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Innovation clusters in the Russian economy: economic essence, concepts, approaches

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Abstract

The article focuses on the notion of the innovation cluster in the Russian economy, analyzes its specificity within the Russian economic environment, the ways of adaptation of the existing approaches to the Russian economic realities. The article dwells on the role of the innovation cluster development in the process of economic growth of Russia, highlights the positive regional experience in the stated sphere.

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1. Introduction

The innovative modernization of the Russian economy is the priority direction for the new cycle of changes in the Russian economy. The local and regional authorities are considered to be the key actors in the course of achievement of this goal and accordingly they are to reorder the priorities. At the previous stage their major task consisted in creation of the favorable conditions for the development of the entrepreneurship with the purpose of attracting investment into the regional economy. But the conditions are changing and the matter of sustainable development of the region is being placed in the forefront, as well as the question of promotion of the innovative activity that supposed to provide for qualitatively new scale of the production performance growth, the diversification and

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improvement of the structure of the regional economy, the growth of the competitive capacity of the products and services.

The solution of this problem is impossible within the traditional schemes of the territorial and sectorial management of the regional economy, it requires the application of new approaches to the organization of the innovative activity that would be able to implement the existing competitive edge of the regional economy as well as to create new one (Ogolyova, 2007). In the modern circumstances the competitive edge of the regional economy to a great extent is determined by its capability of the rapid generation and implementation of the new technologies (in the field of microelectronics, telecommunication, computers, robotics, biotechnologies etc.).

2. Theory

In the effectuation of the technological breakthrough an important role is assigned to the process of regional integration of the companies and organizations that perform various functions (starting with research works and personnel training up to production processes and the products transportation) and united by the common technological process that results in the high-tech product created by the joint efforts of all the participants of this process. The most expedient form of their integration is the cluster. The nominal occasion for its origination can be a regional program the implementation of which causes the consolidation of the interests of the plant facilities, the governing bodies, the consulting and financial organizations, the educational establishments. In this case the effect will be achieved through the establishing situation on the market of high-tech products while there will occur the competition not between the separate enterprises, but between regional industrial and research-and-production complexes that will ensure the reduction of transaction costs due to the technological and scientific and production cooperation of the companies.

In legal aspect the cluster is treated as an alliance of entrepreneurs whose participants are bound by the strategic cooperation agreements (Bespalov, 2012). In the economic aspect the cluster members take over the liabilities to coordinate their actions in the spheres of finance, marketing, investment etc. Cluster affiliation is of free will. The main motive for integration of the enterprises belonging to different proprietors are supposed to be the final results (profit, improvement of the quality of the products and services etc.) that are provided by the cluster approach to the economic activity management.

The foundations for the cluster approach were given in the works of Marshall and Schumpeter, so that as the historical basis of the cluster approach we can name, the Marshall's "industrial region" with its agglomerations on the one hand, and Schumpeter's innovations that prompt the economic growth within that agglomerations – on the other. Hence, cluster serves to solve two problems: 1) reduction of the transaction costs due to the close location of the integrated firms, 2) transition of innovations from firm to firm that contributes to the increase of productivity in the cluster as a whole.

Nowadays the interest in the cluster approach is in many respects associated with the works of Michael Porter (Porter, 2005) who defines clusters as a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities.

Porter singles out several functions of clusters in the economic development of every country:

- Clusters are the critical engines in the structures of the national and regional economies. The prosperity of the region depends on the significant positions in a certain number of the competitive clusters.
- Clusters may determine the fundamental tasks in the national and regional business activity: clusters to a great extent correspond with the nature of competition and microeconomic factors that influence the competitive advantages.
- Clusters provide a new mode of thought in the sphere of economy and the efforts on its structural development. Hence, cluster forces the interchange of the roles of the private business, the government, the trading associations and educational and research institutions in the context of economic development and impels the specification of the common opportunities, not mere general problems of the firms and companies of various patterns of ownership.

According to the opinion of G.Yasheva (Yasheva, 2007), there are national peculiarities of the cluster policy:

- there is no uniformity in the cluster policy tool kit – it is the same only for the countries-participant of one cluster project;
- there is a diversity in the subject of methodology of the cluster policy management that is determined by the national identity features and the adopted concept of the cluster approach;
- the cluster policies of the countries differ in the extent of the state’s interference in the process of clusterization;
- the methodological basis of the cluster policy formation still remain undeveloped.

While on the subject of the innovation cluster infrastructure it is noteworthy that the originality of new business forms in the sphere of is conditioned by the necessity for combination of the active competition with partnership relations and individual creativity. The new business forms of such interaction are various types of business association and intercompany alliances – starting with short-term agreements to the first-rate financial industrial groups. In the market economy countries with a strong state interference the associations are an important factor in determination of the perspectives for long-term economic development. Such associations often have agreements with trade unions and the state that contributes to their efficiency. The R&D centers within such associations solve the problems of principally new economic development bound with formation of new technological structures.

In the processes of implementation, adaptation and diffusion of industrial innovations a special role pertains to sectorial associations. The Russian sectorial associations also take an important part in development of the high tech productions, instrument-making, engineering etc.

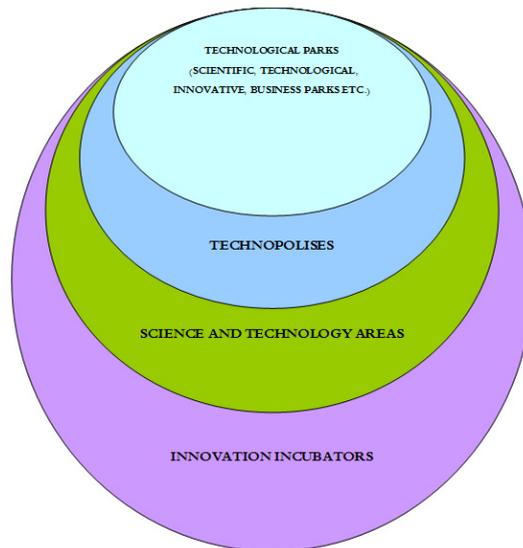


Fig. 1. The structure of the innovation center.

A significant role in activation of the scientific stage of the innovation cycle is played by the research associations that include department of fundamental problem-disclosing research work and the development, analytical and economic groups as well. The research associations are consigned to maintain the close interaction between the academic and educational sector and the industrial production. The close intertwining of cooperation and competition in the last decades evidenced in the establishment of intercompany collaboration within the strategic alliance and coalitions.

The determinant factor in development and further implementation of the scientific concept is a new type of business structures – innovation centers, i.e. technologically active complexes with integrated structure of innovations, they comprise universities and scientific and production firms. In this model the innovation

business provides for the stable interconnection within the comprehensive innovation structure, it has developed network of information exchange and channels for innovation distribution.

Technopark is a whole of centers, each of which supplies a certain set of innovative services. Technopolis is a whole of technoparks, incubators and a complex of various structures that sustain the vitality of the city. Science and technology areas may contain technopolises, technoparks and incubators as well as a divaricated infrastructure that ensure the scientific and production activities. Technopolises fulfill a forming function while influencing the development of regions where they are located and provide for the increase of innovative activity, the innovation infrastructure formation, the commercial novelties promotion, the structural reorganization of production process, contributes to the creation of new jobs, the improvement of the mechanisms of innovation activity, the institutionalization of the innovation sphere, the reinforcement sci-tech development of the industry, the betterment of the state innovation policy, the growth of the innovative capacity of the economy.

The significance of the innovation infrastructure that facilitates the incorporation of the science into the market environment, promotes the business development in the field of science and technology and the increase of the economic efficiency of the novelties is in particular prominent if traced on the example of innovation centers, technoparks and technopolises (see Fig.1). The success probability of the innovation rises sharply due to the formation of the specific institutions, organizations and the innovation process supporting systems, all merged into one innovation environment.

The key role in the innovation sphere is played by the innovation infrastructure that represents the organizational, material, informational, financial and investment base for creation of the conditions appropriate for the effective distribution of funds and rendering services for encouragement of the innovative activity (Ogolyova et al., 2007).

We can be single out the following categories of the innovation clusters typical of Russia:

- naukograds (“science cities”);
- technology development special economic zone (SEZ);
- closed administrative-territorial formations (“closed cities”) founded for the purposes of nuclear industry plants.

In nowadays Russia there are 10 naukograds located in immediate proximity to Moscow, Saint Petersburg an Yekaterinburg (in other words they situated nearly in the megalopolises); Dubna can be treated as an innovation enclave close to Moscow.

As for the beginning of 2009 in Russia there are 4 technology development special economic zones: Zelenograd (Moscow), Saint Petersburg, Tomsk, Dubna. Three of them belong to megalopolises and one (Dubna) – gravitating toward the megalopolis. Hence, in Russia there are areas that can be referred as the innovation cluster.

The condition of the innovation infrastructure is closely related to the model of the economic growth and the degree of the technological development of the national economy. At present time in the world economy the Russian Federation performs the role of the raw materials exporter (see Fig.2) and the importer of the consumer and the investment goods and services. This – resource-based – economic model is incapable of ensuring the satisfactory rate of the people’s welfare on the one hand, and the macroeconomic stability, the international competitiveness of our domestic companies and enterprises and national safety – on the other. Now this thesis is the commonplace not only in the scientific, but in the official documents as well, so that this is a case for the establishment of the non-resource economy in Russia. We will dwell on some possible variants of this sought alternation (conventionally they can be attributed as “diversification” or “high-technology”) and the opportunities for their implementation with taking into account the internal and external terms the national economy exists within. In other words, it is the question of necessity of implementation of the innovation technologies in the state economy.

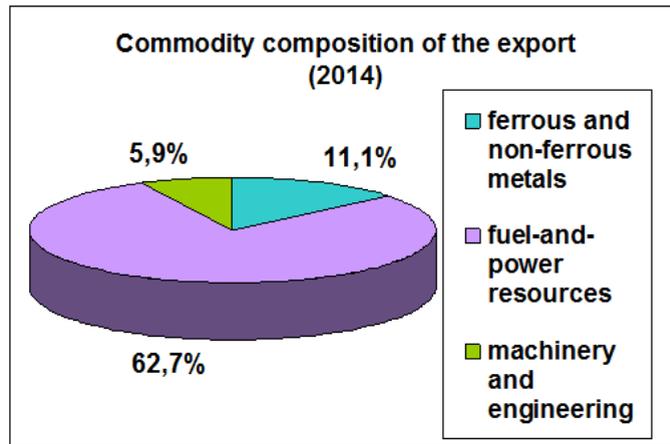


Fig.2. Composition of the Russian export.

According to G.Fetisov's opinion the sizeable (exceeding the world average level) volumes of mineral extraction or raw material production per capita (even those hydrocarbons or, for a example, unprocessed products of agriculture, fishery and forestry) cannot be considered the salient feature of the resource-based economy. Hence, if in 2004 in the countries-members of OECD (Organisation for Economic Co-operation and Development) the world average index of oil and gas extraction per capite was exceeded (0.75 tons and 750 m3 against 0.56 tons and 440 m3), then in the USA the excess was greater (0.91 ton and 1880 m3). The required characteristic may probably be the high rate of the value added produced during the extraction.

According to G.Fetisov, the share of the primary goods in the total export of the country serves as the most "representative" indicator of the resource-based character of the national economy. As far as it is the natural raw materials that are mainly exported it becomes obvious that the economy of this country is incapable of competing with the foreign economies in the sphere of the consumer and the investment products and services. Unfortunately, in recent years the resource-orientation of Russia within the world economy has been growing steadily. Thus, the export of hydrocarbons increased from 28 bln. USD in 1998 to 191 bln. USD , i.e. in 6,83 times (adjusted for the dollar devaluation in 5,5 times); while the ratio of the export to GDP, that I the matter in hand, increased from 10,0 to 19,3%.

The corresponding afflux of "petrodollars" in the post-default period caused the growth of GDP and made possible the salvation of some internal and external social and economic problems. Even in general it is clear that receipt of the natural rent for the export of raw material by the country profuse in the mineral deposits is considered to be a favorable factor for the economic development. But the resource-based model has a number of negative characteristics. It is noteworthy that it excludes the possibility of rapid scientific and technological advance that provides for nowadays economic growth and depends on the new types of products and production technologies. In the primary sector the range of goods is invariable and the advanced technologies are to be imported due to the lack of proper progress in the marketing sector. The exporting countries that receive the natural rent has to pay "intellectual rent" to the world's technology leaders.

3. Results

For the purpose of the adequate estimation of the innovation cluster development in the developed and the developing countries it is worth to introduce a system of indicators defining the threshold values of the innovation cluster functioning process. It becomes possible by means of a set of approaches and principles of innovation cluster formation and development.

3.1. Modeling of the Innovation Indicators

The indicators of innovative development introduced in the model of the state's welfare in accordance with the methodology (Ayvazian, 2003) are to be the modified first major components (FMC) of the unified data integrating the two units of specific criteria:

The unit of development and application of the modern technologies (INK), which includes:

- technological cooperation
- development and application of the technology
- basic research
- the knowledge exchange between the business and universities

The unit of the human resources development (INL), which includes the following positions:

- education system
- economic literacy
- qualified engineers
- skills of using the information technologies

The first principal components were calculated for each of the three clusters (cluster of relatively more developed countries, cluster of relatively less developed countries (including Russia), and cluster of so called “the Four Asian Tigers”) by the following units:

a) the application of the modern technology and its further development;

b) the development of the human resources.

The results are given in the table ____.

Table 1. The quotas of the explained variance for the three clusters.

	Cluster 1		Cluster 2		Cluster 3	
	INK	INL	INK	INL	INK	INL
2004	0.605	0.526	0.559	0.755	0.964	0.645
2005	0.717	0.529	0.634	0.834	0.989	0.659
2006	0.619	0.542	0.660	0.840	0.964	0.663
2007	0.655	0.502	0.663	0.883	0.975	0.768
2008	0.805	0.695	0.700	0.607	0.838	0.842
2009	0.768	0.724	0.711	0.479	0.872	0.595
2010	0.749	0.725	0.665	0.468	0.879	0.673
2011	0.715	0.673	0.557	0.547	0.862	0.798
2012	0.706	0.707	0.614	0.545	0.627	0.626
2013	0.781	0.684	0.693	0.642	0.886	0.884
2014	0.652	0.584	0.742	0.549	0.780	0.845

The quota of the explained first principal component (FPC) of the total variance of the first cluster of countries for each innovation indicator for the whole time interval does not fall below 0.5. In the cluster of developing countries in the respect of the unit of innovation in the sphere of technology the situation is similar, however, in the respect of the unit of the developed human resources in 2009-2010 the explained variance turned to be slightly lower than 0.5. At last for the cluster of the Asian countries the first principal component of the innovation technology unit in certain degree justifies the total variance (upto 0.9 in some years). For the second unit of innovations (HR) the quota of the FPC of the explained variance varies from 0.62 to 0.88.

3.2. Description of the model

The analysis was performed by means of the translog-function. The main advantages of the equations of this type are the possibility of the interpretation of the coefficients in the equations as the indices of the elasticity of the dependent variable according to the explaining factors, and also the bigger, as compared to other functions, flexibility in determining the influence of the factors on the dependent variable. Let's consider the equation of the following type:

$$\begin{aligned} \ln(GDP/N)_{it} = & a_0(t) + a_1(t)\ln(K/N)_{it} + a_2(t)\ln(l/L)_{it} + a_3(t)\ln(INK)_{it} + a_4(t)\ln(INL)_{it} + \\ & + a_5(t)\ln(INK)_{it} \cdot \ln(K/N)_{it} + a_6(t)\ln(INL)_{it} \cdot \ln(l/L)_{it} + a_7(t)\ln(INK)_{it} \cdot \ln(l/L)_{it} + \\ & + a_8(t)\ln(INL)_{it} \cdot \ln(K/N)_{it} + \varepsilon_{it}, \end{aligned} \quad (1)$$

where at each time $t = 2004, 2005, \dots, 2014$ estimated the model of the *cross-section* type (Greene, 2002); $\ln(GDP/N)_{it}$ – logarithm of GDP PPP per capita for the country i in year t ; $\ln(l/L)_{it}$ – logarithm of the share of the employed in the total labour force for the country i in year t (the parameter l/L is used for the purpose of standardization of the factor: l – number of the employed, L – quantity of the labor force); $\ln(INK)_{it}$ – logarithm of the FPC of the innovation unit of the technology development and application for the country i in year t ; $\ln(INL)_{it}$ – logarithm of the FPC of the innovation unit of the labour development for the country i in year t ; $\ln(INK)_{it} \cdot \ln(K/N)_{it}$ – direct (immediate) innovation effect of the technology (of the technology on the capital) for the country i in year t ; $\ln(INL)_{it} \cdot \ln(l/L)_{it}$ – cross innovation effect of the labour (of the innovation in the sphere of the human resources on the capital) for the country i in year t ; ε_{it} – errors of the model under assessment in the year t (for the country i); $a_0(t), a_1(t), a_2(t), a_3(t), a_4(t), a_5(t), a_6(t), a_7(t), a_8(t)$ – coefficients of the model for the variables (the unknown parameters).

3.3. The implementation of the model

Further there are the results of the econometric analysis of the model in the aspect of the influence of the innovation on the level of the state well-being for all the three clusters. The assessment is performed with the method of least squares for each cluster of the countries for each year separately.

3.3.1. The cluster of the developed countries

By assessing the model of type (1) in accordance with the data of the cluster of the developed countries we come to the model of the following type:

$$\ln(GDP/N)_{it} = \hat{a}_1(t)\ln(K/N)_{it} + \hat{a}_2(t)\ln(INL)_{it} \cdot \ln(l/L)_{it} + \hat{a}_3(t)\ln(INL)_{it} \cdot \ln(K/N)_{it} + e_{it}. \quad (2)$$

In particular, for the last assessed year, i.e. for $t = 2014$, the model takes the form as follows:

$$\begin{aligned} \ln(GDP/N)_i = & 1.209 \cdot \ln(K/N)_i + 0.851 \cdot \ln(INL)_i \cdot \ln(l/L)_i - 0.454 \cdot \ln(INL)_i \cdot \ln(K/N)_i + e_i, \\ & (i = 1, 2, \dots, 22). \end{aligned} \quad (2')$$

The assessment results for all $t = 2004, 2005, \dots, 2014$ are given in the table 2.

Table 2. The estimated model coefficients of the cluster of the developed countries.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
$\ln(K/N)$	1.071	1.106	1.046	1.127	1.227	1.261	1.201	1.228	1.277	1.235	1.209
$\ln(INL) \cdot \ln(L)$	1.172	1.205	0.979	1.039	0.971	0.835	0.824	0.828	0.826	0.823	0.851
$\ln(INL) \cdot \ln(K/N)$	-0.561	-0.595	-0.446	-0.515	-0.531	-0.473	-0.437	-0.454	-0.478	-0.452	-0.454

The quality of the model can be estimated through the paired coefficient of correlation between the real values $\ln(GDP/N)$ and its calculated value (the use of R^2 in the absence of the constant is incorrect). For the majority of the time cycles the paired coefficient of correlation exceeds 0.5.

Fig. 3 illustrates the dynamics of the estimations of the factor model parameters for the cluster of the developed countries.

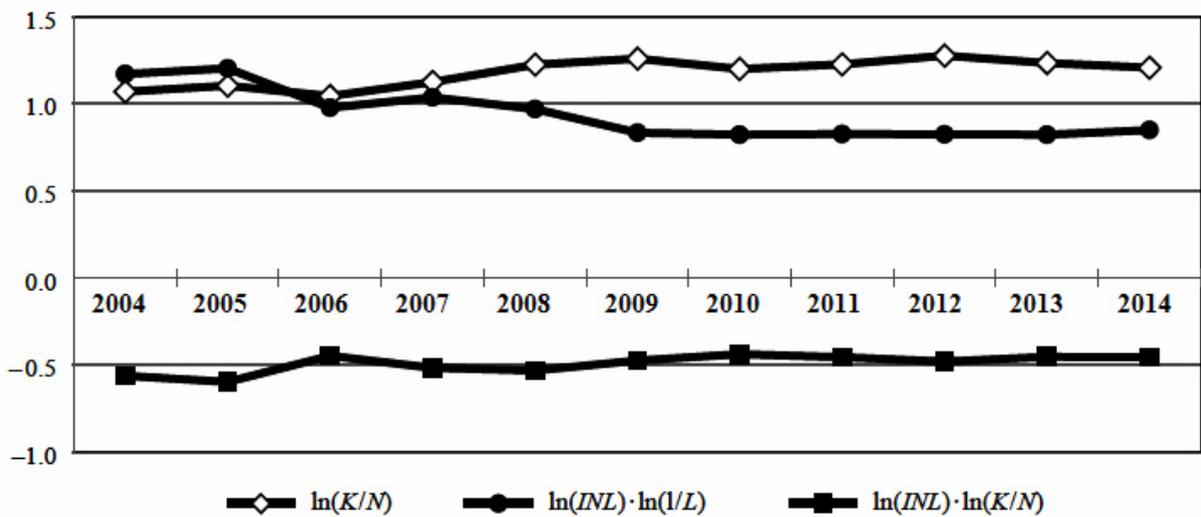


Fig. 3 Dynamics of the estimations of the factor model parameters for the cluster of the developed countries (x-axis indicates the time interval (in years), y-axis – the coefficient values).

Over the entire time interval the value of the estimated coefficient with variable $\ln(K/N)$ is significantly positive value and varies from 1.046 to 1.261.

The value of the estimated parameter $\hat{\alpha}_2(t)$ with variable of the immediate coefficient of the innovation on the product of the labour and the share of the employment $\ln(INL)_t \cdot \ln(L)_t$ fluctuates during the years in the range from 0.823 to 1.2058 and is significant too.

The coefficient $\hat{\alpha}_3(t)$ under the cross effect of the labour innovation on the gross investment into the fixed capital $\ln(INL)_t \cdot \ln(K/N)_t$ takes negative values varying from -0.595 to -0.437. Along with multicollinearity one of the possible explanations for the negative value of this coefficient can be the retardation of the results of the implemented innovation in the sphere of labour. Namely, as a rule, the improvement of the quality of the state's labour force occurs in certain time interval after the innovation undertakings. The retarded character of the innovation results in the sphere of the labour is usually related to the period of study in various educational establishments.

The comprehensive analysis of the dynamics of the parameter assessment of the model indicates the changes in the coefficient values undergone in 2007-2008. The results of Chow test, that rejects the null hypothesis because the P-value turned to amount 0.023, revealed some structural shifts in the model. In other words, the time interval 2004-

2014 can be divided conditionally in two time periods, the pooled-model built within each of them more precisely describes the behaviour of the dependent variable. At various time intervals the models (2) do not change in their general form, however, there are changes in the quality of the models and the coefficient values: the second time interval illustrates the influence of the gross investment per capita and simultaneously shows the loosening dependence of the GDP from the direct and the cross effects of the innovation in the sphere of labour.

3.3.1. Cluster of the developing countries

The structure of the dependence of the GDP from the existing factors is of the same type (2).

Table 2. The estimated model coefficients of the cluster of the developing countries.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
$\ln(K/N)$	1.361	1.365	1.389	1.381	1.299	1.337	1.357	1.359	1.328	1.299	1.318
$\ln(INL) \cdot \ln(L)$	0.494	0.614	0.625	0.592	0.637	0.673	0.631	0.599	0.574	0.503	0.489
$\ln(INL) \cdot \ln(K/N)$	-0.366	-0.441	-0.451	-0.422	-0.394	-0.438	-0.429	-0.416	-0.387	-0.329	-0.338

Table 2 illustrates the values of the estimated coefficients of the model for all the time intervals, in particular with $t = 2014$ the model takes the following form:

$$\ln(GDP/N)_i = 1.318 \cdot \ln(K/N)_i + 0.489 \cdot \ln(INL)_i \cdot \ln(I/L)_i - 0.338 \cdot \ln(INL)_i \cdot \ln(K/N)_i + e_i, \quad (i = 23, 24, \dots, 45). \tag{3}$$

The quality of the model can be estimated through the paired coefficient of correlation between the real values $\ln(GDP/N)$ and its calculated value (the use of R^2 in the absence of the constant is incorrect). For the whole time interval the paired coefficient of correlation exceeds 0.9, and this fact testifies that the model (3) pictures the behaviour of the GDP appreciably more precisely as compared to the model (2), which belongs to the cluster of the developing countries.

Fig. 4 graphically depicts the dynamics of the coefficient values at given factors of the model (for the developing countries).

It's noteworthy that for the whole estimated time interval the coefficient value at given variable that is responsible for the volume of the gross investment into the fixed capital $\ln(K/N)_i$, is a positive value and varies from 1.318 to 1.389.

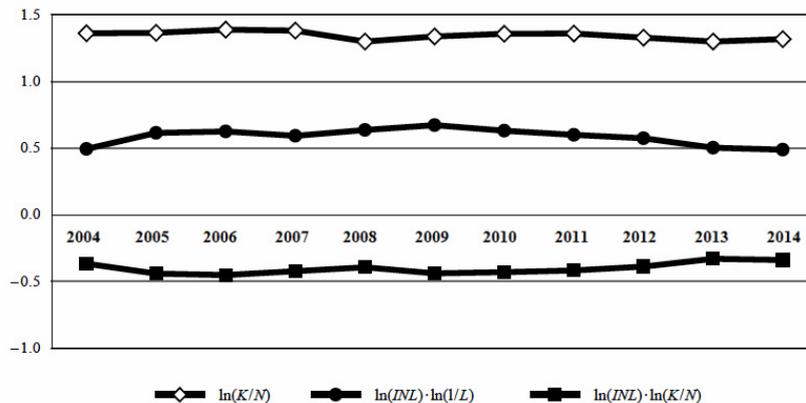


Fig. 4 Dynamics of the estimations of the factor model parameters for the cluster of the developing countries (x-axis indicates the time interval (in years), y-axis – the coefficient values).

The coefficient $\hat{\alpha}_2(t)$ at a given variable of the direct innovation effect of the labour acquires a range of values from 0.489 to 0.637 for different years.

And finally, the coefficient in case of the cross effect of the labour innovation on the gross investment into the fixed capital – $\ln(INL)_t \cdot \ln(K/N)_t$, similar to the first group of the countries, acquires negative values varying from -0.441 to -0.329. Similar to the previous group of the countries, alongside with multicollinearity, the justification is the retarded character of the innovation results in the sphere of labour.

All the parameter estimations are significant at 0.1% level.

Similar to the previous case, the analysis of the dynamics of the coefficient estimation values took place. Chow test with P -value equal to 0.311 does not reject the hypothesis that the integrated model (i.e. built on the basis of the data of the total time period under consideration) is the best one among all the models reckoning the structural shift in 2011-2012. The assessment result of this model on the basis of the panel data for the cluster of the developing countries has the following form:

$$\ln(GDP/N)_{it} = 1.343 \cdot \ln(K/N)_{it} + 0.609 \cdot \ln(INL)_{it} \cdot \ln(I/L)_{it} - 0.414 \cdot \ln(INL)_{it} \cdot \ln(K/N)_{it} + e_{it},$$

(3')

$(i = 23, 24, \dots, 45; t = 2004, \dots, 2014)$

The possibility of integrating the models of the GDP per capita for all 23 countries of the cluster indirectly confirms the analogous growth paths of the GDP, and also the analogous key factors determining the GDP dynamics of these countries.

4. Conclusion

Consequently, it is evident that Russia is at the risk of being reduced to the raw materials appendage for the Occident and Pacific Rim, first and foremost – China. The stated shortcomings of the resource-based development model of the Russian economy should be eliminated within the presumptive “non-resource” model. In 2013 Ministry of Economic Development of the Russian Federation suggested and the federal government approved the diversification alternative for the resource-based economy. This novelty was in some measure used in the course of work on the federal medium-term program of social and economic development of Russia and in formulation of the concept of the long-term social and economic development of the country (till 2030) within which the aspect of innovative development was put in the forefront.

In this respect the reinforcement of the interdependency between the science and technique, economic and social spheres, that would provide for the conversion of the new knowledge into competitive products and services, and into non-market assets as well, is obviously of great current. In other words there is a strong need for the innovation clusters in this stage of the economic development of the country.

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