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ОЦІНКА ІННОВАЦІЙНОЇ ДІЯЛЬНОСТІ ПРОМИСЛОВОСТІ УКРАЇНИ

Семененко О.Г.

Метою роботи є аналіз інноваційної діяльності промисловості України за останні сім років, розглянуто тенденції розвитку та методики оцінки інноваційної діяльності промислових підприємств.

Методи, що були використані в процесі дослідження. Застосовано системний підхід та методології економічного, статистичного та економіко-математичного аналізу для вивчення тенденцій інноваційного розвитку в промисловому секторі економіки країни.

Результати роботи. Стабільне економічне зростання та підвищення конкурентоздатності підприємств промисловості можливе лише за умови ефективного використання інноваційних ресурсів, економіки знань, впровадження сучасних наукомістких технологій, розробки якісно нової продукції, створення інновацій. Ці обставини вимагають створення науково-обґрунтованих методик оцінки інноваційної діяльності. Моніторинг ефективності інноваційної діяльності важливий не тільки для виявлення позиції галузей на конкретних ринках і у світовій економіці взагалі, але для оптимізації ресурсного потенціалу в процесі впровадження інновацій. Оцінка інноваційної діяльності дозволяє зменшити ризики та скорегувати напрями інвестиційної політики, як на рівні окремого підприємства, так і на рівні держави.

Висновки. Оцінка інноваційної діяльності промислових підприємства є важливою складовою моніторингу та прогнозування інноваційного потенціалу, економічної ефективності інновацій для виявлення проблемних секторів, ризиків та перспектив реалізації інноваційних проектів в одному з найважливіших секторів економіки. Розглянутий узагальнений алгоритмічний підхід до розрахунку інтегрального показника інноваційної діяльності підприємств промисловості дозволяє акумулювати декілька методик економіко-математичного аналізу, що суттєво не змінює результати дослідження але полегшує розрахункові завдання.

Ключові слова. промисловість, інноваційна діяльність, оцінка, інтегральний показник, методологія, прогноз.

ОЦЕНКА ИННОВАЦИОННОЙ ДЕЯТЕЛЬНОСТИ ПРОМЫШЛЕННОСТИ УКРАИНЫ

Семененко Е.Г.

Целью работы является анализ инновационной деятельности промышленности Украины за последние семь лет, рассмотрены тенденции развития и методика оценки инновационной деятельности промышленных предприятий.

Методы, которые были использованы в процессе исследования. Применен системный подход и методологии экономического, статистического и экономико-математического анализа для изучения тенденций инновационного развития в промышленном секторе экономики страны.

Результаты работы. Стабильный рост и повышение конкурентоспособности предприятий промышленности возможно лишь при условии эффективного использования инновационных ресурсов, экономики знаний, внедрения современных наукоемких технологий, разработки качественно новой продукции, создание инноваций. Эти обстоятельства требуют создания научно обоснованных методик оценки инновационной деятельности. Мониторинг эффективности инновационной деятельности важен не только для выявления позиции отраслей на конкретных рынках и в мировой экономике вообще, но и для оптимизации ресурсного потенциала в процессе внедрения инноваций. Оценка инновационной деятельности позволяет уменьшить риски и скорректировать направления инвестиционной политики, как на уровне отдельного предприятия, так и на уровне государства.

Выводы. Оценка инновационной деятельности промышленных предприятия является важной составляющей мониторинга и прогнозирования инновационного потенциала, экономической эффективности инноваций, для выявления проблемных секторов, рисков и перспектив реализации инновационных проектов в одном из важнейших секторов экономики. Рассмотрен обобщенный алгоритмический подход к расчету интегрального показателя инновационной деятельности предприятий промышленности позволяет аккумулировать несколько методик экономико-математического анализа, существенно не изменяет результаты исследования, но облегчает расчетные задачи.

Ключевые слова. промышленность, инновационная деятельность, оценка, интегральный показатель, методология, прогноз.

ESTIMATION OF INNOVATION ACTIVITIES OF THE UKRAINE INDUSTRY

Semenenko E.H.

The aim of this work is to analyse of innovative activity of the industry in Ukraine for the last seven years, the article considers the trends of development and assessment methodology in relation to innovation activity of industrial enterprises.

The methods used in the research process. Applied a systematic approach and methodology of economic, statistical and economic-mathematical analysis to study trends of innovative development in the industrial sector of the economy.

The results of the work. Stable economic growth and increase of competitiveness of industrial enterprises is possible only under condition of effective use of innovative resources, knowledge economy, implementation of modern high technologies, developing entirely new products, the creation of innovation. These conditions require the creation of evidence-based methods of assessing innovation. Monitoring of efficiency of innovative activity is important not only to identify the position of industries in specific markets and the global economy in General, but to optimize the resource potential in the innovation process. Evaluation of innovation activities allows to reduce risks and to adjust directions of investment policy at the level of individual enterprises and at the State level.

Conclusions. Rating of industrial enterprises innovative activity is an important component of monitoring and forecasting innovative potential, economic efficiency of innovation and identification of problem areas, risks and prospects related to implementation of innovative projects in one of the most important sectors of the economy. Generic algorithmic approach to the calculation of the integral index for innovation activities of industrial enterprises, described in the article, allows accumulating several methods of economic and mathematical analysis, which does not significantly change the results of the study but simplifies calculations.

Key words. Industry, innovation activity, estimation, integral index, methodology, forecast.

Presentation of the main materials. For Ukraine, the idea of development of innovation activities is extremely important, because the problem of increasing production efficiency is relevant for each business structure and industry branch. Innovations in the industry play a significant role in the process of improving the competitiveness of the economy. Ukraine Industry employs more than 1/4 of the population and generates more than 40% of GDP. Innovative development provides businesses with the opportunity to obtain significant revenues which become the source of GDP generation and fill the budgets at all levels through distribution process. However, GDP growth due to new technology is a mere, comprising 0.7%, while the European average percentage is 25-35% and China reached 40% [1, p. 35].

Evaluation (economic, political) of innovations efficiency plays an important role for strategic planning and forecasting of innovative development for the country and certain branches of the industry in general.

In recent years the economy of Ukraine shows long-term dynamics of economic downturn. However, according to the Ministry of Finance, in 2016 GDP growth was at the level 2.3%. The volume of industrial production increased by 2.1

%, agricultural products - by 6.1%, retail –by 4%. However, statistics demonstrate that economic growth is driven mainly by extensive factors and current economic situation does not provide sustainable economic development.

General dynamics of the main indicators of innovation activity for 2010-2016is presented in table 1.

Table 1. Dynamics of the main indicators of innovation activity of industrial enterprises for 2010-2016.

Directions of innovation activity	2010		2013		2014		2015		2016		The growth rate 2016 to 2010, %	The growth rate 2015 to 2014, %
	Total	Share in the total number of industrial enterprises, %	Total	Share in the total number of industrial enterprises, %	Total	Share in the total number of industrial enterprises, %	Total	Share in the total number of industrial enterprises, %	Total	Share in the total number of industrial enterprises, %		
Number of enterprises engaged in innovation activity	1462	13,8	1715	16,8	1609	16,1	824	17,3	834	18,9	-43,0	1,2
Including spending on												
Internal research and development	224	2,1	215	2,1	189	1,9	151	3,2	232	5,2	3,6	53,6
External research and development	124	1,2	114	1,1	94	0,9	70	1,5	103	2,3	-16,9	47,1
Purchase of machinery, equipment and software	840	7,9	1082	10,6	993	9,9	467	9,8	590	13,3	-29,8	26,3
Acquisition of other external knowledge	100	0,9	85	0,8	83	0,8	32	0,7	74	1,72	-26,0	131,3
Other directions	194	1,8	1,8	165	140	1,4	210	4,4	368	8,3	89,7	75,2
Number of industrial enterprises implementing innovations	1217	11,5	1312	12,9	1208	12,1	723	15,2	735	16,6	-39,6	1,7
Including implementing of												
Innovative processes	522	4,9	557	5,5	459	4,6	400	8,4	526	11,9	0,8	31,5
Low-waste, resource-saving	203	1,9	194	1,9	141	1,4	155	3,3	235	5,3	15,8	51,6
Innovative products	615	5,8	683	6,7	600	6	414	8,7	529	11,9	-14,0	27,8
New types of machinery, equipment, appliances, apparatus	194	1,8	174	1,7	164	1,6	162	3,4	166	3,7	-14,4	2,5

Source:[3,4,5].

In 2016, innovative activity in the industry engaged 834 enterprises or 18.9% of the total. In comparison with 2015, their number increased by 1.2%. For seven years the number of organizations engaged in innovation activities decreased by 43%. 88,1% of innovation-active industrial enterprises (or 16.6% of the surveyed industrial enterprises) implemented innovations in 2016. In comparison with 2015, their number also increased by 1.7%, but from 2010 to 2016, the number of innovation-active enterprises decreased by 482 organizations (39,6% of the total number of industrial enterprises of Ukraine).

Over the past two years leaders in the number of implemented innovations were companies of Zaporizhia, Lviv, Kharkiv, Dnipropetrovsk regions and Kyiv city. By types of economic activity, the best indicators of innovations implementation had enterprises which produce: machinery and equipment not attributed to other groups, foodstuff, and metallurgical production.

In 2015 innovative products represented 1.4% of the total volume of industrial production. In 2014, the share was 2.5% and in 2013 – 5.6% [3,4,5].

Analysis of dynamics of financing the innovation activities showed that it has increased over the five years in all directions by 18% in average.

Table 2. Sources of financing of innovation activities from 2010 to 2016

Years	Total costs, kUAH	Source of financing							
		Ownfunds		State budget		Foreign investors		Other sources	
		kUAH	% of total costs	kUAH	% of total costs	kUAH	% of total costs	kUAH	% of total costs
2010	8045,5	4775,2	59,4	87,0	1,1	2411,4	30,0	771,9	9,6
2011	14333,9	7585,6	52,9	149,2	1,0	56,9	0,4	6542,2	45,6
2012	11480,6	7335,9	63,9	224,3	2,0	994,8	8,7	2925,6	25,5
2013	9562,6	6973,4	72,9	24,7	0,3	1253,2	13,1	1311,3	13,7
2014	7695,9	6540,3	85,0	344,1	4,5	138,7	1,8	672,8	8,7
2015	13813,7	13427	97,2	55,1	0,4	58,6	0,4	273,0	2,0
2016	23229,5	22036	94,9	179,0	0,8	23,4	0,1	991,1	4,3

Source: [3,4,5]

Amount of financing in 2016 comparing with previous period increased almost twice mainly due to increase of own contributions by industrial enterprises. We can also observe positive trend of increasing the share of State budget in financing compared to 2015 by three times. However, the amount of state financing is two times less than in 2014.

In the structure of financing of innovation activity there is a steady tendency to increase the share of own funds (from 59.4% in 2010 to 94.9% in 2016).

The largest increase in 2015 compared to 2014 and 2010 was seen in own funds of enterprises – they increased by 2.5 times. Decreased financing: by 95.7% - funds from non-profit organizations, by 20.2% - funds from the higher education sector and by 4% from foreign investors. In 2016 the share of foreign capital was the lowest for the last seven years.

In 2015 compared with 2014, on the contrary, the share of foreign investment increased by 8.8%. Analysis of the data provided in table 2 shows that science, as well as existing and new progressive technologies, remains undemand in Ukraine, despite the fact that today innovation activity is of top-priority importance.

The matter of security and wealth is being increasingly considered worldwide as a matter of access to new technologies and information. Stimulation of innovation process helps to keep the status of influential State. It is an urgent demand of the economy and human development. The analysis showed the absence of systematic State support and effective strategy development of scientific research, including those related to innovation.

Big Science in the leading countries of the world is being considered in the following chain: science - innovation - real economy. In market conditions the main engine of the movement through this chain is intellectual property – its protection, management and commercialization. Today in Ukraine it is difficult to raise funds for science and innovation, to create conditions for attraction of investment into new domestic technology. At the same time, there is continuous growth of knowledge-based products all over the world and commercial success of the launched products is more and more based on the new knowledge [10].

One of the factors of innovation activity is the end result – sales income. Calculation of dynamics of the sales income from innovation activity for industrial enterprises in Ukraine performed based on the data from [4,5,6] is presented in Fig. 1.

The total volume of innovative products sold in 2015 compared to 2014 decreased by 2618,9 mUAH, including the products which were new on the market increased by 3% (218 mUAH), and the products which were new only for the company decreased by 2836,7 mUAH. Amount of innovative products sold outside Ukraine in 2015 was equal to 10843,8 mUAH which is 44.6% higher than sales in 2014.

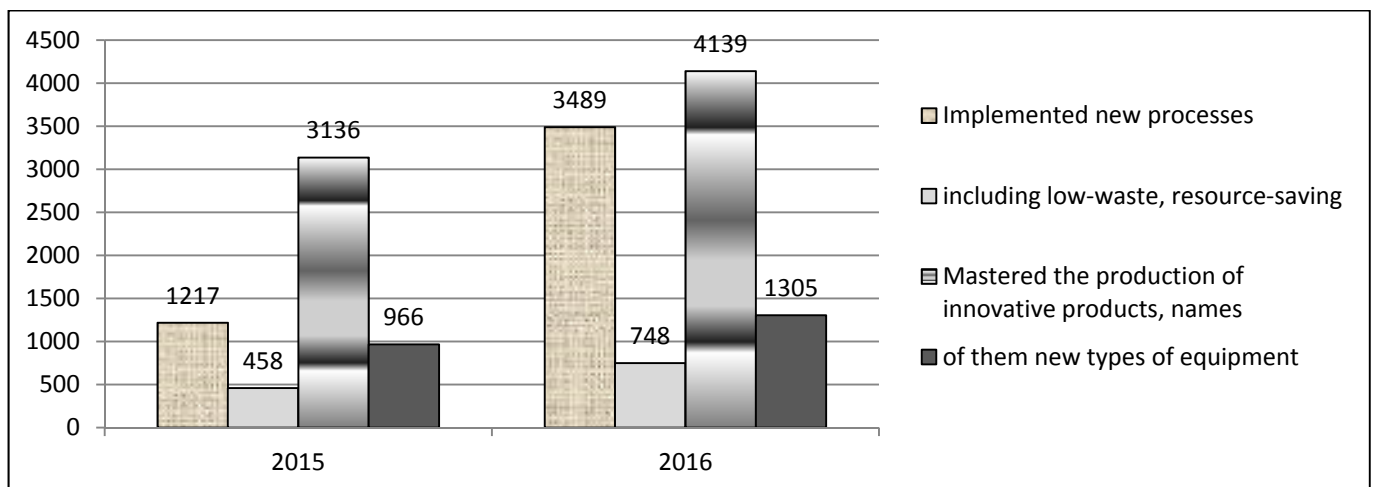


Figure 1. Dynamics of the volume of innovation products sold in Ukraine in 2015-2016, units

Source: [3,4,5]

In 2016 at all types of innovations, there was a significant increase of indicators: number of implemented technological processes showed three times increase, manufacturing of innovative products has grown by 32%.

Therefore, in Ukraine there is an increase in performance from implementing innovation, especially in the export of finished products.

During analysis of innovation activity it is important to evaluate «innovative index of the economy» (Table.3).

According to the WEF report, in 2015 Ukraine was ranked 52 among 144 countries for subindex «Innovation». In 2014, we were on the 54 place. In 2012, Ukraine ranked 71. In recent years there is a tendency of improvement in subindex components (table. 3).

During 2012-2016 the level of ability to innovate in Ukraine has increased, the quality of research institutions has improved, companies' expenditures on research and development and volume of government financing of high-tech products have increased. It is also noted that there is a low level of cooperation in research activities between educational institutions and industry, as well as the number of registered patents for invention, and availability of scientists and engineers [1,8].

Table 3. Components of subindex «Innovation» in the competitiveness index of Ukraine (by 7 point scale)

Innovation index	2012	2014	2015	2016
The ability to innovate	3,3	3,6	4,4	4,4
The quality of scientific research institutions	3,7	3,8	4,2	4,2
The companies' expenditures on research and development	2,7	3,1	3,3	3,3
Interaction of educational institutions and industry in the implementation research and development	3,6	3,5	3,5	3,5
The purchase of high-tech goods at government expense	3,2	2,9	3,1	3,1
The presence of scientists and engineers	4,8	4,3	4,7	4,7
The number of invention patents per 1 million population	3,1	3,2	3,9	3,9

Source [1,2].

Analysis of subindexes of Global innovation index shows that the main weaknesses that prevent innovation development in Ukraine, is the lack of efficiency of public administration and regulatory control, lack of supremacy of law, not attractive business environment, complexity of tax payment and bankruptcy, lack of energy efficient and environmentally-friendly industries, low rates of capital formation, insufficient level of competition in the domestic market, the low level of cluster development, etc. [1]. However, this rating is a comparative expert assessment, based on the results of innovation activities of EU countries.

Given the state of the economy, it is too early to compete with top innovation leaders in Europe. Therefore, the assessment of innovation activity on the basis of the algorithm developed by our scientists, provides possibility to set adequate limitations and make relevant conclusions based on our own experience.

Economic evaluation of efficiency of innovation activity involves dealing with complex issues such as:

- selection and justification of the strategic direction of research;
- definition of criteria and indicators of its economic efficiency;
- assessment of the impacts on the performance of innovation activities based on various factors, and the choice of an effective method of evaluation.

Approaches and methods of assessment of efficiency of innovation activity are widely described in economic literature. Almost all of them are based on the ratio – effect vs cost (economic efficiency ratio or its opposite ratio – payback period for additional costs) and its subsequent comparison with the target value. Yet, the end result can be achieved in different ways and it is important to consider this during the comprehensive assessment of innovation activity.

The most known indicators for the evaluation of innovation activity presented in the table 4.

Table 4. Key indicators of efficiency of innovation activity of industrial enterprises

Groups by directions of assessment of innovation activity	Indicators
Indicators of research level	-coefficient of production capacity of science; -correlation between the number of own developments to the number of acquisitions; -coefficient of using the results of purchased development in the total number of own developments; -coefficient of innovation growth
Indicators of level of innovation activeness	-share of innovation-active enterprises in the total number of industrial enterprises; -share of enterprises that implemented innovations in the total number of industrial enterprises; -share of enterprises that implemented innovative products in the total number of enterprises
Indicators of the level of implementation of innovation activities	-share of enterprises that implemented innovative products in the total number of enterprises; -share of realized innovative products in the total volume of industry; -share of implemented innovative products in the total volume of industry sales; -volume of innovative products sold outside of Ukraine, in the total volume of sold products; -share of the volume of performed research and development in GDP, generated by the industry.
Indicators of the level of the investment component	-share of financing from foreign investors; -annual growth of R&D expenditures; -share of net income directed into R&D
Indicators of profitability level for innovation activity	-profitability of innovation activity; -share of expenditures on research and development in GDP; -share of expenditures on research and development funded from the State Budget vs GDP produced in industry;
Indicators of research activeness in industry	-correlation between the number of specialists involved in research and development to the number of the employed population; -number of Doctors and PhD employed in industry in the total number of Doctors and PhD employed in the economy; -coefficient of inventive activity; -number of research and development personnel in the total number of employed population

Among the generalizing assessment of the innovation activities there are three approaches: estimated level of the final result of innovation to the final results of business activity; integral evaluation, based on the normalized indexes of the generalized formula and tabular output; rating based on expert opinions compared to other objects of study.

In some scientific works there is a combination of all these methodologies or their parts. This approach, in our opinion, is the most optimal for the generalization of evaluation of innovative development. We offer the following algorithm:

1. Data collection and calculation of indicators, including peer assessment.
2. Evaluation of indicators (using the formula or functional dependency).
3. Calculation of the integral indicator (using the formula or functional dependency).
4. Preparation of the table with intermediate values of the integral indicator to make conclusions regarding the level of innovation performance (development, capacity, safety, etc.).

We propose to demonstrate this algorithm in practice, comparing different methodologies. As input statistical data we took the innovation performance of the industry in 2010-2015 (table.5).

The input data is normalized via dividing each indicator by the normal rate (Table. 5). The normal rates were developed by the National Institute for Strategic Studies [8]. To calculate the integral indicator for assessment of innovation activity of industrial enterprises the following formula is used:

$$I = \sum_{j=1}^n \omega_i p_i \tag{1}$$

where n is the number of indicators ω_i - weight of i-indicator, p_i - i-indicator

Table 5. The dynamics of the main indicators of innovation activities from 2010 to 2015

Indicators	2010	2011	2012	2013	2014	2015	Normal rate
coefficient of production capacity of science	0,56	0,76	1,03	0,89	0,40	0,56	>=4-5%
correlation coefficient	4,60	3,38	4,18	4,02	2,29	8,93	>=1
coefficient of innovation growth	0,78	0,51	0,35	0,34	0,37	0,51	0,55 - 0,60
share of innovation-active enterprises in the total number of industrial enterprises,%	13,8	16,2	17,4	16,8	16,1	17,3	30 %-20%
share of enterprises that implemented innovations in the total number of industrial enterprises,%	11,5	12,8	13,6	12,9	13,1	16,6	35-25%
share of enterprises that implemented innovative products in the total number of enterprises,%	20,1	21,9	23,9	20,9	21,4	13,3	35-25%
share of realized innovative products in the total volume of industry,%	3,23	3,25	2,64	3,30	2,50	1,30	15-12%
volume of innovative products sold outside of Ukraine, in the total volume of sold products,%	40,7	29,8	36,9	44,8	29,2	47,0	45-30%
share of expenditures on research and development in GDP,%	0,75	0,65	0,67	0,70	0,60	0,55	0,8-1,4%
share of researchers per 1000 people of the employed population,%	6,00	5,70	5,50	5,20	5,00	5,00	6-5%
share of State funds in the overall financing of innovations,%	1,08	1,04	1,95	0,26	4,47	0,40	1,5-2,5%
share of own funds in the total financing of innovations,%	59,3	52,9	63,9	72,9	84,9	97,2	50-60%
share of foreign investments in total financing of innovations,%	29,9	0,40	8,66	13,1	1,80	0,42	25-35%
Interaction of educational institutions and industry in R&D process, points	3,50	3,60	3,60	3,50	3,50	3,50	5,8-7,0
Number of patents on invention per 1 million of population, points	0,40	0,30	3,10	3,20	3,90	3,90	7,00

Source: [3,4,5].

There is an easier way of normalization – to approximate the input by function which values vary from 0 to 1, such as logistics sigmoidon:

$$f(x) = \frac{1}{1+e^{-x}} \tag{2}$$

As a result, we obtain converted input data which, according to the equation method of neural networks, corresponds to the calculation of the integral indicator of innovation activity

$$I_{IH} = \frac{1}{n} \sum_{i=1}^n f(x_i) \tag{3}$$

The results of the calculated values of integral indicators is shown in Fig.2.

As you may see on the picture, integral indicator according to the method presented in [8] is almost in line with integral index by the formula (3), but has another trend which is important for making conclusions.

The scale of assessment presented in [8] uses the following observation: the critical area (0-19 %); dangerous area – (20-39 %); unsatisfactory area (40-59 %), satisfactory area (60-79 %), optimal area (80-100 %). We will use the same areas for the second integral evaluation.

Thus, according to the calculations by the first method, the level of innovation activities from 2010 to 2015 is in the unsatisfactory area (59%). Some improvement was observed in 2014 and 2015. However, the value of integral indicator is at the lowest level of satisfactory area for innovation. Another overall indicator demonstrates a

smoother line which allows building a higher quality forecast. Starting from 2012, in the innovation activity of industrial enterprises we can observe a steady tendency to growth. Although in general, innovation activity is close to the border of unsatisfactory area. In the next five years, the overall level of innovation activity will increase by 0.03 points and will move out of unsatisfactory area. Based on the statistics, the weakest components are the following indicators:

- innovative growth that shows little experience of enterprises on the optimal management of innovation projects;

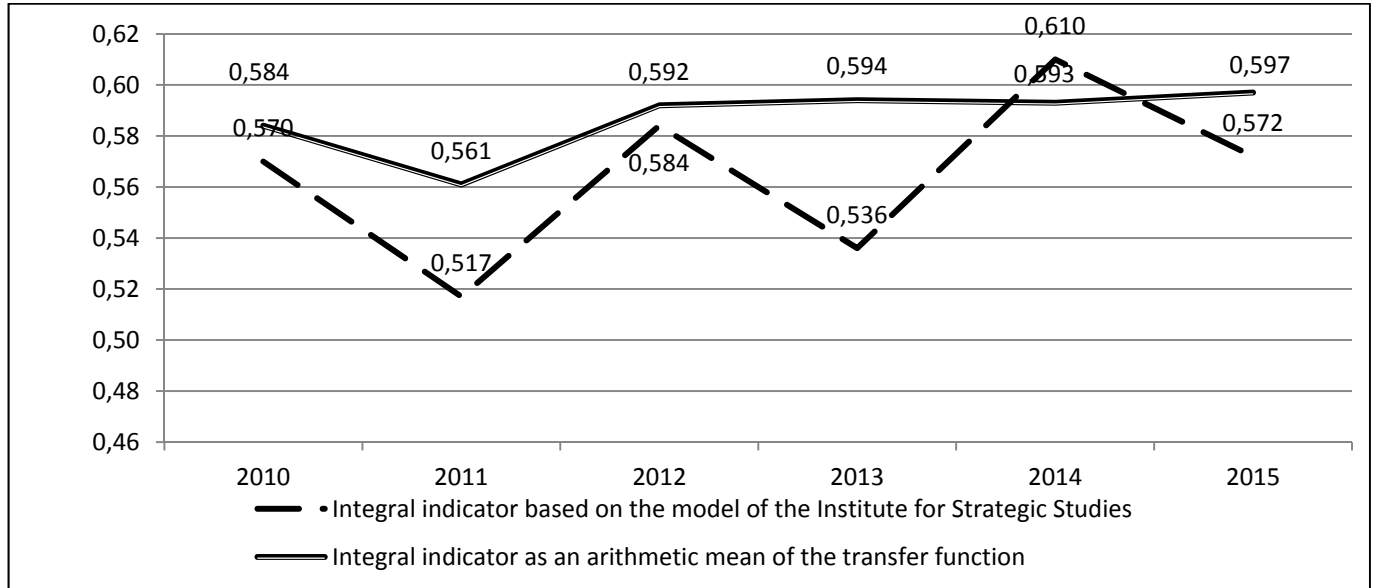


Figure 2. Dynamics of the integral indicator for estimation of innovation activity of industrial enterprises in Ukraine from 2010 to 2015.

- share of innovation-active enterprises – there is a necessary to increase their number twice;
- shares of State funds and foreign investments, so there is a need to change the Government policy to support innovative projects and attract foreign investors;
- there is still problem with quality of interaction between educational institutions and industry in R&D process, so there is a need of efficient program for such interaction.

In the process of development and implementation of industrial policies, it is important to use approaches that are specific to national industrial policy, which is implemented considering interests of individual producers, companies and the economy as a whole. In this regard, evaluation of innovation effectiveness can be performed by various methods, including those presented in this work.

Estimation results which show the level of innovation activity in the industry of Ukraine, provide possibility to determine the directions of overcoming the threats which involves development of an effective system of innovation policies in the industry to strengthen the innovative development of the country.

Conclusions. To eliminate the technological backwardness of the domestic industry, innovative activity should be performed constantly, because production, technology and organizational innovations are interdependent.

The basic principles of innovation management are:

- continuous forecasting of results of innovation development;
- dynamic overcoming of the technology gap;
- systematic implementation of the new products in the interrelated areas of business activities;
- integrated use of financial, technical and economic-mathematical analysis[10].

The proposed methodological approach to the calculation of the integral indicator of innovation activities allows combining several methods of economic-mathematical modeling, which does not significantly change the results of research, yet simplifies calculations and allows performing adequate monitoring of innovation development.

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