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AN APPROACH TO INNOVATION FACTOR MEASUREMENT AT MACRO- AND REGIONAL LEVELS

In the context of investment activity an approach to assessment of the innovation factor is proposed. Specific techniques were used, the results of innovation activity measurements in Russia's regions are shown. Findings regarding regional economic development and evaluation of innovation activity may be of some interest to Ukrainian academia.

Keywords: *labor productivity; innovation factor; investments; capital productivity.*

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ПІДХІД ДО ВИМІРЮВАННЯ ІННОВАЦІЙНОГО ФАКТОРУ НА МАКРО- І РЕГІОНАЛЬНОМУ РІВНЯХ

У статті запропоновано підхід до оцінювання інноваційного фактору відносно інвестиційної діяльності. На основі використання конкретних методик представлено результати вимірювання інноваційної активності регіонів Росії. Висновки, що стосуються економічного розвитку і оцінювання інноваційної діяльності регіонів, можуть становити певний інтерес для української наукової спільности.

Ключові слова: *продуктивність праці; інноваційний фактор; інвестиції; капіталовіддача.*
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ПОДХОД К ИЗМЕРЕНИЮ ИННОВАЦИОННОГО ФАКТОРА НА МАКРО- И РЕГИОНАЛЬНОМ УРОВНЯХ

В статье применительно к инвестиционной деятельности предложен подход к оценке инновационного фактора. С использованием конкретных методик представлены результаты измерений инновационной активности регионов России. Выводы, касающиеся регионального экономического развития и оценки инновационной деятельности, могут представлять определенный интерес для научного сообщества Украины.

Ключевые слова: *производительность труда; инновационный фактор; инвестиции; капиталоотдача.*

Problem statement. The issues of the relationship between product dynamics and fixed capital, between labor productivity and capital-labor ratio on the macrolevel are studied in the paper. In more exact terms, the purpose is, if possible, basing on empirical materials to reveal the effect of both quantitative (extensive) and qualitative investment indicators on production growth. From the author's position, GDP growth caused by improved qualitative investment characteristics (e.g., application of advanced technologies, materials, facilities etc.) is related to innovation activity and innovation factor of growth. For countries and regions with technological progress it can be assumed that innovation factor manifests itself as an investment resource saving without any adverse effects on economic growth.

It is considered that S. Durlauf and D. Quah (1998) posed as the central question in the modern theory of growth: why do some counties grow faster than others? It is also believed that the so-called conventionalized facts formulated by W. Easterly and R. Levine (2000) represent some results of empirical investigations in this field.

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One of them is that accumulation of production factors is not of crucial importance for a larger part of cross-differences in the levels of economic growth. It was stated earlier that capital increase is not sufficient to account for production growth (Romer, 1989)[2]. Different aspects of the problem are considered in the works of the following researchers (Alam et al., 2008; Bessonov et al., 2009; Lavrovskii, 2015; Voskoboynikov and Gimpelson, 2015).

Approach to innovation factor evaluation. One area where the consequences of innovation activity are revealed is the sphere of investments. The result of this activity is providing economic growth at lower costs of investments or making economic growth greater, while investments amount being the same. Under this approach innovation activity is seen as a force that can slow down or even overcome the objective tendency of the investments per unit to increase in the transition to higher technological level of production. Certainly, later that idea will be transformed into certain model structures, depending in particular on the capabilities of calculation to be supported with data.

This attempt to reveal the impact of the innovation factor at the macro- and regional levels is related to the simplest model case which is limited to the classical triad "product – capital – labor". The economic system state can be defined by using a vector comprising 3 components, namely, the volume of manufactured product, the number of people employed and the accumulated fixed capital (fixed assets). The industrial basis of this system reflecting both its scientific-technological level and investment efforts is characterized by the parameters of productivity and capital-labor ratio. Being a derivative of these parameters yield on capital investment illustrates capital productivity.

Within this model detection, identification and evaluation of an innovation trend in the development of an economic system are connected with demand for investment to produce a certain amount of output. The lower these needs are than at some initial (zero) level, the more confidently we can speak about the implemented results of innovation activity, about new tangible content of investments, that is the result of highly intellectual labor.

The need for investments to produce a given amount of output depends on the cumulative variation of productivity and capital-labor ratio parameters. According to changes in these parameters it is possible to determine the character of innovative activity. In particular, stability of these parameters over some period of time and an absolute stability of demand for investments per unit are interpreted within this model as an absence of innovation activity results over this period of time (in the context of investments).

In this regard a (conditional) rate of demand for capital K^r_t is calculated for the year t along with the data regarding the actual amount of fixed capital K_t.

K^r_t is a hypothetical amount of fixed capital in the year t which is necessary to manufacture the product in the year t and depends on such economic system parameters as productivity and the capital-labor ratio in the reference year 0. In other

[2] Systematic presentation of the most important trends and theories used in studies of economic growth is given in (Sharaev, 2006).

words, the value K^r_t necessary to manufacture the product in the year t characterizes the demand for capital, if:

- no results of innovation activity during the considered retrospective (prospective) period [l, t] are available;
- this capital reproduces technologies with the parameters of the base period.

The idea of the approach to assessment of the innovative factor by comparing real and hypothetical amounts of fixed capital is based on the assessment of dynamics of productivity and capital-labor ratio, illustrating the trend of the demand for investments to decline or increase.

According to the investment factor role there are the following types of economic development:

1. $$K_t > K^r_t. \quad (1)$$

This type of development is interpreted as absence of innovation activity results, as generating a potential and creating conditions for obtaining these results at the next development stages.

2. $$K_t = K^r_t. \quad (2)$$

This type of development is of as a boundary type. It reproduces technology parameters of the base period and does not demonstrate any results of either innovation, or regressive development.

3. $$K_t < K^r_t. \quad (3)$$

This type of development demonstrates innovation activity results. The results are in a new investment quality, more preferable relationship between productivity and capital-labor ratio than it is in the base period. The effect of the innovation factor can be calculated by using the parameter, characterizing a measure of superiority of capital productivity accumulated by the year t as compared to the base year 0.

Russian regions: innovation factor. Using the above methodological technique which includes the comparison of the investment activity scale and its results in the form of output, implies the availability of data on fixed capital at constant prices, which is not always possible. Investment statistics are provided much wider.

It is commonly known that investments in fixed assets lead to production increase. This means that the value of investments over a particular period can correspond to the increase in production obtained because of them over this period, but not the absolute scale of output.

Identification of the innovation factor in this case is connected with the assessment of inter-regional relations between the rates of increase of production and investments; the latter causes this increase for a particular period of time. Correct comparison of these indicators to measure innovation factor includes:

- calculation of investments per unit of labor productivity increase in each region (in this sense – the indicators of marginal capital ratio) for a particular period of time;
- correction of indicators of marginal capital ratio by taking into account the distance from regional productivity to national average (meaning a noticeable difference in technological level of regional economy, which manifests itself in a different value of labor productivity indicators);

- elimination of regional economies scales due to normalizing of investments per person employed.

Putting it simply, as part of this approach the intensity of innovation activity in the region *i* for the period is performed by comparing the marginal capital ratio in the region *i* with the same national average (taking into account the requirements set forth above). Thus, the evaluation of innovation activity becomes relative, the higher it is – the smaller is the indicator of marginal capital ratio towards the average for Russia.

Finally, correct measurement of innovation factor in the framework of this approach implies compliance with clearly defined conditions: a sufficiently long period of sustained economic growth, the lack of any appreciable amount of unused capacity to its beginning.

Having in mind the very specific nature of economic development in the post-Soviet period, the question of choosing the time interval for comparative analysis of regions does not seem banal. We chose two periods: 2005–2007 and 2008–2013.

To assess the results obtained, it is worthwhile comparing them with other innovation processes measurement techniques. V.I. Suslov and N.A. Kravchenko (2014) highlighted a group of regions with innovative development, their leadership is quite stable over time. During the period of 2000–2012 these developed regions in the "use of innovation" were marked in the number of 27, to make comparisons with later on.

For convenience, later on the developed here approach we will call technique A, method for isolating regions, whose leadership is " stable over time", – technique B. There is a certain, although a small one, intersection of the leading regions in both methods. For the purpose of greater convexity, contrasting effect, crossing portion in the analysis is excluded.

Table 1 shows the leading regions by Method A, Table 2 – by Method B.

Most of the labor productivity indicators of the leading regions by method B did not reach in 2004 the national average values. Moreover, these figures by 2007 in many cases, deteriorated or stayed approximately at the same level. Along with this, negative trends in the period of 2005–2007 affected the regions with not only relatively low levels of productivity, but also with the values above average. It is important that in those few cases where there was preferential productivity growth towards national average, it was accompanied by disproportionately high investment efforts.

Dominating in 2004–2007 trends retained their validity during 2008–2013. Most of productivity indicators (usually below average in 2008) remained stable or decreased towards the average. Rare cases of growth were accompanied by high, not proportional investments.

The features of economic development in the leading regions identified by Method A, look much more preferable. Many of them by 2004 can be already attributed to technological leaders on the national scale, due to the fact that achieved labor productivity indicators are higher than the national average or comparable with it. And during 2005–2007 there is preferential or comparable with the average dynamics. However, investment efforts connected with productivity growth are not always adequate to the results.

Positive trends prevailing in 2005–2007 didn't weaken in the following years. All regions improved their relative positions in 2013 or maintained the status quo. In

Table 1. **Economic characteristics of some leading regions (method A),** *authors' calculations on* (www.gks.ru)

Region	2005–2007			2008–2013		
	Labour productivity towards the country's average in 2004	Labour productivity towards the country's average in 2007	Investments per average annual person employed towards the country's average, 2005–2007	Labour productivity towards the country's average in 2007	Labour productivity towards the country's average in 2013	Investments per average annual person employed towards the country's average, 2008–2013
Russia	1	1	1	1	1	1
Novosibirsk region	0.95	1.0	0.75	-	-	-
Krasnoyarsk region	1.58	1.48	1.04	-	-	-
The Republic of Karelia	1.08	1.08	0.82	-	-	-
Kamchatka region	1.21	1.15	0.80	-	-	-
Orenburg region	1.05	1.04	0.83	-	-	-
Primorsk territory	0.95	0.92	0.58	-	-	-
Lipetsk region	1.37	1.35	1.35	-	-	-
Kaliningrad region	0.95	1.03	1.18		-	-
Irkutsk region	1.09	1.20	1.02	1.20	1.32	0.92
Belgorod region	1.06	1.17	1.33	1.17	1.45	1.38
Sakhalin region	2.14	2.55	6.54	2.55	2.59	3.98
Krasnoyarsk region	-	-	-	1.48	1.57	1.82
The Republic of Khakassia	-	-	-	0.78	0.84	0.58
Omsk region	-	-	-	1.08	1.07	0.70
Magadan region	-	-	-	1.26	1.38	1.70
Chukotka Autonomous region	-	-	-	1.71	1.79	2.64
Saratov region	-	-	-	0.71	0.78	0.64

Table 2. **Economic characteristics of some leading regions by Method B),** *authors' calculations on* (www.gks.ru)

Region	Leaders by Method B, excluding the same leaders by Method A (2005–2007)			Leaders by Method B, excluding the same leaders by Method A (2008–2013)		
	Labour productivity towards the country's average in 2004	Labour productivity towards the country's average in 2007	Investments per average annual person employed towards the country's average, 2005–2007	Labour productivity towards the country's average in 2007	Labour productivity towards the country's average in 2013	Investments per average annual person employed towards the country's average, 2008–2013
Russia	1	1	1	1	1	1
Novgorod region	1.03	0.97	0.98	-	-	-
Tomsk region	1.81	1.49	1.23	-	-	-
Yaroslav region	0.99	1	0.97	-	-	-
Volgograd region	0.82	0.76	0.61	0.76	0.67	0.65
Nizhny Novgorod region	0.87	0.87	0.84	0.87	0.84	1.02
Oryol region	0.63	0.62	0.57	0.62	0.62	0.58
The Republic of Mordovia	0.54	0.61	0.81	0.61	0.63	0.90
Chuvash Republic	0.59	0.62	0.71	0.62	0.55	0.68
Vladimir region	0.64	0.66	0.56	0.66	0.61	0.63
Vologda region	1.63	1.51	1.81	1.51	1.30	1.25
Voronezh region	0.62	0.67	0.63	0.66	0.74	1.04
Kaluga region	0.74	0.77	0.71	0.77	0.92	1.21
Murmansk region	1.53	1.37	0.87	1.37	1.12	1.03
Stavropol region	0.63	0.60	0.56	0.60	0.60	0.60
The Udmurt Republic	0.91	0.86	0.72	0.86	0.83	0.59
Khabarovsk region	1.14	1.06	1.10	1.06	0.99	1.54
Ulyanovsk region	0.67	0.69	0.61	0.69	0.66	0.75
Samara region	-	-	-	1.26	1.19	1.05
Tula region	-	-	-	0.79	0.80	0.79
Chelyabinsk region	-	-	-	1.13	0.98	0.81
Samara region	-	-	-	1.26	1.19	1.05

roughly half of them the investment efforts during 2008–2013 are adequate to achieved productivity indicators. In these federal subjects it is more possible than in those close to national average to successfully counteract the upward trend of investments per unit in the transition to higher technological level of production.

The approaches' difference, of course, affected our results. However, due to the comparative analysis done a question comes up which doesn't have an answer yet: what, in fact, is behind the published high innovation indices of a number of regions, what kind of economic benefits they actually have and can be proud of. Or innovation rating calculation is a kind of self-challenge, no way or poorly linked to traditional economic problematics?

Conclusions. Using specific techniques in evaluation of innovation activity intensity in the field of investments in Russian regions for the periods of 2005–2007 and 2008–2013 is demonstrated in this article. Quite noticeable differences in the ranks of leading regions are demonstrated.

Limitations & recommendations. The key feature of the suggested approach to innovation factor measurement is the following. The result of this measurement is the region's relative position to country's average. It is claimed that during the same period of time intensity of innovation activity is higher in one region and lower in another region than in Russia as a whole. In this relation the above approach can be called structural.

No less and perhaps more important is the dynamic approach, under which it is possible to measure the innovation activity intensity over time, to compare data from different periods for Russian Federation as a whole and for its specific regions. Its further development might be the subject matter for further research.

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