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ECONOMIC FRAMEWORK OPTIMIZATION AS AN INSTRUMENT FOR REGIONAL DEVELOPMENT

Modern economic development of territories requires a comprehensive, interdisciplinary approach. This article discusses the geographical model of the supporting framework of economy (SEF) as a constructive tool in regional economic policy. The SEF has a linear-nodal structure and includes such key elements as large urban agglomerations (economic nodes and local clusters), economic centers and connecting lines between the basic elements of regional economy. SEF is a universal concept which allows us to describe the main features of economic territorial organization, its shortcomings and advantages, and identify areas for implementation of large investment projects.

This article focuses on the case of the Volga Federal District, in particular Perm region, and analyzes the main problems in this region's economic development. These include the hypertrophied role of the regional capitals, struggling periphery, lack of sufficient transport, marketing, production and other connectivity between different elements of the regional network for the development of a large domestic consumer market; and shortage of innovation and modern investment infrastructure. A particular problem of regional economy is the limited accessibility of some territories and the impossibility to build the shortest routes between disparate centers and nodes, which reduces the productivity of labor and the competitiveness of manufactured goods and services.

Based on the analysis of these problems in the economic territorial organization by applying the SEF model, we outline possible solutions to this region's problems.

Keywords: territorial organization of regional economy, supporting economic framework, linear-nodal structure, hypertrophied economic node, distribution of functions between economic elements, transport connectivity of regional economy.

Introduction

As many regions are transitioning to the mode of 'self-governing' and are trying to become more self-sufficient, their economic efficiency, which includes efficient use of the available resources, becomes a matter of vital importance. Economic prosperity of regions increases the wealth and standards of living of their population. Economic stimulation can take different forms and focus on different spheres: for instance, it can allow room for a variety of ownership forms; promote technological innovation; enhance the region's independence from the intraregional economic ties; encourage cooperation between enterprises of different sizes and profiles, and so on. The geographical distribution of economic objects and the results of their activities are of utmost importance in this respect. The basis of the territorial organization of regional economy in Russia is **the supporting economic framework (SEF)**, which has a linear-nodal structure. Let us consider the possibilities of applying this model in theory and in practice by focusing on the case of Perm region, which is one of the oldest industrial regions of Russia and has now reached a turning point in its economic history.

Methodology

The concept of a supporting framework in territorial systems was first introduced by Nikolai Baransky in the 1920s, who referred to such framework as the 'carcass of the territory'. His followers developed this theory by putting forward the concept of a supporting frame of a settlement between the 1960s and 1980s. At a later stage, the concept of an ecological framework of regions was proposed. In the 1990s, human geography and related sciences (for instance, geo-informatics and territorial planning) started using the concept of framework when referring to the spheres of transport, tourism and recreation. Today we can talk

about a regional framework of sustainable development as a combination of elements of territorial structure and spatial relations inside the region. Nowadays ‘framework’ and other related concepts are widely used in theoretical and applied geographical studies within the so-called **framework approach**. Table 1 illustrates the evolution of this approach.

Table 1.

Evolution of the framework approach in geography

Concepts	Scholars and spheres of application	Period
Framework (‘carcass’) of the territory	Nikolay Baransky [1]	Late 1920s
Supporting framework of a settlement	Boris Khorev [2], Georgy M. Lappo, Pyotr Polyanskiy [3]	1960s-1980s
Ecological framework of regions	Vladimir Preobrazhensky [4]	1980s-1990s
Transport, tourism, recreation, historical and cultural planning framework	In documents of territorial planning, City-Planning Code of the Russian Federation [5]	Mid- and late-2000s
Regional framework for sustainable development	Nikolay Nazarov, Tatiana Subbotina, Mikhail Sharygin [6]	Mid-2000s

The evolution of the framework approach in geographical studies was accompanied by the development of theoretical and empirical research in this sphere. Initially, the ‘framework’ was seen as a static phenomenon (‘carcass of the territory’) and this term was applied to describe territorial patterns of settlements or other economic and regional objects. Following the proliferation of system-structural methods, the SEF is currently considered to be a dynamic phenomenon that involves constant transformations of territorial configurations inside the specific spheres of human life and among them. The SEF also encompasses the ever-changing spatial relations between different locations and areas. Therefore, it is important to emphasize the dual nature of the framework concept: it combines inertia and dynamism, concentration and dispersion, differentiation and integration, a tendency toward self-development and external regulation, and so on (see Figure 1).

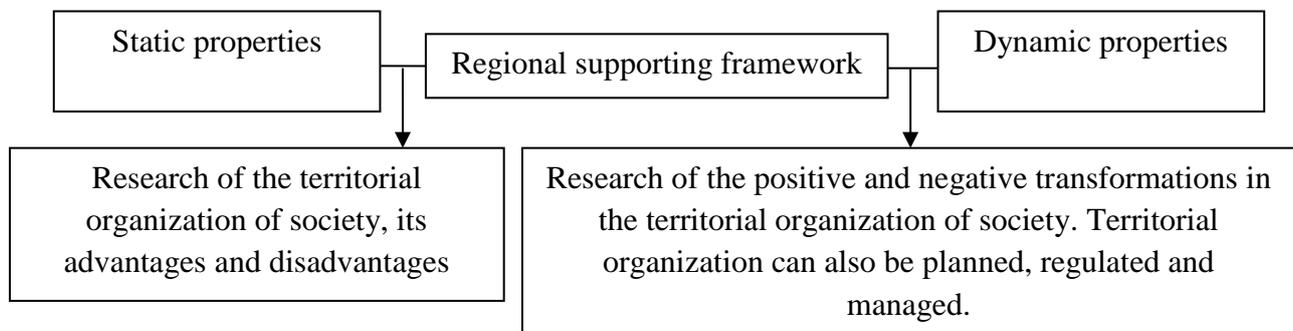


Fig. 1. The main aspects of the framework approach in geographical studies

Among the different frameworks mentioned in scientific literature and formal documentation, the supporting frame of the regional economy (SEF) is one of the most important and useful concepts. We define it as a concentrated invariant of territorial organization of economy, a model for spatial combination of the largest (central, focal) elements of the territorial structure of a regional economy connected through feeding lines and systems. The SEF has a *linear-nodal structure* (see Figure 2) as it contains both *nodes* and *linear components*. The most complex elements of SEF are *areas*. Among the nodes, we can distinguish between economic centers and hubs as well as individual objects of production, market, innovative, scientific and technical infrastructure, which are seen as optional elements although their importance has been growing in

the recent years. As for areas, we can distinguish between economic areas (agglomerations, territorial complexes, regional and clusters) and zones formed in the process of long-term and joint development of various territorial and economic combinations. Linear objects are distribution highways (general and specialized transport routes, energy and electronic communication lines, telephone communications), connecting elements of the SEF and ensuring their interaction with each other [7].

At present, the main documents of territorial planning in Russia refer to the framework of urbanization, transport, tourism and recreation and even historical and cultural resources, but they do not mention the framework of economic development. However, modeling of such frameworks may be valuable when designing policies for optimization of different aspects of regions' economic development.

Further we are going to describe some of the ways that SEFs can be used to enhance regional development by focusing on the case of the Volga Federal District and in particular Perm region.

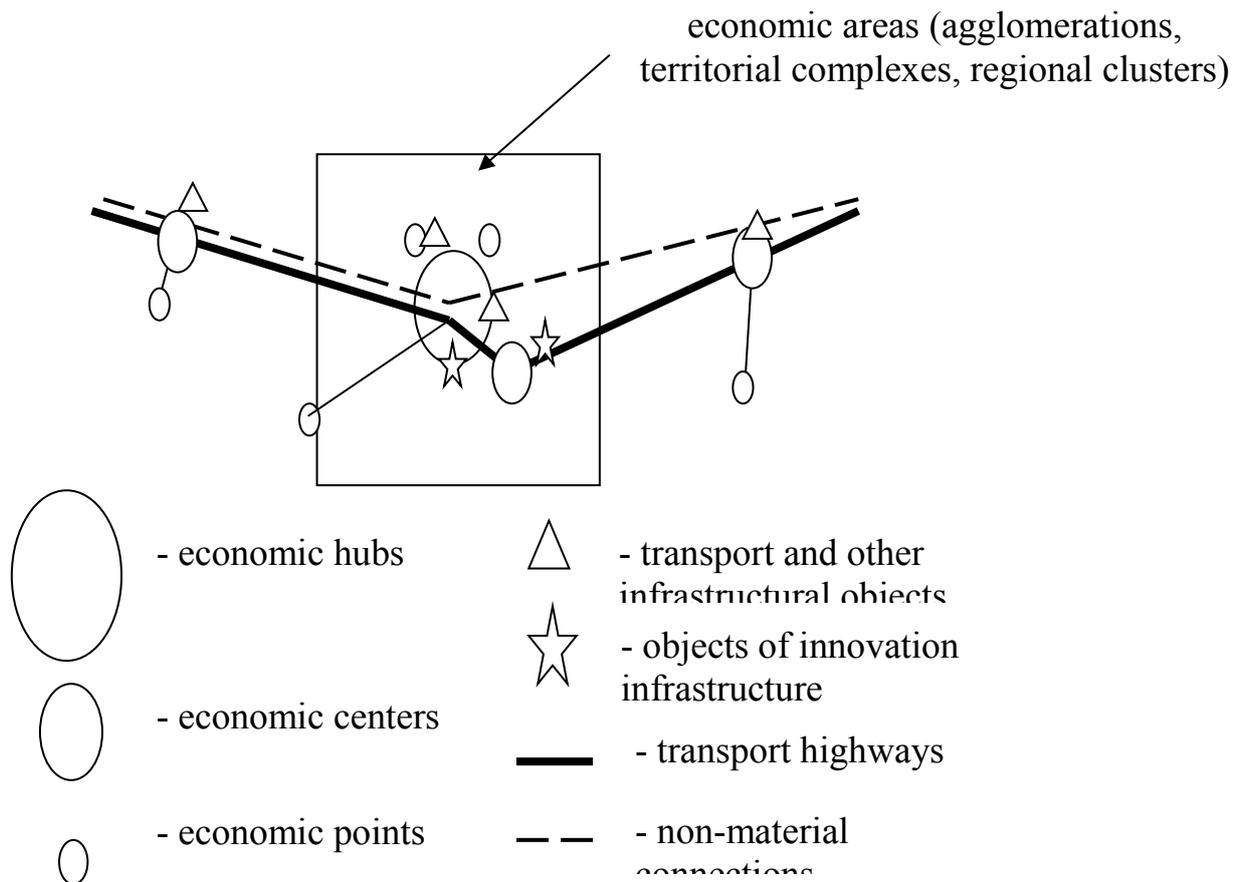


Fig. 2. General scheme of the regional SEF [7]

1. The SEF model can help regional governments address the problems their regions are facing. The agglomeration-nodal structure of regional development means that there is one economic hub that dominates over the others while the peripheral areas are in decline.

Table 2 shows hyperconcentration of value in different industrial parts of the regional center. This indicator – the total value of manufactured goods – allows us to avoid a possible statistical error, which usually manifests itself in exaggerating the value of extracted natural resources in the headquarter-city of the extracting company instead of the area where these resources are extracted. On the contrary, if we take into account only the profitability of the processing types of industry, we will be able to assess the concentration of added value in the regional capital and the peculiarities of added value redistribution among other cities and territories.

Dynamics of the share of regional capitals according to the total value of manufactured goods in 2005-2015, %¹

Regional center	2005	2007	2009	2010	2011	2013	2015
Izhevsk	57,6	60,6	46,2	45,8	48,4	48,8	50,5
Yoshkar-Ola	40,3	33,4	35,2	33,7	34,2	38	32,8
Kazan	20,9	17,6	23,1	21	19,5	19,9	20,9
Kirov	49	51,3	45,2	46	44,7	43,7	42,7
Nizhny Novgorod	33,4	30,2	21,8	22,3	22,9	29,8	29,5
Orenburg	20	16,6	18,5	17	18,1	41,3	38,7
Penza	64,7	68,3	67,1	66,9	64,9	64,9	48,6
Perm	56,7	61,2	64,2	65,5	64,2	68,2	57
Samara	24,7	26,3	30,7	28	26,8	25,2	25,8
Saransk	46,5	51,4	49,4	48,1	44	43,1	44,7
Saratov	50,1	47,7	51,5	50,2	43,3	46,6	41
Ufa	52,6	49	58,6	58,3	57,4	67	52,7
Cheboksary	61,2	65,6	66,7	65,2	50,1	59,9	52
Ulyanovsk	58,6	64,3	72,5	75,7	69	64,3	71,1
<i>Average share by years:</i>	45,45	45,96	46,48	45,98	43,39	47,19	43,43

The most interesting situation is in Ulyanovsk, Penza region, Udmurtia, Bashkortostan, Chuvashia and Perm region. In each of these regions, the role of 'metropolitan' cities in the value of manufactured products in 2005-2015 was more than 50 %. In addition, until recently, the dynamics of this indicator was positive, which meant the growing influence of the regional center in the economic complex. A relatively more balanced situation is in Samara and Orenburg regions as well as Tatarstan, where there are two or more established and regulated economic nodes (large industrial agglomerations) which receive some of the load from the capital 'node' (Tolliati, Orsk-Novotroitsk, Nizhnekamsk and Naberezhnye Chelny). They perform a significant part of their regions' economic functions and compete for resources, people, finances and investment, ensuring a more even distribution of added value across the region and thus making their regional economies more balanced.

When economic resources are concentrated in regional capitals, the so-called capital effect occurs, which has not been sufficiently studied in modern geographical and regional economic literature. This effect was described by Alexander Druzhinin and Natalia Zubarevich. According to the former, 'in the regional political and economic contexts of post-Soviet Russia, the metropolitan areas (*the largest cities*) are rent-oriented (they are oriented towards obtaining and redistributing rents, mostly resource and positional rents). The conditions that metropolitan areas are functioning in are determined by the dominance of economic and political monopolies. The monopoly on power (including the priority access to the resource potential of the territory) and on institutions creates conditions for emergence of metropolises; for their prolonged territorial, social and economic dominance and the 'profit margin' these metropolises receive on a regular basis (positional rent); for new quantitative and qualitative changes that demonstrate and support their

¹ Source: Database on Social and Economic Development of Russian Cities. Retrieved from http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1138631758656

privileged status' [8, p. 57]. Alexander Druzhinin also points out territorial-social segregation as one of the main problems that stem from the domination of a large city.

In Perm region, in 2015, the capital city (Perm) concentrated 57% of the total value of the goods manufactured in the region. In 2016, Perm also accounted for a large share of the region's population (40%), attracting direct investment in the economic sector (50%), the total cost of industrial products (including extractive production, production and distribution of electricity) (69%). As a result, the economy and the population of peripheral areas started to decline. Other problems include a sharp reduction in intra-regional connectivity and opportunities for development of the domestic market, concentration of added value within a limited number of cities. Thus, Perm can be compared to an island of extensive growth surrounded by the deteriorating periphery. Figure 3 shows the distribution of the value of manufacturing industries between different economic nodes and centers of Perm region. Such situation is obviously abnormal and some serious policy adjustments are needed to solve this problem in the future.

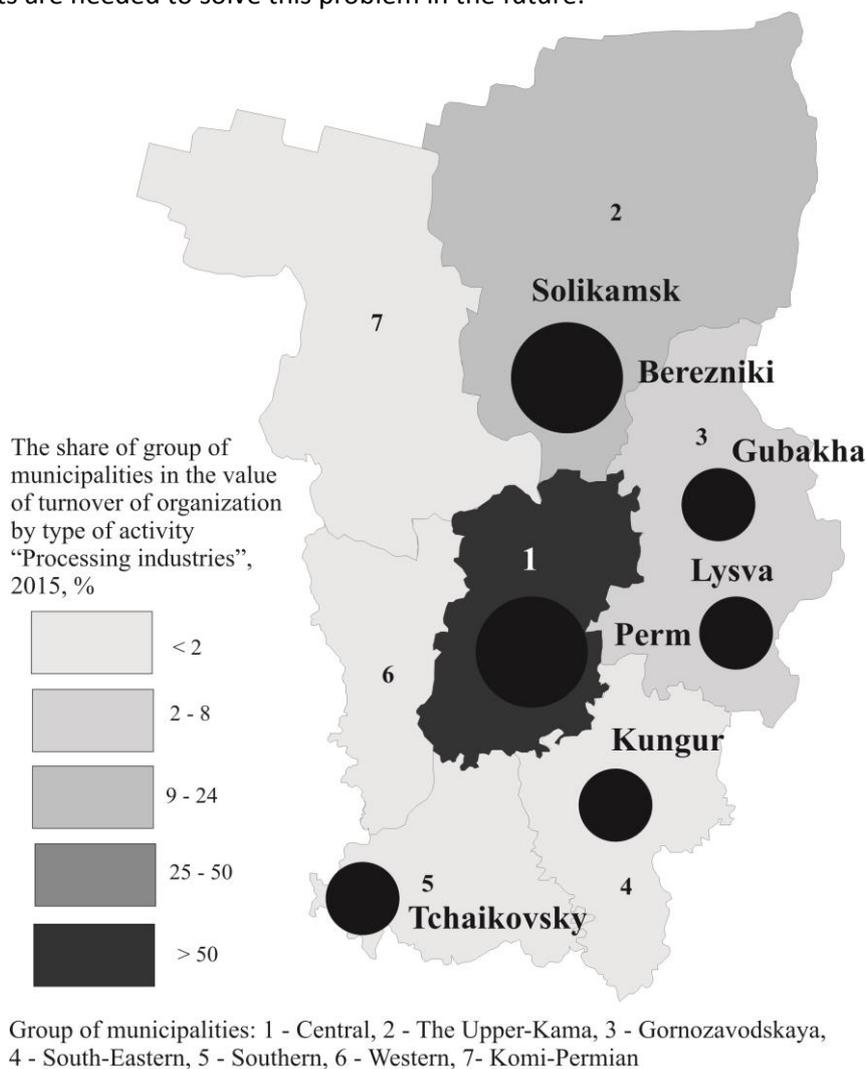


Fig. 3. The distribution of value of manufacturing industries among groups of municipalities of Perm region in 2015, %²

At the same time, we should not adopt a negative perspective on large cities as sources of problems for territorial development. Different studies clearly show that for Russia and many other countries with

² Source: Database of Indices of Municipalities in Perm region. Retrieved from http://permstat.gks.ru/wps/wcm/connect/rosstat_ts/permstat/ru/municipal_statistics/main_indicators/

transitional or developing economies, the importance of largest cities cannot be overlooked. According to cumulative models of development of economies and territories (in particular, H.Hirsch's model of a 'city-volcano' [9]; F.Perroux's concepts of growth poles [10] and his followers J.-R. Boudeville, J. R. Lasuen; the diverging effects pointed out by G. Myrdal; H. Richardson's agglomeration economy [11]; J. Friedmann's theory of center-peripheral relations, [12], further stimulation of a new type of economy is possible, mainly, in the key territorial elements, which are characterized by concentration of financial, industrial, scientific and educational resources for stimulating innovation in regional economy. An interesting idea was proposed by A.I. Tatarkin, who pointed out that 'nowadays the largest cities are leaders of investment, innovation, social processes, and points of economic growth. It is the strategy of their development that determined the country's economic growth' [13].

Large cities have both the potential and the tools for becoming drivers of economic growth. Large cities' opportunities are connected with administrative and agglomeration effects. While administrative effects are more likely to have negative consequences, agglomeration effects, according to Paul R. Krugman [14], act as a 'second nature' factor that stimulates the development of regional economy. Positive effects of the agglomeration approach are shown in Figure 4.

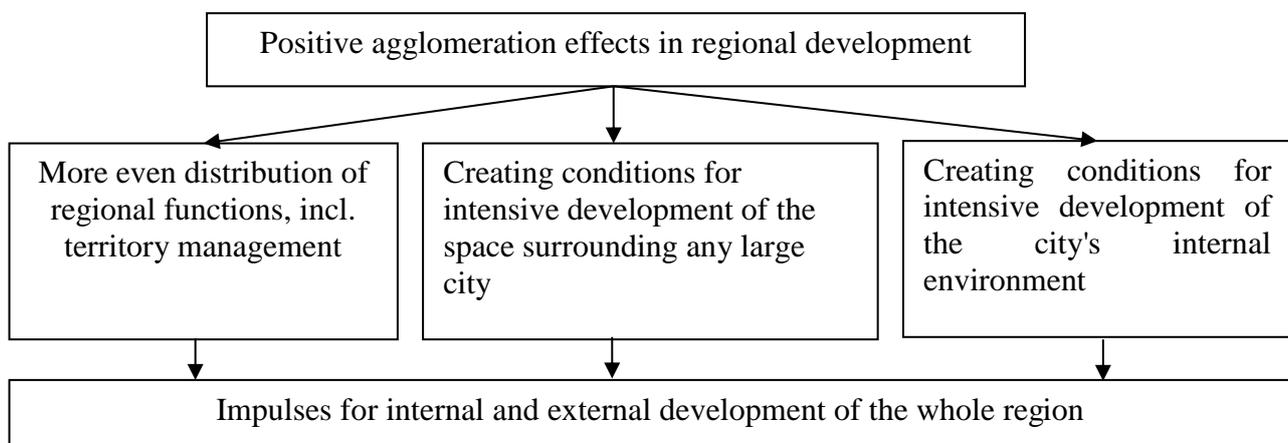


Fig.4. Positive agglomeration effects in regional development [15]

Thus, by adjusting agglomeration effects in regional development (they should be used in a balanced way), we can handle the situation when the largest city receives more advantages than any other cities, towns and settlements. In our opinion, the role of the largest city in regional and national development should be changed by balancing the interests of cities on different hierarchical levels and redistributing their regional functions. Self-organization of urban space, the acquisition of excess profits (rents) and additional benefits should not be the main focus of the urban policy. In other words, regional capitals and large cities, which are the main poles of economic growth in the country, the 'carcass' of the territorial organization of modern Russian society (SEF), must participate in the lives of their subordinate territories, take responsibility for their development, create opportunities for equitable distribution of functions in the regions. As a result, the apparent centripetal tendencies that have developed in modern Russia would be replaced by bilateral – centripetal and centrifugal – tendencies.

The city of Perm should become the leader of such new 'smart' and balanced development policy in the region. Its main functions should include uniform organization of the regional space, creation of incentives for common and individual development, territorial branding, etc. The city has the necessary human, scientific and economic resources to accomplish these aims (see Figure 5). For example, the innovative cluster – technopolis 'Novy Zvezdny' – is currently used for development and testing of new engines for space launch vehicles and aviation. Other examples include the IT- and fiber-optic cluster 'Photonics' and the pharmaceutical cluster that is now under construction. Other branches of machine manufacturing and chemical industry have a great potential for clustering and enhancing the region's competitiveness by completing new value chains, upgrading the existing ones and restoring old values chains in technological (energy-related) cycles. These include electro-technical and oilfield engineering; production of plastics and

other synthetic products made of hydrocarbons; wood processing; development of technologies for processing paper raw materials; development and production of new types of composite materials.

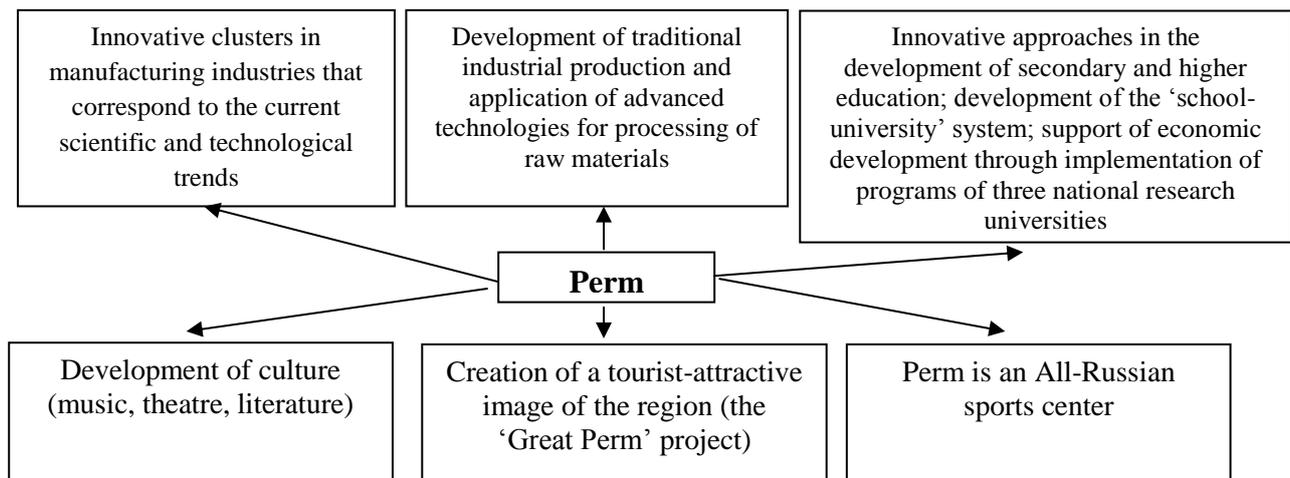


Fig. 5. Modern positive ('smart') functions of Perm in the regional SEF

In addition to positive leadership in the secondary sector of economy, Perm is already a national leader in terms of culture: music, theater, and ballet. Moreover, it is now being widely promoted as a tourist destination (the 'Great Perm' project). The secondary and higher education systems in the city are also developing. However, in our opinion, social technologies in health care and insurance medicine, leisure and recreation still leave much to be desired. The level of transport and logistics in the city is also lower than could be expected. These areas of development should become the main priorities for urban and regional planning in the future.

Another area of development involves transfer of certain functions (secondary economic activities) from the regional center (Perm) to towns and villages of Perm urban agglomeration. According to A.P. Burian and A.M. Korobeynikov [16], a similar or alternative development of Perm urban agglomeration is based on deconcentration and decentralization of the socio-economic extensive development of Perm and the accelerated development of small towns and villages on the periphery, enhancing the connection between its various elements and the integrated realization of the agglomeration's potential.

The functions that can be transferred from the regional capital to its immediate surroundings may include industrial processing (food, woodworking enterprises, medium-sized machine manufacturing enterprises that do not require skilled labor, etc.), tourist-recreational, cultural-cognitive, transport-logistic, and social services. Among the most important agglomeration subcenters are towns Dobryanka, Krasnokamsk, Okhansk, Nytva; villages Polazna, Ilyinsky, Yugo-Kamsky, Kukushtan, Sylva and Uralsky. A possible distribution of functions among these settlements is shown in Figure 6.

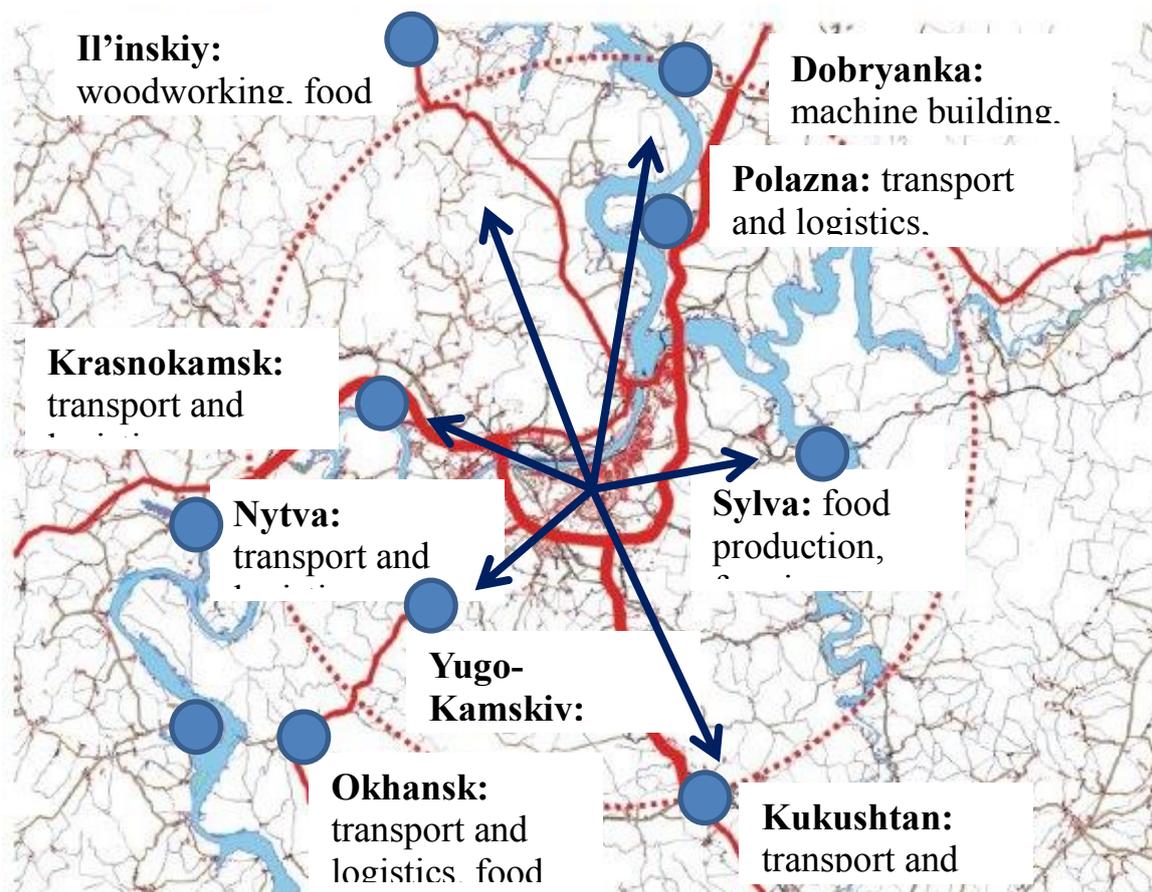


Fig. 6. Subcenters of Perm urban agglomeration and their possible specializations

2. Alignment of an economic landscape should result not only from redistributing the load of the region's central nodes proportional to their capacities but also from stimulating the development of new functional economic centers on lower levels of the regional hierarchy.

The strategy of improving the framework of the regional economy was described by Jose R. Lasuen [17], who studied the links between urbanization processes and spatial features of economy. He believed that growth poles (geographic locations with the potential for economic development) need not necessarily be related to the national economy and the export of goods abroad. A growth pole could be a regional complex of enterprises (rather than branches) located in one of the 'geographical concentrations' of the region and associated with its exports. Growth poles appear due to the growth in the nationwide demand. Through market ties (not only through links of supply and sales), the growth momentum from such centers is transferred to secondary industries and peripheral sectors.

Thus, growth poles can occupy the middle parts of economic areas and contribute to a more even distribution of regional income. According to J.R. Lasuen, 'development in developed countries is becoming less polarized, due to a more diversified business structure, which leads to a vast spatial spread of innovation and economic development, which means that developing countries can accelerate their growth by creating diversified corporate structures that reduce the severity of polarized strategy' [17].

Following the ideas of the Spanish scientist, we can note that economic centers located within the regional semi-periphery have potential for innovative growth. The most important task is to identify the local potential and to identify the optimal functions for new economic centers. Moreover, the search for new functions or modernization of the existing ones is also possible, for instance, most semi-peripheral parts of the Ural-Volga region traditionally specialize in industry while their new functions could lie in the service sector. Development of the economic centers with the help of modern technologies based on infrastructural

and managerial mechanisms and encouraging these areas to capitalize on their geographical and other advantages can also be a point (or focus) of growth of these territories.

In our opinion, the following assumptions are relevant for qualitative growth and modernization of the territorial-industrial combinations that have developed in the semi-periphery of Perm region:

a) studies of technological added value chains (in the form of energy and production cycles) [18] in order to improve the main production process and develop auxiliary (including environmental and recycling) technologies;

b) stimulation of industrial production through innovation and development of investment infrastructure.

In the first sphere, we can point out that energy and production cycles (or EPC, the term introduced Nikolay Kolosovsky) include technological processes that allow us to combine various stages of raw materials processing and energy transformation. Analysis of the existing chains enables us to anticipate the development of new types of industrial activity (with higher added value), and to plan the integration of industries for recycling of industrial waste and inter-branch relations into other types of manufacturing industries. Thus, EPCs comprise geographic, technological, economic, environmental, innovative and other aspects of production. Table 3 shows that it is possible to modernize industry in Perm region by targeting specific EPCs in the region's industrial centers and by capitalizing on the territory's unique potential.

Table 3.

Energy and production cycles at industrial centers of Perm region

Industrial center	Energy and production cycles	Manufacturing industries
Gubakha	Gas-chemical cycle	Production of synthetic resins, plastics, technical spirits and related products, nitrogenous compounds
	Timber and wood chemical cycle	Hydrolysis of wood with the production of food and technical spirits, wood-fiber boards, dry lumber
Kungur	Industrial-agrarian cycle	Manufacturing of confectionery, grain products, meat and milk products
	Industrial-building cycle	Products from limestone rocks, incl. wall panels, roofing materials
	Group of machine-building cycles	Production of equipment for oil and gas extraction, construction industry, metal processing
Lysva	Pyrometallurgical cycle of ferrous metals	Modern types of steel and rolled products, metal products, blanks for machine-building enterprises
	Group of machine-building cycles	Electro-technical engineering, production of equipment for oil and gas extraction, instrument engineering
Tchaikovsky	Group of machine-building cycles	Production of equipment for oil and gas extraction, production of household appliances, instrument engineering
	Gas-chemical cycle	Processing of petroleum gas for manufacturing of simple and complex polymers, synthetic fibers and threads, synthetic rubber and rubber products

Particular importance should be given to the development of new types of production in local EPCs in towns Kudymkar, Osa, Vereschagino, Chusovoy and Kizel. These towns used to be reasonably stable industrial centers, but today their industry is declining and their contribution to the regional economy has reduced.

It is possible to realize production functions through the development of manufacturing, engineering, innovation, service and investment infrastructure in these areas, which may include establishment of

business incubators, industrial parks, technoparks, local innovative clusters, and so on. The choice of locations for infrastructural objects is also a vital planning task.

Despite the fact that industrial functions still determine the trends (often negative) in municipal and regional economy of Perm region, it becomes clear that gradual but systematic transformation of economic functions is required. More emphasis should be made on social services. As we have indicated earlier, the leader in this sphere is the regional capital, but towns and districts of the regional semi-periphery and periphery can also be actively involved in this process. In some of them (Tchaikovsky, Lysva, Gubakha, and Kudymkar), post-industrial functions are already important components of the urban economy, affecting the rebranding of the territory, investment attraction, the life of the local community, etc.

We can provide some examples of such transformations. The town of Tchaikovsky is a major center of musical culture not only of regional but also of national significance. The town has a theatre of comedy and drama and a music school. It also hosts the national competition of young composers named after Peter Tchaikovsky. One more postindustrial function of this town is the development of sports and sports infrastructure. On the territory of village Prikamsky, located near Tchaikovsky, there is the Federal Training Center of the Russian Olympic Team 'Snowflake'. Thus, Tchaikovsky is a well-known center of the country's sports life, a popular venue for Russian and international sports forums (Russian and international summer biathlon championships, the summer Grand Prix stage for ski jumping, etc.). A more significant role in the future will be played by tourist-recreational (ecological, sport, historical and cultural, etc.) and transport- logistic functions (exits from the Western Urals to the Middle Volga region).

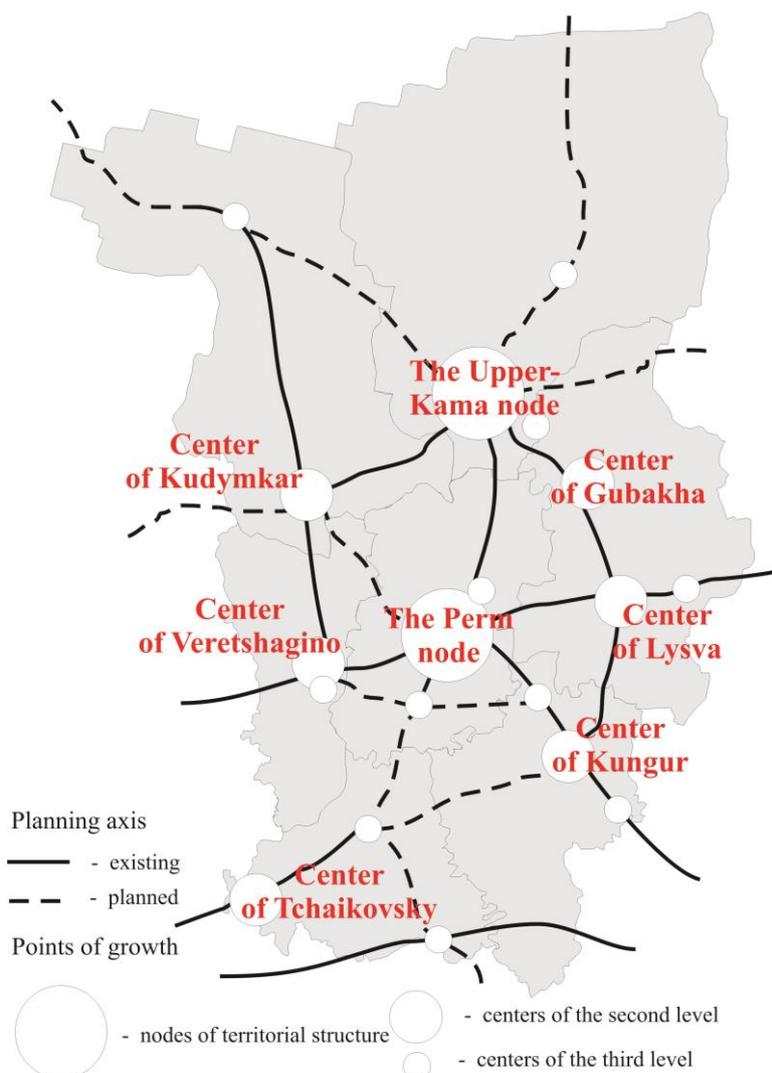


Fig. 7. Development potential of the SEF of Perm region

In Gubakha, a town located in the east of the region, local inhabitants are interesting in changing the urban environment and landscape by developing the post-industrial sector of economy. Among the main service functions of this town there are tourist-recreational (ski center, fishing, festivals); cultural (theater-studio 'Dominanta', participation in various Russian theater festivals; a unique museum of coal; interactive displays and games offered by the town library); and sports (competitions in sport fishing, ski cross). The growth of the postindustrial sector is accompanied by changes in the attitudes of the local inhabitants to their town, changes in the urban infrastructure (small architectural forms, year-round ice rink, a park of culture and recreation) and renovation of streets and squares. So, tourist-recreational, transport-logistical, sports, cultural and educational, financial and other services could stimulate economic life in small and medium-sized towns of the Ural-Volga region.

In general, the two spheres that we have indicated can make the region's SEF more balanced. This process should involve careful strategic and territorial planning as well as active involvement of the local population (see Figure 7). We are convinced that as a result, the region's economy will be less concentrated in the capital city and that more even distribution of income will provide more resources to the struggling peripheral areas.

1. Transport systems and nets of regions, especially their territorial structure, require modernization.

For the economic and socio-demographic development of the country, it is necessary to optimize transport and logistics flows [19]. Optimization of transport and logistics will accelerate innovation processes in regional and national economies. Optimization also implies improved transport connectivity between economic entities inside the region and between different regions, which means cutting transportation costs: temporal, spatial, material, financial and so on [20].

Transport connectivity of economic nodes does not always coincide with the actual flows associated with technological, economic, sales and marketing other connections. On the one hand, the economic framework forms a transport frame and, on the other hand, the transport frame is necessary to form an economic framework. In a certain period of regional development, both of these processes become interconnected and run simultaneously. At later stages, the economic framework can be transformed without taking into account optimization of the transport system, or vice versa, the transport framework can develop or deteriorate, regardless of the economic framework transformation (see Figure 8).

The most obvious way to optimize the economic framework is to adjust the flows to the existing transport infrastructure. The processes of expansion, rectification, reduction, variation (or alternativization) are essential for the development of transport and logistics systems.

Co-development of several frameworks occurs asynchronously due to many factors of both natural (endogenous) and subjective (exogenous) character. If the time and resources are unlimited, all the locations constituting the territorial framework or the economic framework tend to be connected by shortest paths and by several means of transport. In the context of competitive economy and market relations as well as limited opportunities and resources, transport planning is based on a complex hierarchy of priorities and values.

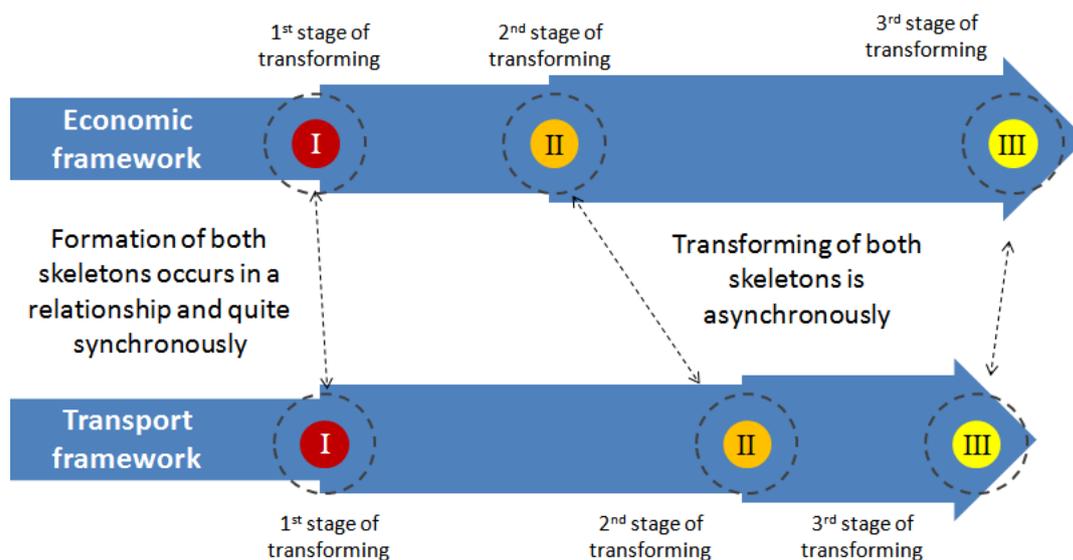


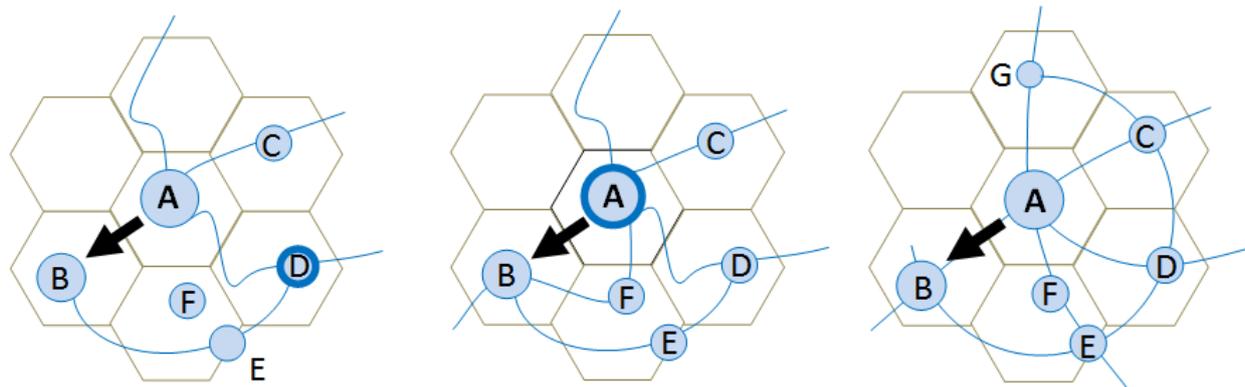
Fig. 8. Formation of transport and economic frameworks

At a certain moment, the transport frame starts expanding extensively, encompassing more and more new locations. Actively interacting locations tend to reduce the time distances between each other, although sometimes it takes some time to achieve this effect. Hydrographic and orographic objects are the most serious obstacles [21]. But if the strength of communication between such locations is great and they manage to maintain stable interaction and the regular flows of goods of sufficient volume, then overcoming the obstacles becomes just a matter of time.

Transport communication between such points gradually improves and the efficiency of transportation increases (see Figure 9).

Another factor that shapes the configuration of land routes is that the network needs to cover as many locations as possible, which creates additional potential for the development of new industries and can be a factor in the transformation of the settlement system. This potential, however, is not always realized.

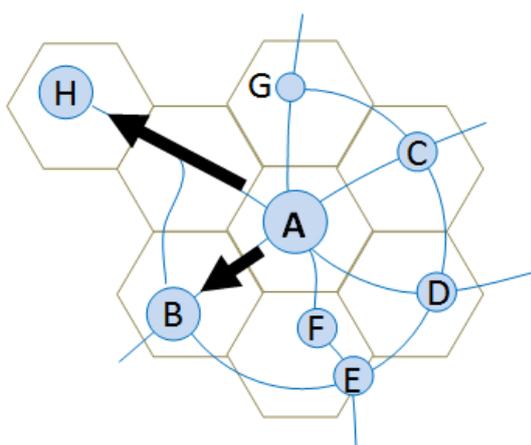
In an ideal situation, with unlimited resources and time, all points will sooner or later be interconnected by shortest routes, thereby significantly reducing the transport and logistics potential of any nodes, formed due to the configuration of the transport network and (or) the availability of transport infrastructure. At the same time, some points in the transport system still have a higher logistics potential [22] due to the possibilities of distribution within the system and between the systems. This potential depends exclusively on the characteristics of settlement systems and their economies. It should be noted that in each type of resettlement there are strengths and weaknesses from the perspective of logistics. In some settlement systems, conditions for intrasystem logistics are more favorable, in others, on the contrary, competitive conditions are formed for intersystem logistics.



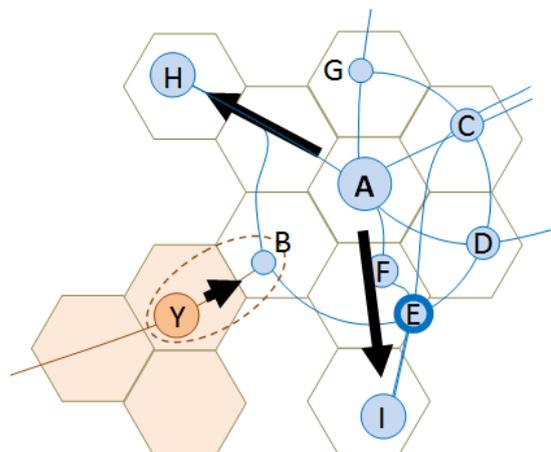
I. Two actively interacting centers (A and B) are connected to each other indirectly

II. All centers are directly connected but with a high degree of curvature

III. All centers are directly connected with a minimum degree of curvature



IV. Although there is a transit flow (between A and B), a new transport and logistics node on the transit route does not evolve



V. A large production center (B) loses its importance in the regional system and is attracted to another regional center (Y) with which it has closer ties. The transformation of the industrial-technological relations (I) leads to transport-logistic restructurization of the system

Fig. 9. Various scenarios of the formation of transport networks and frameworks

A change in the spatial organization of economy and the transformation of production and technological links leads to a change in transport and logistics potentials and creates conditions for development of new nodes with the functions of accumulation and distribution of flows (see Figure 9).

One of the key indicators of the transport framework's effectiveness is the degree of curvature of the real route between the actively interacting nodes within the economic framework. In fact, it reflects the deviation of the real routes between the points in the transport system from the minimum physical distances between them.

The largest integral degree of curvature of the roads in Perm region is observed for Lysva (1.44) and Krasnokamsk (1.41) (Table 4).

The integral index of the curvature of railways reflects the weak connection between railway junctions in the transport system of Perm region, from which Tchaikovsky is virtually excluded (the degree of curvature is 2.59) (Table 5).

Such deviation may be caused by the need to bypass settlements, physical and geographical objects. As a rule, such deviations insignificantly affect the curvature of the route. A significant index of curvature will be indicative of the fact that there is no direct communication between the points. In the case of a high level of socio-economic interaction between the points, the curvature of the communication between them should tend to the minimum. In reality, however, this is not always the case because one of the frameworks ('carcasses') is lagging behind the other in its development.

Table 4.

Degree of curvature of the real car route from the minimal (physical) distance between the ten largest cities of Perm region

	I	II	III	IV	V	VI	VII	VIII	IX	X	Integral
I. Perm	X	1,09	1,09	1,38	1,28	1,73	1,33	1,29	1,17	1,32	1,28
II. Berezniki	1,09	X	1,04	1,30	1,21	1,29	1,36	1,24	1,21	1,21	1,26
III. Solikamsk	1,09	1,04	X	1,30	1,19	1,26	1,34	1,21	1,18	1,20	1,22
IV. Tchaykovsky	1,38	1,30	1,30	X	1,47	1,49	1,24	1,38	1,38	1,23	1,36
V. Kungur	1,28	1,21	1,19	1,47	X	1,38	1,36	1,21	1,29	1,34	1,29
VI. Lysva	1,73	1,29	1,26	1,49	1,38	X	1,65	1,60	1,59	1,36	1,44
VII. Krasnokamsk	1,33	1,36	1,34	1,24	1,36	1,65	X	1,34	1,81	1,50	1,41
VIII. Chusovoy	1,29	1,24	1,21	1,38	1,21	1,60	1,34	X	1,32	1,29	1,30
IX. Dobryanka	1,17	1,21	1,18	1,38	1,29	1,59	1,81	1,32	X	1,28	1,33
X. Chernushka	1,32	1,21	1,20	1,23	1,34	1,36	1,50	1,29	1,28	X	1,29

One of the most striking examples is the lack of direct transport connection between large economic centers Perm and Tchaikovsky. Despite the fact that the nodes actively cooperate in chemical, petrochemical, machine-building, and food production, there is no direct railway communication between them (see Figure 10). Moreover, the automobile routes between them are curved considerably. Physical and geographical characteristics of the territory, features of the settlement system and administrative boundaries are reflected in the 'refraction' of transport routes.

Table 5.

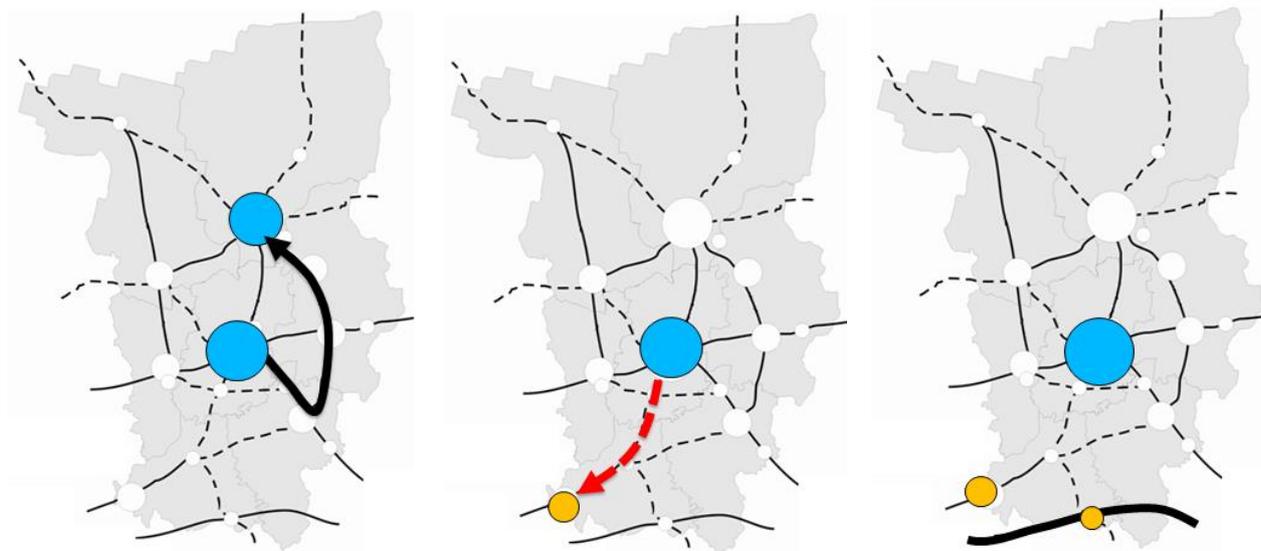
Degree of curvature of the real railway route from the minimal (physical) distance between the main railway nodes of Perm region

	I	II	III	IV	V	VI	Integral
I. Perm	X	1,63	2,72	1,17	1,47	1,46	1,85
II. Berezniki	1,63	X	2,32	1,94	1,63	1,34	1,91
III. Tchaykovsky	2,72	2,32	X	2,68	3,37	2,34	2,59
IV. Vereshagino	1,17	1,94	2,68	X	1,45	1,34	1,83
V. Kungur	1,47	1,63	3,37	1,45	X	2,21	2,16
VI. Chusovoy	1,46	1,34	2,34	1,34	2,21	X	1,86

Another example is that for a long time there was no direct connection (185 km) between the two key economic centers of Perm region – Perm and Berezniki. Up until 1996, the car traffic between these two cities passed through Kungur, Lysva, and Chusovoy, which increased the route to 400 km, that is, the distance was more than doubled (see Figure 10).

Another example is the south of Perm region, where the development of the transport framework did not lead to economic growth. Despite the fact that the bimodal corridor connecting Moscow, Nizhny Novgorod, Kazan and Ekaterinburg passes through these regions, there are no visible positive changes in the

economy of Chernushka, Kuyeda and Oktyabrsky (see Figure 10), which is a consequence of the discrepancy between the transport and economic frameworks.



1. For a long time there was no direct road connection between the main economic nodes in Perm region – Perm and Berezniki. The direct road was built only in 1996.

2. There is no direct railway connection between Perm and Tchaikovsky, despite the fact that these nodes are actively interacting in the chemical industry.

3. Although in the south of Perm region, the transport network is sufficiently developed (there is a multimodal line), there are no significant economic benefits.

Fig. 10. Various examples of asynchronous development of transport and economic frameworks

The discrepancy between the development of the transport and economic frameworks can lead to liquidation of the existing industries that emerged at previous stages and thus cannot cope with the competition on the market. In Perm region, such situation occurred in Krasnovishersky district (liquidation of pulp and paper production) and in Komi-Permian district (dissolution of wood processing and food production enterprises).

An opposite situation occurs when the transport frame is developing while the economic framework is deteriorating. Thus, the bimodal meridional corridor Solikamsk-Chusovoy was not sufficient for building new large production facilities in the area of the former Kizelovsky coal basin.

Another important area of optimization of transport frameworks is alleviating the load on large economic and administrative centers. If these nodes are overloaded, it becomes necessary to create a transport-logistic buffer on their periphery in the form of logistics infrastructure (terminals, centers, complexes). Such transport-logistic buffer will allow to reduce congestion by accumulating and distributing cargo flows in space and time, thus helping the centers to cope with some of their transport problems.

In Perm region, due to its specific transport configuration, a large number of forced transit flows pass through Perm [23]. Therefore, it is necessary to create a logistic buffer for Perm agglomeration along the line of Chusovoy – Kungur – Kukushtan – Yugo-Kamsky – Okhansk (a kind of ‘deep southern bypass’ around Perm).

The above-described list of ways of SEF optimization is by no means exhaustive. All these ways should be considered as instruments of sustainable development, aimed at improving the quality and standards of living in the region.

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