urals supplies products of oil-refining, metallurgy and engineering industries; West Siberia is the main supplier of oil and gas, East Siberia - electric power and timber; Russian Far East – sea food. The balance of interregional exchange at 1990 prices is positive for the European part only (Table 2, the last row – in absolute terms; Table 9, row 1 – in relative terms); East Siberia and the Far East have particularly adverse balance.

Table 2

Balance of actual interregional exchange in 1993

(billion rubles, 1990 prices)
(estimate on the model solution) *)

	European part	Urals	West Siberia	East Siberia	The Far East
1. Power industry	0,822	-0,414	-0,750	0,723	-0,381
2. Oil industry	-0,755	-0,228	2,323	-0,759	-0,581
3. Oil-processing industry	-2,052	2,712	-1,143	0,316	0,168
4. Gas industry	-2,850	-1,704	4,569	-0,014	-0,002
5. Other fuel producing industries	0,097	-0,504	0,144	0,187	0,076
6. Ferrous ores	0,050	-0,284	-0,012	0,250	-0,004
7. Ferrous metals	-1,413	2,149	-0,260	-0,238	-0,238
8. Non-ferrous ores	-0,028	-0,009	0,003	0,003	0,031
9. Non-ferrous metals	-0,554	0,471	-0,019	0,013	0,089
10. Basic chemistry	0,096	0,153	0,156	0,058	-0,463
11. Petrochemistry	0,047	0,124	-0,040	0,035	-0,166
12. Machine building	5,513	0,874	-2,877	-1,674	-1,836
13. Timber industry	-0,060	0,029	-0,008	0,031	0,008
14. Woodworking industry	0,016	-0,027	-0,118	0,101	0,028
15. Pulp and paper industry	0,009	-0,031	-0,148	0,108	0,062
16. Textile industry	2,281	-1,129	-0,631	0,061	-0,582
17. Clothing industry	0,989	-0,104	-0,296	-0,262	-0,327
18. Other light industry	1,351	-0,263	-0,774	-0,100	-0,214
19. Meat and dairy industry	-0,325	0,177	0,377	0,089	-0,318
20. Fishing industry	0,169	-0,450	-0,236	-0,209	0,726
21. Other food processing industry	6,681	-1,337	-2,550	-1,714	-1,080
22. Flour-grinding and cereals industry	-0,218	0,524	-0,145	-0,164	0,003
23. Plant-growing	3,964	-0,998	-0,472	-0,820	-1,674
24. Stock-raising	3,118	-0,171	-0,534	-0,931	-1,482
Total	20,867	-1,269	-6,040	-5,098	-8,460

*) In this table and all the following tables that contain industry information, the industries producing non-transportable goods, and a number of "other" industries were excluded.

Analysis of the results of calculations for all possible coalitions makes it possible to create a table of the effects of interregional interactions. In Table 3, the effects are presented in relative terms for the situation of fixed foreign trade. Hundred percent are the actual value of the regional goal function - consumption of the population. Contribution of the European part constitutes 39.4%; i.e., under the conditions of complete autarky this region can provide

39.4% of the actual value of the goal function. Interaction with the Urals adds 15.4%, with West Siberia - 29.1%, and so on. The fixed foreign economic ties provide for mere 2.6% of consumption. It is clear from the table that eastern regions have no opportunities to develop under autarky. In Russia as a whole, the largest contribution is made by the European part (summarizing column of the table): it supports almost a half of total consumption. This, however, is significantly less than the consumption in this region itself. Second contribution value belongs to West Siberia: almost a quarter of the total consumption; this, on the contrary, is higher than its own consumption. Balance of interaction (Table 6, row 4), i.e., the difference between total regional contribution and regional consumption (more precisely, total internal effect), is +136.7% of the consumption for West Siberia and -26.3% for the European part.

Table 3

Effects of interregional interactions under fixed foreign trade in % to consumption of the population

	European part	Urals	West Siberia	East Siberia	The Far East	Russia Total
European part	39.4	56.1	68.4	60.4	56.3	46.7
Urals	15.4	8.1	14.7	14.4	20.7	14.7
West Siberia	29.1	16.2	0.0	17.5	16.1	23.1
East Siberia	8.8	3.8	5.8	0.0	4.6	7.1
Russian Far East	4.7	9.8	4.3	4.6	0.0	3.5
Foreign trade	2.6	6.0	6.8	3.1	2.3	3.5
Total	100	100	100	100	100	100

These figures, however, should be treated with extreme caution. Their recording up to decimal point of a per cent is rather formal. We hope that the real balances of interaction are positive for West Siberia, negative for the European part, and the absolute values are about 1/6 - 1/3 of consumption for those regions.

The level of non-equivalency of interregional exchange for the actual state is rather high (Table 9, row 2). The values of balances of internal interactions in equilibrium prices (these are dual estimates of constraints - the balances of production and distribution) are sig-

nificant and differ essentially from those in actual prices of 1990. These differences are particularly large for the European part and West Siberia. Because of the radical change in the price structure during 1990-1993 (the structure changed in the direction of equilibrium prices), the estimates of internal export - import balance in the actual 1993 prices apparently occupy an intermediate position (between the first and the second row of Table 9).

Table 4

Effects of interregional interactions under free foreign trade in % to consumption of the population

	European part	Urals	West Siberia	East Siberia	The Far East	Russia Total
European part	25,9	14,0	18,7	17,6	15,3	21,7
Urals	0,9	5,3	0,5	0,5	4,7	1,2
West Siberia	4,9	0,0	0,0	1,6	1,2	2,6
East Siberia	3,2	-0,8	0,9	0,0	0,0	1,6
The Far East	0,2	3,5	1,5	1,0	0,0	1,7
Foreign ties	64,9	78,0	79,3	78,4	78,8	71,2
Total	100	100	100	100	100	100

Table 5

Effects of interregional interactions under regulated foreign trade in % to consumption of the population

	European part	Urals	West Siberia	East Siberia	The Far East	Russia Total
European part	27,1	32,9	37,0	34,9	32,9	31,1
Urals	11,4	5,4	10,7	10,8	16,5	10,6
West Siberia	20,4	15,5	0,0	19,9	17,7	14,2
East Siberia	4,5	1,9	5,5	0,0	4,7	4,2
The Far East	3,1	6,5	4,2	3,6	0,0	3,7
Foreign ties	33,5	37,8	42,6	30,8	28,2	36,2
Total	100	100	100	100	100	100

Table 6

Final indicators of the effects of interactions under fixed foreign trade, in % to consumption of the population *)

	European	Urals	West	East Siber-	the Far	Russia
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	part		Siberia	ria	East	Total
Own contribution	39.4	8.1	0.0	0.0	0.0	26.8
Pure internal effect	58.0	85.9	93.2	96.9	97.7	69.7
Total internal effect	97.4	94.0	93.2	96.9	97.7	96.5
Balance of interaction	-26.3	32.9	136.7	18.7	-23.7	0.0

*) The first row of the table was formed with the diagonal elements of Table 3; the third row was obtained by subtracting the effects of foreign trade presented in row 6 in Table 3, from 100; indicators in the second row are differences between the corresponding indicators of the third and first rows; indicators in the fourth row were obtained by subtracting the total internal regional effects (they are presented in relative terms in the previous row) from the total regional contributions (they are presented in the relative terms in the total column of Table 3), and by dividing by the final regional consumption of the population.

Table 7

Final indicators of the effects of interactions under free foreign trade in % to consumption of the population

	European part	Urals	West Siberia	East Siberia	The Far East	Russia Total
Own contribution	25,9	5,3	0.0	0.0	0.0	13,9
Pure internal effect	9,2	16,7	20,7	21,6	21,2	15,9
Total internal effect	35,1	22,0	20,7	21,6	21,2	29,8
Balance of interaction	-1,0	-10,7	10,4	9,0	3,4	0.0

Table 8

Final indicators of the effects of interactions under regulated foreign trade in % to consumption of the population

	European part	Urals	West Siberia	East Siberia	The Far East	Russia Total
Own contribution	27,1	5,4	0.0	0.0	0.0	14,7
Pure internal effect	39,4	56,8	57,4	69,2	71,8	49,1
Total internal effect	66,5	62,2	57,4	69,2	71,8	63,8
Balance of interaction	-21,0	31,3	116,6	-5,0	-19,3	0.0

Table 9

Balance of interregional exchange in % to consumption of the population (with actual territorial pattern of consumption of the population)

Prices:	European part	Urals	West Siberia	East Siberia	The Far East
Fixed foreign trade					
1990	15.9	-5.6	-29.9	-40.7	-64.1
Equilibrium	-3.2	-10.1	101.4	-43.3	-76.5
Complete liberalization of foreign trade					
1990	-8.9	2.3	78.4	-5.6	-30.9
Equilibrium	-20.7	10.2	161.1	7.5	-57.8
Foreign trade liberalization under export-import constraints					

1990	-10.2	11.2	69.0	5.9	-29.6
Equilibrium	-18.0	22.8	112.1	-2.1	-37.0

However, the actual situation is formally mutually beneficial. I.e., any coalition of regions will lose if it isolates itself from the system. This happens due to weak adaptive abilities of large regions to breaking the ties under the fixed foreign trade conditions. The system core area is large and includes the actual point (Table 13, rows 1,3). The core area is most stretched in the direction of West Siberia: final consumption of this region may be increased more than by four times at the expense of other regions in the core area. For the Urals, East Siberia and the Russian Far East, the increase is possible by about two times; and for the European part – by less than one and a half times.

Table 10

**Balance of export-import
(billion rubles, 1990 prices)**

	Actual		Completely free foreign trade		Regulated foreign trade	
	Domestic prices	World prices	Domestic prices	World prices	Domestic prices	World prices
1. Power industry	0,373	0,556	-1,878	-2,798	-2,446	-3,644
2. Oil industry	5,583	18,480	12,445	41,193	8,688	28,757
3. Oil-processing industry	4,282	4,582	-14,612	-15,635	-3,480	-3,724
4. Gas industry	3,136	6,711	1,952	4,177	1,915	4,098
5. Other fuel producing industries	0,589	0,477	0,023	0,019	0,000	0,000
6. Ferrous ores	0,373	0,373	0,367	0,367	0,367	0,367
7. Ferrous metals	4,755	5,611	4,494	5,303	4,465	5,269
8. Non-ferrous ores	-0,021	-0,015	-0,034	-0,024	-0,033	-0,023
9. Non-ferrous metals	5,962	9,360	5,649	8,869	5,669	8,900
10. Basic chemistry	1,342	0,993	-1,473	-1,090	-1,255	-0,929
11. Petrochemistry	2,572	1,620	1,791	1,128	1,803	1,136
12. Machine building	2,797	3,356	-5,387	-6,464	-5,609	-6,731
13. Timber industry	1,181	0,933	1,225	0,968	1,132	0,894
14. Woodworking industry	1,763	1,269	-0,259	-0,186	-0,235	-0,169
15. Pulp and paper industry	1,020	0,775	0,761	0,578	0,729	0,554
16. Textile industry	-3,218	-1,255	-11,084	-4,323	-10,345	-4,034
17. Clothing industry	-2,953	-0,974	-9,730	-3,211	-9,053	-2,987

18. Other light industry	-2,748	-1,071	-6,949	-2,710	-6,533	-2,547
19. Meat and dairy industry	-4,870	-1,851	-30,590	-11,624	-17,984	-6,834
20. Fish industry	0,185	0,089	-1,235	-0,593	-1,193	-0,573
21. Other food processing industry	-7,031	-2,742	-31,636	-12,338	-30,474	-11,885
22. Flour-grinding and cereals industry	0,174	0,111	3,149	2,015	-0,009	-0,006
23. Plant-growing	-5,620	-2,473	5,447	2,397	-7,247	-3,189
24. Stock-raising	-0,163	-0,029	-27,434	-4,938	-9,556	-1,720
Total	11,893	46,899	-107,840	0,001	-83,286	0,008

Table 11

Equilibrium prices under completely free foreign trade

	European part	Urals	West Siberia	East Siberia	The Far East	Commodity exchange rate of the ruble
1. Power industry	2,571	2,556	2,545	2,519	2,492	1,490
2. Oil industry	5,710	5,660	5,632	5,631	5,535	3,310
3. Oil-processing industry	1,852	1,837	1,829	1,822	1,840	1,070
4. Gas industry	3,708	3,679	3,633	3,655	3,566	2,140
5. Other fuel producing industries	1,393	1,395	1,391	1,358	1,345	0,810
6. Ferrous ores	1,724	1,717	1,700	1,688	1,684	1,000
7. Ferrous metals	2,037	2,020	2,013	2,003	1,981	1,180
8. Non-ferrous ores	1,211	1,201	1,196	1,191	1,171	0,700
9. Non-ferrous metals	2,713	2,688	2,678	2,661	2,632	1,570
10. Basic chemistry	1,280	1,269	1,264	1,251	1,245	0,740
11. Petrochemistry	1,087	1,078	1,076	1,065	1,059	0,603
12. Machine building	2,072	2,054	2,048	2,037	2,015	1,200
13. Timber industry	1,358	1,346	1,338	1,324	1,312	0,790
14. Woodworking industry	1,241	1,236	1,232	1,215	1,202	0,720
15. Pulp and paper industry	1,310	1,306	1,301	1,281	2,268	0,760
16. Textile industry	0,674	0,669	0,666	0,663	0,655	0,390
17. Clothing industry	0,570	0,566	0,563	0,560	0,554	0,330
18. Other light industry	0,674	0,668	0,665	0,662	0,655	0,390
19. Meat and dairy industry	0,660	0,655	0,653	0,652	0,644	0,380
20. Fish industry	0,832	0,826	0,823	0,821	0,798	0,480
21. Other food processing industry	0,675	0,670	0,667	0,664	0,657	0,390
22. Flour-grinding and cereals industry	1,104	1,094	1,094	1,090	1,069	0,640
23. Plant-growing	0,752	0,744	0,763	0,765	0,755	0,440
24. Stock-raising	0,316	0,314	0,314	0,317	0,312	0,180
Exchange rate of dollar (dual prices of e)	1,727	1,713	1,705	1,696	1,677	

Table 12

Equilibrium prices under regulated foreign trade and export-import tariffs

	European part	Urals	West Siberia	East Siberia	The Far East	Tariffs	Share of tariff in internal price	Commodity exchange rate of the ruble
1. Power industry	2,052	2,097	2,072	2,032	2,096	0,023 (i)	1,1	1,490
2. Oil industry	3,579	3,561	3,501	3,599	3,731	1,08 (e)	28,9-30,8	3,310
3. Oil-processing industry	1,639	1,586	1,616	1,576	1,511	0,127 (i)	7,7-8,4	1,070
4. Gas industry	3,027	3,018	2,954	3,022	3,057			2,140
5. Other fuel producing industries	1,136	1,203	1,191	1,118	1,135			0,810
6. Ferrous ores	1,407	1,408	1,383	1,392	1,424			1,000
7. Ferrous metals	1,663	1,657	1,668	1,683	1,705			1,180
8. Non-ferrous ores	0,988	0,985	0,973	0,983	0,989			0,700
9. Non-ferrous metals	2,227	2,205	2,194	2,195	2,225			1,570
10. Basic chemistry	1,045	1,041	1,029	1,032	1,052			0,740
11. Petrochemistry	0,887	0,884	0,889	0,918	0,947	0,017 (e)	1,8-1,9	0,603
12. Machine building	1,691	1,707	1,718	1,733	1,755	0,051 (i)	2,9-3,0	1,200
13. Timber industry	1,120	1,103	1,088	1,090	1,107			0,790
14. Woodworking industry	1,013	1,053	1,082	1,049	1,016	0,079 (i)	7,3-7,8	0,720
15. Pulp and paper industry	1,069	1,108	1,096	1,056	1,071	0,037 (e)	3,3-3,5	0,760
16. Textile industry	0,550	0,547	0,542	0,547	0,554			0,390
17. Clothing industry	0,466	0,461	0,458	0,463	0,469			0,330
18. Other light industry	0,550	0,554	0,541	0,546	0,554			0,390
19. Meat and dairy industry	1,162	1,161	1,156	1,163	1,169	0,626 (i)	53,6-54,2	0,380
20. Fishing industry	0,680	0,678	0,671	0,679	0,614			0,480
21. Other food processing industry	0,551	0,549	0,543	0,549	0,556			0,390
22. Flour-grinding and cereals industry	0,901	0,868	0,891	0,900	0,875	0,02 (i)	2,2-2,3	0,640
23. Plant-growing	0,628	0,543	0,622	0,635	0,640			0,440
24. Stock-raising	0,352	0,370	0,359	0,375	0,377	0,127 (i)	33,7-36,1	0,180
Dollar exchange rate (Dual prices of e)	1,409	1,395	1,399	1,386	1,417			

Table 13

Regional pattern of consumption of the population
(parameters λ^r)

	European part	Urals	West Siberia	East Siberia	the Far East
under the exogenous foreign trade					
Actual	65.4	11.6	10.1	6.3	6.6
Equilibrium	65.8	10.5	18.7	3.5	1.5
Core boundaries	32-90	1-28	0-44	0-16	0-16
complete foreign trade liberalization					
Equilibrium	52.1	12.7	26.5	5.8	2.9
At world prices	50.5	14.5	26.7	5.5	2.8
Core boundaries	2.1	2.7	6.5	.8	.9
Foreign trade liberalization under the export-import restrictions					
Equilibrium	52.0	12.6	26.8	5.7	2.9
At world prices ^B	50.2	14.1	27.2	5.6	2.9
Core boundaries	21-78	3-15	6-30	0-8	0-7

7. Foreign trade liberalization.

Consequences of the foreign trade liberalization are estimated. The variables of export and import (v^f, w^f) become endogenous and c constraints (see Section 4) on the regional balance of foreign trade are imposed. In the calculations these balances were assumed to be equal to zero ($S^f = 0$). The decisive role in such model experiments belongs to the commodity exchange rates of the ruble (parameter p^f). Their values are presented in the last columns of Tables 11 and 12. As is seen, domestic prices differ essentially from the world ones: oil price is more than by 3 times lower than the world price; price of stock-raising products – by more than 5 times higher than world one. This predetermines very serious consequences of foreign trade liberalization.

If territorial structure would not change and would stay on the actual level (the system would not come to equilibrium), then the nature of interregional ties would change radically. European part of Russia is the only region which has a positive actual balance of interregional exchange, would be the importing region (Table 9, row 3); positive balance of West Siberia would reach almost 80% of regional consumption, Urals region would get small positive balance of exchange. Measurement of these balances in equilibrium prices provides the estimates

of non-equivalence level of interregional exchange (Table 9, row 4). The level of non-equivalence increases in comparison with the actual state under fixed foreign trade. Burden on West Siberia grows substantially; Urals and East Siberia become recipients. European part appears to be the biggest donor (20% of regional consumption is formed at the expense of other regions).

Further on, the system is brought to equilibrium (equivalent exchange). Foreign trade turnover increases significantly (as compared with the actual turnover), foreign trade pattern changes (Table 10, columns 3,4 B in comparison with columns 1,2). Oil export increases more than by 3 times, import of light, food and stock-raising industry products increases by 3, 4 and more times. Russia becomes an importer of oil-processing and engineering products; sign of export-import balance changes for several other products too.

Domestic equilibrium prices for the above situation are presented in Table 11. They coincide with the world market prices with an accuracy of transportation costs. Data from the Table gives proof to this: if domestic price is divided by exchange rate of the dollar (in rubles) given in the last row of the table (these are dual estimates of constraints on the regional balances of foreign trade), then the result will be similar (with an accuracy of transportation costs) to the commodity exchange rate of ruble.

Complete foreign trade liberalization results in:

- a) Consumption increased by 1.5; consumption in West Siberia increased more than by 4 times;
- b) On the average, employment decreased almost by 10 percent points (it was particularly significant in the Russian Far East, East Siberia and in the Urals)
- c) Total destruction of stock-raising, oil-refining, meat and dairy industries, catastrophic decrease of production in consumer goods and food processing industries;

d) Practically complete disintegration of the internal economic space: the regions do not exchange products, they operate in the world market only.

Export proceeds from oil, gas, metals, timber are used for the import of oil-refining products, consumer goods, food products and some other products. As for the regional consumption pattern, West Siberia's share had risen, share of the European part had decreased essentially (Table 13, rows 4,5). The system core is reduced to a single point - the state of equilibrium (in Table 13, row 6, the core is presented as a point that coincides with the equilibrium).

It is like the situation in the recent past, but in exaggerated and even caricatured form.

Interaction effects were estimated in order to compare with the previous version. They are presented in Tables 4 and 7. Effects of foreign trade are the most important: they amount to almost 80% of regional consumption. With the complete economic disintegration of internal space these effects should be equal to 100%. But, as the weak ties among regions, particularly in some coalitions, still do exist, the effects of interregional interactions have rather low values. They are not of any particular interest.

8. State control of the foreign trade.

Therefore, complete foreign trade liberalization is damaging the Russian economy. Protectionist measures are necessary. In the analysis in question, they were introduced in two ways. First, export tariffs were introduced on primary fuel, metals, and lumber products. As a result, domestic prices of these products decreased and they became affordable for Russian consumers. Second, import tariffs were introduced on the products of some processing industries. As a consequence, domestic prices of such products grew and they became profitable. The consequences of the unified customs policy for the country were tested, i.e., the system of macro-regions was regarded as the customs union (as compared with previous variant, i con-

straints were introduced in the model, their dual values are interpreted as export-import tariffs). The value of export and import duties was fixed in such a manner so as to allow to keep all industries at the level not lower than 90% of the production in 1993.

In the model solutions under actual territorial pattern of consumption of the population, interregional turnover at actual 1990 prices does not decrease as compared with the situation of totally free foreign trade (Table 9, rows 5,6). A new quality is that East Siberia becomes a region with positive balance of internal exchange. However, the level of non-equivalence of exchange (balance at equilibrium prices) decreases. On the contrary, East Siberia, instead of being a recipient, becomes a donor.

Then, as before, the system was transformed into equilibrium state (equivalent exchange). In comparison with the previous case, export-import volumes are reduced, mainly due to oil export and import of meat, dairy and stock-raising products (Table 10, columns 5,6). Signs of export-import balances change in two industries only. Exchange rate of dollar falls dramatically, i.e., the ruble gets stronger (compare the last rows of Tables 11, 12). Domestic equilibrium prices, as it was conceived, begin to differ from world prices (Table 12). For instance, if we add export tariff to domestic oil price (column 6) and divide the result by dollar exchange rate, the world price will be obtained (the corresponding commodity exchange value of the ruble). Foreign trade tariffs are essential for three industries only (Table 12, column 7): oil industry (export tariff is almost 30% of domestic price), meat and dairy industry (import tariff is more than half of domestic price), and stock-raising (import tariff is a little higher than 1/3 of domestic price).

As the result of foreign trade regulation, consumption in the country decreased on the average by 5%, employment increased (it reached the level of 1993 - 88% of active population); internal commodity exchange has been restored, but not in full measure. Equilibrium regional structure of the final consumption almost did not change, as compared to the case of

complete foreign trade liberalization (Table 13, rows 4,7,8). • The system core expanded (Table 13, row 9), but remained remarkably narrower than in the case of fixed foreign trade.

In Tables 5, 8 (effects of interactions), the effect of foreign trade decreased by 2 times (in comparison with the case of completely free foreign trade), the effects of interregional exchange became more substantial.

Table 14

**Differentiation of per capita consumption
(in % to the Russian mean)**

	European part	Ural	West Siberia	East Siberia	The Far East
Fact of 1993:					
In model	101	84	99	102	129
RF Goskomstat Data	103	88	87	90	129
Equilibrium, Foreign trade:					
Fixed	102	76	183	57	29
Free	81	92	260	94	57
Regulated	80	91	263	92	57

The shares of East Siberia and the Far East are understated in the equilibrium (i.e., equivalent exchange) regional structure of consumption, particularly under the conditions of exogenous foreign trade (Table 13, row 2), (to a certain extent it may be due to the fact that some factors were not taken into account). Per capita income in these regions decreases by 1.5-2 times under equivalent exchange. High regional disparities in per capita consumption (Table 14) can cause the disintegration of the country. Interregional exchange within a federal state does not have to be equivalent in order that internal economic space is sufficiently homogeneous; and interregional differences in living standards are not very large. Certain redistribution of financial and other resources is required. However, the level of exchange non-equivalence and volumes of transfers (and other gratuitous transfers of financial resources – subsidies, budget financing) must be reasonable. The values of the interregional redistribution

of financial resources supporting the non-equivalence of the interregional exchange, for the actual level of 1993, are the balances of interregional exchange in equilibrium prices presented in Table 9. For fixed foreign trade, they amount to about 10% of the total consumption of the population or about 7% of the GDP. Under completely free foreign trade, noticeably higher volume of financial redistribution – about 17% of total consumption or almost 12% of the GDP (row 4)- is required in order to support the actual level of non-equivalence of exchange. The need in financial redistribution goes to 13% of total consumption or 9% of GDP (row 6) due to regulation of foreign trade. Apparently, it is not that much, because currently (1996-1997) about 5% of GDP is redistributed via the budget channels. The point is whether the level of exchange non-equivalence is sufficient; it evidently requires further investigations.

Table 15**Indices of volumes of production in % to 1990**

	European part	Urals	West Siberia	East Siberia	The Far East	Russia
1996 (estimate)	41	49	60	56	41	46
Solution of the model						
Complete foreign trade liberalization	48	50	59	56	46	50
Regulation of the foreign trade	57	55	65	62	51	58
Expert estimation of an influence of foreign trade regime changing						
	64	64	71	69	61	67
Expert estimation of share of other factors						
	39	31	28	30	34	37

In this study the impact of changes in foreign trade regime on the Russian economy and its macro-regions was explored. In particular, it was shown that foreign trade liberalization results in the decrease in internal production. It is possible to estimate significance of the influence of this factor on the total decrease of production in Russia. Table 15 proves that the actual drop in production from 1990 to 1996 in Russia was 54%. The model solutions show that complete liberalization of foreign trade would result in decrease of production by 50%

and under state control – by 42%. Such decline, only as the result of one factor impact, would take place if market mechanisms have turned the system into equilibrium.

If we assume that only $\frac{3}{4}$ of this task was actually completed, and the two hypothetical situations considered (complete liberalization and state regulation of foreign trade) are implemented in practice with equal weights (0.5 and 0.5), then the actual decrease related with the change in foreign trade regime amounts to merely 33% (row 4). I.e., other factors (reduction of investment, financial disproportion, etc.) determine 21 percentage points of production decline. Their share equals to 37% (additional row of the table). The most significant influence of other factors takes place in the European part (39%). On the contrary, the consequences of foreign trade liberalization reduced production in West and East Siberia, and in the Urals to the highest extent.

10. Conclusion

This study can be regarded as an initial stage of analysis of interactions between macro-regions and world economy. Further, many fragments of the input data will have to be verified, the models will be modified and the results will be tested more carefully.

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