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DIFFUSION OF INNOVATIONS, KNOWLEDGE SPILLOVERS AND ECONOMIC GROWTH OF THE REGIONS OF KAZAKHSTAN

Abstract. Kazakhstan is a country with a large territory and uneven economic development of regions. The task of transition from a raw orientation of economics to industrial development implies the increase of innovative activity that leads to acceleration of growth. The knowledge spillover between the regions of the country can play an essential role. Taking into consideration the main foreign theories of innovations' diffusion of E. Rogers and the theory of the knowledge spillover of Marshall-Arrow-Romer, L. Anselin, the model of the endogenous growth of J. Grossman and E. Helpman, using the originality of the model of Ph. Aghion and P. Howitt about the knowledge spillover, we explored how the economic growth of territories is associated with innovations. Using panel data on innovative indicators of the regions of Kazakhstan for 2005-2015 the regression models with fixed effects were estimated. Conclusions are made about the ability of the knowledge spillovers to reduce inequality in innovation activity among the regions – innovative leaders and regions lagging behind in innovations. The calculations showed that the knowledge spillover leads to the spread of knowledge to neighboring regions, and from them to neighboring ones, forming so-called "centers of innovation". Alignment in the level of innovative activity leads to an equalization of the rates of economic growth of the regions.

Key words: diffusion of innovations, knowledge spillovers, region, social filter, spatial econometric analysis.

Introduction

A small number of the works representing its evaluations for the most diverse countries of the world is devoted to characterization of interrelation between knowledge spillovers and economic development[1]. The conceptual framework for those works consists in the theory of innovations' diffusion and knowledge spillovers. As per standard presentation thereof, it assumes that the knowledge spillover is available for all firms and researchers, and anyone can use these results to create another improved technology. Location of the regions within the space affects economic activity of the agents.

There is relatively small flow of the international comparable researches, which show that speed and directions of innovations' diffusion depend on a distance from a centre of origin of an innovation and internal characteristics of a region, in particular, its innovative potential[2]. With respect to the knowledge spillovers, there is inverse relation between intensity of the spillovers and exchange of knowledge and

[1] As an example see the works of Aghion P., Howitt P. (1994); Anselin L. (1988); Crescenzi R., Rodriguez-Pose A., Stoper M. (2007); Fagerberg J., Schrolec M. (2008); Jaffe A. B. (1986); Audretsch D. B., Feldman M.P. (1996).

[2] See detailed review of the influence of the knowledge spillover and the results of the R&D on economic growth in the works of Acs Z., Varga A. (2002), Uzawa H., Marrocu E., Paci R., Usai S.(2013), Kaneva, M.A., Untura, G.A.(2014, 2016), V. Baburin., S. Zemtsov, (2013).

distances, since an opportunity of direct relation and spillovers of unobvious knowledge decreases at a distance.

Taking into consideration in our work the main foreign theories of innovations' diffusion of E. Rogers [1] and the theory of the knowledge spillover of Marshall-Arrow-Romer [2], L. Anselin [3], the endogenous growth model [4], using the originality of the model of Ph. Aghion and P. Howitt [5], which introduces the hypothesis of the knowledge spillover, we explored how the economic growth of the areas is associated with innovations.

The task of the transition from the raw orientation of the economy to the industrial development lies in enhancing innovative activity. The spillover of knowledge between the regions – as a condition of economic growth of Kazakhstan – can play an active role in this.

As V.L. Baburin notes: creative regions[3] of the former USSR included in the order of priority: Moscow, Kiev, Minsk, Leningrad, and Kharkov, Tomsk, Moscow regions, Alma-Ata. Acceptor region[4] included the regions of intensive agricultural reclamation (West Kazakhstan), as well as the regions closely adjacent to the creative centres: Leningrad, Minsk, Kiev, Alma-Ata regions [6].

V.L. Baburin concluded that all of this could evidence of existence of active knowledge spillovers in the former USSR between the regions [6]. The knowledge spillovers affected growth rates of the regions.

Since the USSR dissolution Kazakhstan became an independent state. Kazakhstan is a country with relatively large territory and unbalanced development of the regions. The population size increases, i.e. the number of potential users of innovations grows. In the 2000th the material welfare of the most of the citizens improved in Kazakhstan that resulted in gradual growth of consumer capacity.

All of this makes to search the ways to strengthen competitiveness of the country, including by creating and borrowing new technologies, new production methods, etc.

The purpose of the article is to evaluate the role of the knowledge spillovers materialized in the form of research and development (hereinafter – the R&D) and technologic innovations on the economic development of Kazakhstan regions.

Methodological framework for measuring efficiency of innovations' diffusion and knowledge spillovers. Innovations' diffusion means a process by which the ideas, objects, technologies being new for the society are interchanged through communication channels between the members of the social system. The knowledge spillovers mean interchange of ideas between the individuals, which is materialized through costs for the R&D and technologic innovations.

The first ideas of spatial innovations' diffusion and knowledge spillovers sprang out in the scientific researches within the context of anthropology and rural sociology [1], economics [7], marketing [8], and in the work of Z. Griliches [9] in which distribution of hybrid wheat seeds were studied within the limits of local cenosis in the USA.

As T. Hagerstrand showed in his works, the spatial innovations overspread by law of innovations' diffusion [10], but the speed and directions of the innovations' diffusion depend on a distance from a centre of origin of an innovation and internal characteristics of a region, in particular its innovative potential [11].

The theory of innovation's diffusion and knowledge spillovers states that the knowledge can cross the administrative limits and stimulate technologic changes both in a region and on neighbouring[5] areas [12].

In other words, a distance (geographic proximity) and potential of both obvious and unobvious knowledge to overspread are correlated. An ability to absorb knowledge from the parties of interchange (whether individuals, companies or regions) dies out in inverse proportion to a distance between the parties, efficiency of the knowledge spillover depends on absorption capacity of the regions [13].

The foreign researches evidence that a speed of diffusion depends on "throughout capacity" of transmission channels – respective infrastructure and institutions. The high level of openness of the society is required [14].

[3] Creative regions mean the regions implementing acquired skills.
[4] Acceptor regions mean the regions implementing personal enrichment and competence enhancement.
[5] Regions – as a rule, the neighbors are much interconnected between each other than those located at a considerable distance.

The geographic proximity (geographic coincidence index) lead to greater positive influence of knowledge on innovations in neighbouring and immediate regions. The theoretic concept of the knowledge spillovers suggest that the regions[6] located near to the other regions with high costs for the R&D and technologic innovations will grow faster than the regions near which there are not any regions, which are intense in R&D [15].

The literature noted that the processes of innovations' diffusion significantly accelerated with expansion of the Internet, social media, wireless devices, various products, services, and institutions, etc. [16-18].

Starting from the 2000th, the level of human capital assets determining the level of the fund of knowledge was considered as one more significant factor [19-22]. A set of the factors also included the knowledge spillovers subject to distance matrix W. So, for instance, Charlot et al. [21] determine the regional production function of knowledge measuring the fund of knowledge in a region as follows:

$$K_{r,t}=f\,(RD_{r,t},\ HK_{r,t},\ WRD_{r,t},\ WHK_{r,t},U_{r,t}) \qquad (1)$$

where r means region, t means year, RD means costs for R&D as % of the GRP of a region; *HK* means human capital assets calculated as % of people having higher education in a region; *WRD and WHK* mean variables representing the spillovers of R&D and human capital assets, *U* means a set of unobservable factors affecting the fund of knowledge, and *f* means Cobb-Douglas function.

The results of the similar researches in the USA and Russia are respectively presented in the works of [23-24]. On the basis of the previous researches, the following hypotheses are made and tested in this work:

1. There is positive interrelation between the knowledge spillovers and the GRP growth rates per capita in Kazakhstan.
2. The regions located near the other regions with high costs for the R&D will grow faster than the regions near which there are not any regions, which are intense in R&D.

Data. The authors used statistics on innovative activity over the period from 1990 to 2017. The sources of information were the books "Regions of Kazakhstan"[7] published by the RK Statistics Agency [25].

In the context of proposed model, the authors composed a data base considering a set of indicators determining social and economic peculiarities of a region such as a rate of unemployment, persons involved in R&D, the share of population employed in the agriculture, the share of population at the age under 28 years old and the share of people employed in the industry of the regions in 2005-2015.

The GRP growth rates per capita are used in this research as indicators of "consequence" of innovative development and an indicator of economic growth. So, the authors assume that the innovations eventually must further increase in a level of social and economic development. The model includes indicators measuring growth of the gross regional product of the regions of Kazakhstan.

The used methods are similar to the methods of the other works devoted to a posteriori estimate of the model of innovation diffusion. Our goal is firstly to understand what are the reasons for relation between economic growth of the areas and innovations. First, using the example of Kazakhstan to empirically verify existence/absence of the knowledge spillovers.

Materials and Methods

The model of the knowledge spillover, which is a way to determine efficiency of the knowledge spillovers on regional growth widely used at the present, was proposed by Jaffe [26].

The statement of the basic model of this research corresponds to the traditional models of catch-up endogenous growth (catch-up growth models) [27].

The authors' work originality consists in selection of the factors of innovative development, formulation of hypotheses concerning their influence on economic growth, generation of a social filter subject to specific nature of the regions of the Republic of Kazakhstan.

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[6] Independent geographic agents

[7] http://stat.gov.kz/faces/wcnav_externalId/publicationsCompilations?lang=ru&_afrLoop=726311086825700#%40%3F_afrLoop%3D726311086825700%26lang%3Dru%26_adf.ctrl-state%3Dnz77pit99_96

The model is based on estimation of the equation as follows:

$$growth_{i,t} = \alpha + \beta_1 log(y_{i,t-1}) + \beta_2 R\&D_{i,t} + \beta_3 SocFilter_{i,t} + \beta_4 Spill_{i,t} + + \beta_5 ExtSocFilter_{i,t} + \beta_6 ExtGDPpc_{i,t} + \varepsilon_{i,t} \quad (2)$$

where $growth_{it}$ means the gross regional product growth rate per capita (%);

i means an index of a region;

t means a time period;

$log(y_{i,t})$[8] means base logarithm of the GRP per capita. Logarithmic transformation allows evaluating percentage changes in regression coefficients with treating the coefficients as elasticity;

$R\&D_{i,t}$ means costs for R&D as % of the GRP;

$Socfilter_{i,t-1}$ means an index of social and economic conditions in each region;

$Spill_{i,t}$ means *spillover* of the share of costs for R&D and costs for technologic innovations in the GRP between the RK regions;

$ExtSocfilter_{i,t}$ means influence of social and economic conditions of all other regions on that region or "spillover of social and economic conditions". The formula to calculate the variable *ExtSocFilter* is similar to the formula to calculate the variable *Spill*, but the variable *SocFilter* is used instead of costs for R&D as the GRP percentage.

$ExtGDPpc_{i,t}$ means impact of the GRP in the neighbouring regions on economic growth of that region or "spillover of the GRP per capita"; this variable measures impact of economic growth in other regions on economic growth in a region concerned. The formula for *Spill* variable is used again, but the variable "costs for R&D as percentage of the GRP" is replaced with the variable "GRP per capita".

$\varepsilon_{i,t}$ means accidental error of the model.

Here we should make two important notes. First: the econometric model of impact of innovative indicators on economic growth in a region separately considers the indicator of the knowledge spillover on the basis of the matrix of spillovers of costs for R&D and costs for technologic innovations. We propose a model (1) to account for the knowledge spillovers in a form of R&D or technologic innovations and spillovers of social and economic activity and overall welfare.

The second note relates to the definition of the "Social filter". This is a direct analogy of the effects of impact of social and economic conditions in a region on the other regions. The social filter shall mean a set of factors relating to a level of development of human capital assets and demographic structure of a region. It is assumed that unemployment in one region may attract labour power from neighbouring region furthering thereby economic development in the first region. Similarly, the high percentage of population with high education can, in the event of migration of that population to the neighbouring areas, result in economic growth of the area through output of a new product.

In 1999 Rodríguez-Pose [28] stated first the importance of the social filter when evaluating innovative activity in a region. The author stated that an area characterized with a great share of youth, population with higher education and employment in highly technologic branches has higher innovative potential. Innovations in such regions can more increase the GRP as compared to the other regions.

The positive effect of the social filter was confirmed by calculations based on regressive model connecting a rate of growth of the GRP per capita and innovative activity of the regions in the works of [29-30].

The factor analysis was carried out in the principal components method. The mathematical treatment of the findings was carried out using STATA Statistics package. Primary observations, statistical significance estimation and factor analysis were used.

On the basis of the principal components selected by variable estimator the index "Social filter" was calculated. To reduce number of variables the procedures of the factor analysis were used: construction of mutual correlation matrices and selection of high-correlated and uncorrelated indicators; checking data distribution uniformity. The factor analysis allowed not only detecting related indices, but also following

[8] Introduction of the lagged variables always aggravates the problems about self-correlation both in LSM and in the fixed-effect model. Therefore, the dynamic model must be further evaluated using any variant of the Arellano-Bond estimator.

up their combination in the same regions that determines the social and economic conditions of a region. Similarly, using the data of costs for technologic innovations and costs for R&D the index of the knowledge "spillover" was calculated. The factors explain 60.5% of variance.

When making decision on a number of the factors, the results of the indicator of factorization completeness allowing judging about "quality of adjustment" by estimating differences of basic and calculated correlation coefficients based on χ^2-criterion were taken into consideration. After having identified the factor structure using multiple regression equations, the factor scoring of detected variables was calculated. In addition, importance of the Bartlett's test of sphericity is within the range of 0-0.05, i.e. application of the factor analysis is adequate.

Table 1 - Factor analysis of the indicators of innovative activity: explained total variance

Variables – factor conventional denomination	Initial eigen values	Difference	Share, % of variance	Cumulative
Rate of unemployment in a region,%	1.72082	0.41661	34,42	0.3442
People involved in R&D (% of the total employed)	1.30420	0.37660	26,08	0.6050
Share of employed population in a region at the age under 28 years old, %	0.92760	0.08606	18,55	0.7905
Share of population employed in industry of a region, of the total employed population, %	0.84154	0.63570	16,83	0.9588
Share of population employed in agriculture of a region, of the total employed population, %	0.0	0.20584	4,12	1.0000

Source: compiled by the authors

One factor combines highly correlating variables. Each factor explains specific percentage of cumulative data variance, as well as it relates to each of variables by loads. The first component matches the largest share of variance; each following one matches the lesser share. The principal components are selected by applying the Kaiser measure based on detection of eigen value of each of the components. To detect the components the share of explained variance is essential. When applying the Kaiser measures, it is required to take as principal components (factors) only those ones the eigen value of which exceeds 1.

To estimate reliability of calculation of the elements of correlation matrix, to determine sampling adequacy and opportunity to describe the same using the factor analysis the Kaiser-Meyer-Olkin (KMO) test was used. The value of the KMO test was equal to 0.2767 and the significance level matching it – 0.000 that evidences that the data is acceptable to carry out the factor analysis. The high level of reliability of the Bartlett's test (0.000) allows considering the results of the factor analysis as adequate and significant.

Table 2 represents the ultimate set of parameters of the social filter detected using the principal component method (varimax input data). Variable rotation is required to explain by resulted components of the maximal share of variance and maximal correlation between variables in the factors.

As a result of deletion of those variables, which, having high factor weight, were included into the factors identified using that variable only, as well as deletion of non-unique variables, i.e. variables with approximately equal factor loads for two and more factors, the factor structure composed of two variables (see table 2) was derived.

Table 2 - Factor loads (pattern matrix) and unique deviates

Variables	Factor 1	Factor 2	Unique deviates
Rate of unemployment in a region,%	0.2967	0.5495	0.6100
Employed in R&D (% of the total employed)	-0.5298	0.7043	0.2233
Share of employed population in a region at the age under 28 years old, %	0.3951	0.5461	0.5457
Share of population employed in industry of a region, of the total employed population, %	-0.6509	-0.3633	0.4443
Share of population employed in agriculture of a region, of the total employed population, %	0.8788	-0.2756	0.1517

Source: compiled by the authors

The first factor was distinguished. An index with weights like in table 2 was made of it. As a matter of fact that index is converse to social filter. Variables of R&D and employment in industry are negative, i.e. the higher they are the lower the index is. We multiplied the index by – 1 to be able to directly interpret the same – the higher the index is the stronger development is.

Table 3 represents the variables describing social, economic conditions in the regions of Kazakhstan or, as per the terms of Rodríguez-Pose and Crescenzi [30], the “filters”.

Table 3 - Coefficients of indicators for factor 1 of the variable SocFilter

Coefficients	Factor 1
Rate of unemployment in a region, %	0.2025
Employed in R&D (% of the total employed)	0.2558
Share of employed population in a region at the age under 28 years old, %	0.2624
Share of population employed in industry of a region, of the total employed population, %	0.2623
Share of population employed in agriculture of a region, of the total employed population, %	0.3280

Source: compiled by the authors

Results

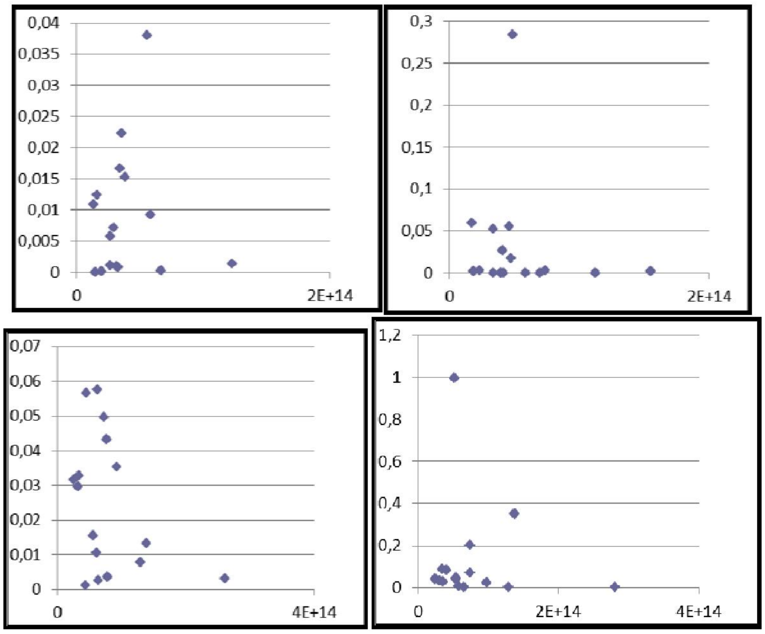
The results of verification of existence of relation between economic growth of the regions and the variables described above are given in table 4. Column 2 shows that relation between the spillovers of R&D, spillovers of social and economic conditions, spillovers of the GRP per capita and a rate of growth of the GRP per capita is significant and negative. This assumes that differences in regional efficiency likely relate to differences in amount of costs for innovations.

Table 4 - Fixed effects model, dependent variable of the rate of increase of the GRP per capita

Independent variables	Number of observations = 192
1	2
GRP per capita base logarithm	-77.67357*** (26.29)
Investments in R&D as % of the GRP subject to a lag of	-18.92963 (12.17)
Social filter	-0.102757 (0.18)
R&D Spillovers	-240.4126*** (85.34)
Spillover of social and economic conditions	-0.834956** (0.46)
GRP per capita Spillover	-7.07E-07** (3.38E-07)
Constant	706,3865*** (213,12)
Fischer’s test for relevance of coefficients to zero regression coefficient	F(6,16)= 4.701818 [0,0000]
R^2	0.367

Note: *** –is at 1-percent level; ** –is at 5-percent level;
* –is at 10-percent level.
Source: compiled by the authors

Estimation of quality of a particular coefficient (*t*-criterion) and the whole equation (*F*-test) show reliability of the results. The fact of negative relation between the spillovers of R&D and the GRP per capita contravenes the results of a number of foreign researches, which evidence existence of positive relation [31]. As Table 4 shows, all coefficients with variables are negative, i.e. nothing furthers economic growth of the regions. What is the matter? We looked at dependence of the costs for innovations on the GRP. Horizontally – GRP, vertically – costs for innovations.



Source: compiled by the authors

Figure 1 – Dependence of costs for innovations on the GRP:
horizontally – GRP, vertically – costs for innovations

The picture obviously demonstrates that dependence between the costs for innovations and the GRP is negative or weak. And the model assumes that the costs for innovations as % of the GRP must further economic growth. However, in our opinion, not the fact that the share of costs for innovations in a neighbouring region is great, but the fact that the amount of costs for innovations is large will affect the knowledge spillover.

However, the above contradiction is settled, if we consider the variables of costs for innovations and R&D as percentage of the total GRP in all regions that represents their absolute values (results of calculation are given in table 5).

Table 5 - Catch-up growth model with the R&D spillovers, dependent variable of the rate of increase of the GRP per capita

Independent variables	Number of observations = 160
1	2
GRP per capita base logarithm	-109.2283*** (31.17)
Investments in R&D as % of the GRP	1.39E-13 (12.17)
Social filter	-1.064928** (0.55)
R&D Spillovers	-22.73779** (17.76)
Spillover of social and economic conditions	-1610.395 ** (737.84)
GRP per capita Spillover	-2.13E-07 (2.55E-07)
Constant	902.1817*** (258.86)
Fischer's test for relevance of coefficients to zero regression coefficient	F(6,16)= 3.053483 [0.000048]
R^2	0.317

Note: *** – significance is at 1-percent level; ** – significance is at 5-percent level;
* – significance is at 10-percent level.
Source: compiled by the authors.

When estimating basic equation (1), estimation of a coefficient with constant and variable of the GRP per capita for each region is found important at 1-percent level. Coefficient of the index of the GRP per capita spillover was insignificant in the model. The great values of the indicator of the GRP per capita spillover as regard to the other variables had the result that the values of the coefficients with that variable proved to be close to zero: when increasing by one the indicator *ExtGDPpc* in the model, the rate of increase of the GRP per capita increases by 0.0000213 percentage point.

The signs of the coefficients with LGRP1M, SPILL INNOA match here the economic sense. The results of regression analysis demonstrate that the spillovers of costs for technologic innovations relate to higher economic growth. The interpretation is very simple here: the regions, which are geographically closer to the regions with high level of costs for technologic innovations, grow faster than the regions surrounded by the areas with low costs for technologic innovations. The availability index growth by 1% results in growth of the rate of increase of the GRP per capita by 0.18%. An additional argument for importance of diffusion of knowledge for the rates of increase of the GRP per capita is the fact that the model is characterized by high R^2=31.7%. Such level is deemed rather high for that type of equations.

Discussion

Some coefficients are negative, for example, with the variable "Spillover of socio-economic conditions". A similar situation occurs in studies in Russian regions, for example, in studies of Kaneva and Untura [24]. It is explained by the migration of the unemployed population from neighboring regions to this region. The interpretation here is quite simple: regions geographically close to regions with a high level of expenditure on technological innovations are growing faster than regions surrounded by territories with low expenditures on technological innovations.

For the development of the object of research it is necessary to analyze the specifics of Kazakhstan. The solution of the problem will be carried out step by step. First, evaluate the regression equation only for convergence, see the speed, compare with the results of other works. Then add R&D expenses, see how they affect GRP and how the convergence coefficient is. Innovation can and strengthen convergence. Calculate the "social filter" and flows. If possible, consider interregional migration. Calculate the intersection of the filter with R&D? Try the model in the first differences compared to fixed effects. 16 regions in 10 years – the time series is comparable to the number of objects.

The introduction of lagged variables always exacerbates problems with autocorrelation. And in the method of least squares, and in the model with a fixed effect. Therefore, in the future, we will evaluate the dynamic model using some version of the Arellano-Bond model [32].

The above-mentioned models created initially for studying the economy of individual countries have been subjected to empirical testing many times, including on the basis of econometric modeling [30]. The development of empirical work also led to the fact that growth theories were used to test growth hypotheses, convergence or lack thereof and sources for a group of countries (for example, the EU), as well as for regions within one country (US states, provinces of Spain, subjects Federation of Russia).

Conclusion

The analysis of efficiency of the knowledge spillovers is the subject of the researches of many works all over the world. By estimating the model of the knowledge spillovers for all regions of Kazakhstan we show that inside the country the levels of efficiency of the knowledge spillovers may be strongly different. The fact of such regional differences raises many questions. Efficiency of the knowledge spillovers of some regions match the indicators for developing countries; and that of the other regions match the indicators for developed countries.

The developed hypotheses of important impact of the indicators of innovative activity and regional social and economic conditions on economic growth were tested.

The analysis of resulted estimations evidences of positive impact of social and economic conditions in other regions and their GRP on economic growth of the region during the period studied.

The model of interrelation of innovative activity and economic growth of the regions considers significant inequality of development through use of fixed effect panel regression: econometric model of interrelation between the GRP and unobservable characteristics, which are sources of inequality.

The research confirms basic abstract theorem that the innovative activity taken into consideration in calculations through costs for R&D and costs for technologic innovations and the knowledge spillovers is an endogenous factor able to explain the differences in economic growth of the regions of Kazakhstan.

Made calculations showed that the knowledge spillover results in expansion of knowledge into neighbouring regions, and from them to those neighbouring, forming the so called "centres of innovations". It is evidences that knowledge are dispersed among the regions having close rates of economic development, but their influence on the rates of increase of the GRP per capita is insufficiently represented, i.e. it remains insignificant in the model.

The developed fixed effect models confirmed main hypothesis of the research concerning impact of the knowledge spillovers on economic growth in the regions of Kazakhstan. Innovations' diffusion and knowledge spillover from innovative centres to the peripheral regions takes place one way or another. Innovative activity is carried out at more intensive rate where the concentration of intellectuals is higher. The gained results evidence that improvements in innovative development can lead to levelling of a level of innovative activity among the regions – by the innovative leaders and regions remaining within innovations. The results of the research can be used when forming regional innovative policy in the Republic of Kazakhstan.

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ИННОВАЦИЯЛАРДЫҢ ДИФФУЗИЯСЫ, БІЛІМНІҢ ТАРАЛУЫ ЖӘНЕ ҚАЗАҚСТАН ӨҢІРЛЕРІНІҢ ЭКОНОМИКАЛЫҚ ӨСУІ

Аннотация. Қазақстан – үлкен аумағы бар және өңірлері экономикалық тұрғыда біркелкі дамымаған ел. Экономиканың шикізаттық бағдарынан өнеркәсіптік дамуға көшу міндеті инновациялық белсенділікті арттыруды білдіреді, бұл өсуді жеделдетуге әкеп соғады. Ел аймақтары арасында білімді тарату маңызды рөл атқара алады. Э. Роджерстің инновациялар таралуының негізгі шетелдік теорияларын және Маршалл-Эрроу-Ромердің, Л. Анселиннің білімдерінің таралу теориясын, Дж. Гроссман мен Э. Хелпманның эндогендік өсу моделін, сондай-ақ Ф. Агион мен П. Ховитттің білімнің таралуы жайлы моделінің бірегейлігін пайдалана отырып, біз аумақтардың экономикалық өсуі инновациялармен байланысты екенін зерттедік. Қазақстан өңірлерінің 2005-2015 жылдардағы инновациялық көрсеткіштері бойынша панельді деректерді пайдалана отырып, тіркелген әсерлері бар регрессиялық модельдер бағаланды. Инновация көшбасшылары мен инновацияларда артта қалған өңірлер арасындағы инновациялық қызметтегі теңсіздікті төмендетудің қайталама білім көздерінің қабілеті туралы қорытынды жасалады. Есептеулер білімнің таралуы білімнің көрші өңірлерге, ал олардан – көрші өңірлерге таралуына әкеліп, «инновация орталықтарын» құратынын көрсетті. Инновациялық белсенділік деңгейін теңестіру өңірлердің экономикалық өсу қарқынын теңестіруге алып келеді.

Түйін сөздер: инновация диффузиясы, білімді тарату, өңір, әлеуметтік сүзгі, кеңістіктік эконометриялық талдау.

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ДИФФУЗИЯ ИННОВАЦИЙ, РАСПРОСТРАНЕНИЕ ЗНАНИЙ И ЭКОНОМИЧЕСКИЙ РОСТ РЕГИОНОВ КАЗАХСТАНА

Аннотация. Казахстан – страна с большой территорией и неравномерным экономическим развитием регионов. Задача перехода от сырьевой ориентации экономики к промышленному развитию подразумевает повышение инновационной активности, что приводит к ускорению роста. Распространение знаний между регионами страны может сыграть существенную роль. Принимая во внимание основные зарубежные теории распространения инноваций Э. Роджерса и теорию распространения знаний Маршалла-Эрроу-Ромера, Л. Анселина, модель эндогенного роста Дж. Гроссмана и Э. Хелпмана, используя оригинальность модели Ф. Агиона и П. Ховитта о распространении знаний, мы исследовали, как экономический рост территорий связан с инновациями. Используя панельные данные по инновационным показателям регионов Казахстана за 2005-2015 гг. были оценены регрессионные модели с фиксированными эффектами. Делаются выводы о способности вторичных источников знаний снижать неравенство в инновационной деятельности между регионами – лидерами инноваций и регионами, отстающими в инновациях. Расчеты показали, что распространение знаний приводит к распространению знаний в соседние регионы, а от них – в соседние, образуя так называемые «центры инноваций». Выравнивание уровня инновационной активности приводит к выравниванию темпов экономического роста регионов.

Ключевые слова: диффузия инноваций, распространение знаний, регион, социальный фильтр, пространственный эконометрический анализ.

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