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THE INFLUENCE OF THE INDUSTRY'S INNOVATION ACTIVITIES INDICES ON THE INDUSTRIAL PRODUCTS' REVENUE OF UKRAINE

Olha Ilyash,

*The National Technical University
of Ukraine "Igor Sikorsky
Kyiv Polytechnic Institute", Kyiv,
Ukraine,
Nicolaus Copernicus University,
Torun, Poland
E-mail: oliai@meta.ua
ORCID: 0000-0002-7882-3942*

Iryna Dzhadan,

*National Institute for Strategic
Studies,
Kyiv, Ukraine,
E-mail: dzhadan.i@bigmir.net
ORCID 0000-0003-3887-4312*

Grzegorz Ostasz

*Rzeszów University of Technology,
Rzeszów, Poland,
E-mail: gost@prz.edu.pl
ORCID 0000-0002-7785-9302*

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ABSTRACT. The article determines the scientific and methodological prerequisites for studying the influence of the industry's innovation potential indices on the industrial products' revenue of Ukraine. The analysis of the main indices of industrial and technological development that influence the industry's development is conducted. The major problems of the industry's functioning and development are revealed. Direct foreign investments in the Ukrainian industry and direct Ukrainian investment in professional, scientific and technical activities of the world are investigated. It is established that Ukraine often finances the scientific and technological progress of other countries, at the same time remaining raw-oriented. The export of high-tech products in Ukraine and other countries of the world is analysed. Assessment of the level of dependence of the world economies' competitiveness on the development of innovations is carried out along with the assessment of effectiveness of the innovation potential implementation in Ukrainian industry during 2005-2016. The mathematical model of correlation between the industrial products' revenue and the indices of the innovation potential development of the Ukrainian industry is proposed. The results of the analysis of the innovation development indices, calculated for each factor of linear, power and multiple models are obtained. The ratio between the influence of innovation activities indices and the index of the industrial products' revenue is elaborated.

Keywords: innovation development, industrial production, industry's innovation activities, effectiveness of the innovation potential, industrial products' revenue, the volume of sold industrial products.

Introduction

The study of theoretical and practical aspects of the international economy functioning as a whole and of national economies separately, indicates an orientation towards the increasing importance of industries in the development of the world economy. Development of Ukraine's market economy clashed with the intensification of globalization processes in the world economy, which greatly influenced the prioritization of the domestic industry growth. If we talk about the directions of industrial growth in developed countries of the world, it must be noted that they concentrate efforts on the development of high-tech industries, whereas mass production is significantly reduced practically in all directions of the world industry.

We want to note that such a course is not accidental, but logical. Therefore, based on the results of the theoretical and practical research carried out by well-known foreign and domestic scientists, the determining source of a general improvement of production in the market environment should be a radical economic reform of the knowledge-intensive spheres of industrial activities. Grayson Jackson K. and Carl O'Dell in the book "American Management at the Turn of the Twenty-First Century", even before the crisis, pointed out that "the main feature of new economic systems should be the focus on the long-term perspective of fundamental research on industrial innovation".

O. Zozulov, while assessing the role of the innovation component in industrial development, identified innovational marketing as the main priority, noting that "integration processes between national economies will help reach the synergy effect due to establishing internal economic relations between production and consumption" (Zozulov, 2007). At the same time, scientists of the Institute of Industrial Economics of NAS of Ukraine in Kyiv think that the reasons for low level of competitiveness of Ukrainian industrial products are inefficient state policy in the industrial sphere, disinterest of domestic producers in developing their own innovation potential, and also overall political and economic instability in the country (Amosha, 2007).

1. Literature review

There are many approaches to defining the notion of innovation development of industry in scientific literature. The theory of the innovation type of development by J. Schumpeter (Schumpeter, 1934) consists in the fact that innovation as a change in technology or management is a factor of dynamic changes in the economy. G. Mensch determined that the economic crisis is a major stimulant to innovation development of industry (Mensch, 1979). Despite the fact that during the crisis, the size of corporate profits is small, investors think that it is less risky to invest in innovation technology than in existing products or technology (Mentel & Brożyna, 2015). R. Foster (Foster, 1986) discovered the regularities of innovation development of industry and the possibility of its prediction. C. Freeman, J. Clark and L. Soete, the authors of the concept of the technological system formation and the diffusion of innovations, introduced into the economic science a new category. They explained that "technological system is an innovation complex, associated with a common technological base, the spread of which greatly affects many fields of the economy even those which are not related to it" (Freeman, 1982).

Austrian economists F. Hayek and P. Drucker concluded that the two main criteria of industrial development were an innovative economy and an entrepreneurial society. These criteria consisted in describing the American model of innovation industrial development in

the 90's of the XX century that was characterised by the transformation of knowledge into a decisive productive force of economic development (Drucker, 1985). It is also worth noting that Drucker regarded innovation development as the transformation of market changes into new opportunities by entrepreneurs. According to the socio-psychological theory of innovation development by H. Barnett, E. Witte, E. Denison, the main factor of economic development is highly skilled workforce that generates new knowledge (Kolodiychuk, 2012; Bilevičienė et al., 2015).

Despite the considerable work of scientists, there is an objective need for an in-depth study of the influence of the innovation potential in industry on the formulation of a competitive strategy of the national economy based on the use of a mathematical model of dependence of industrial production volumes on the indices of the innovation potential of the Ukrainian industry. This actualizes the need to develop and apply functional models of intensifying the inflow of funds for innovation activities, the introduction of new technological processes and the manufacture of innovation types of products in the Ukrainian industry. The purpose of the study is to establish the existing functional dependence between the indices of innovation activities of industrial enterprises and the level of the national economy development.

2. Research methodology

It is worth mentioning that in order to prove the fact that the industry's efficient functioning depends on the level of innovation in this area, it is necessary to solve the problem of finding such an indicator of innovation activities in industry, which has the greatest impact on the industrial products' revenue (the volume of sold industrial products) of Ukraine.

In order to improve the accuracy of calculations and construct a predictive model, statistical information for the last 12 years has been processed. The choice of the period under study is conditioned by the following reasons: 1) the longer the period under study, the more accurate the forecast; 2) we use the statistical information from 2005 to 2017 because the macroeconomic indicators of Ukraine's development stabilized at that time.

In this case, we introduce graphical symbols for modelling: Y – revenue of industrial products, X1 – financing for innovation activities, X2 – new technological processes that are introduced, X3 – the manufacture of innovation types of products. The mathematical model of the process is presented graphically in Figure 1.

We will make a calculation when constructing the linear dependence of selected factors of innovation activities of Ukraine's industry by using the least squares method. To construct mathematical dependencies, we have solved a system of equations to determine the influence of each selected factor of the industry's innovation potential on the volume of sales.

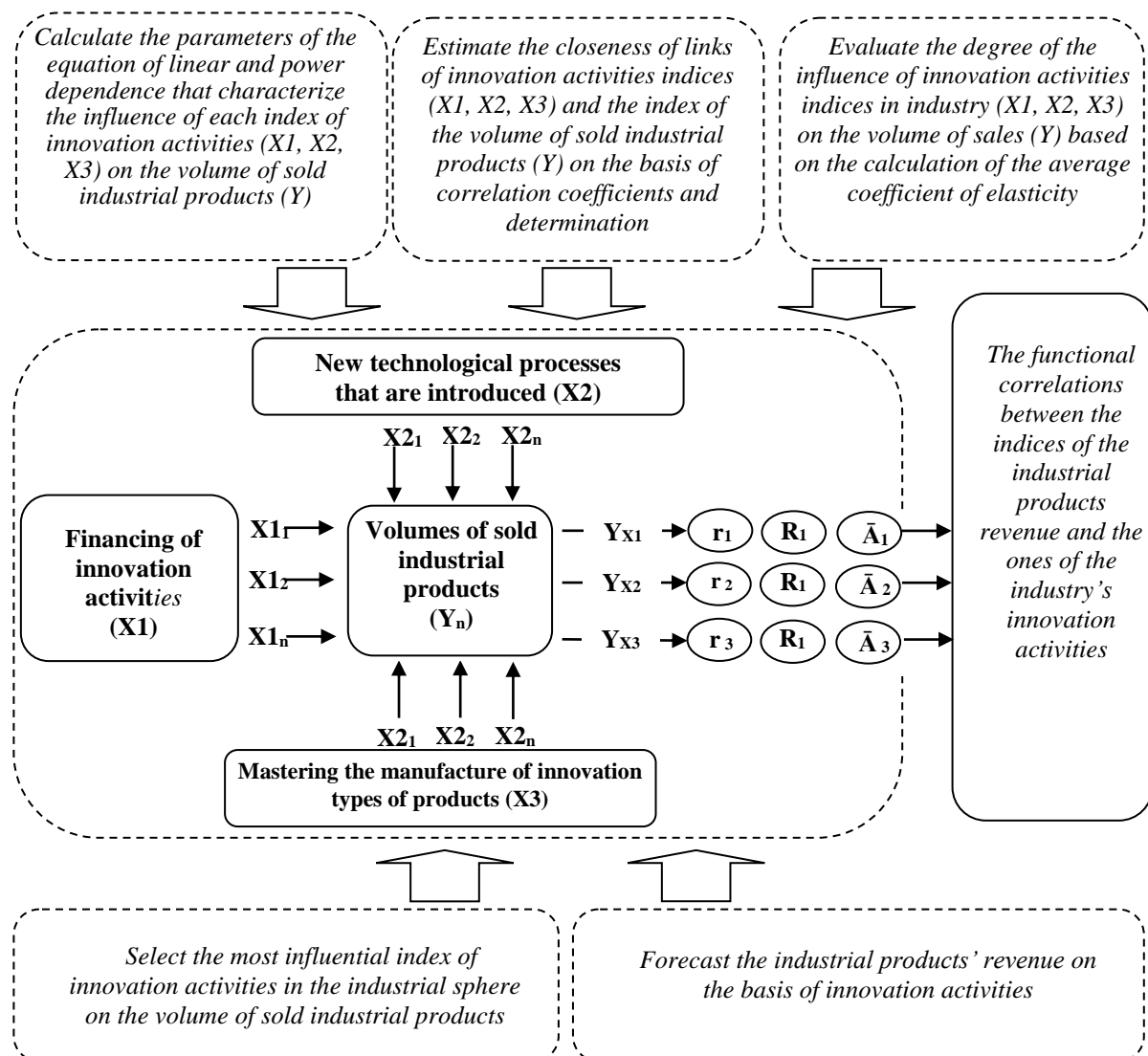


Figure 1. The mathematical model of correlation between the industrial products' revenue and the indices of innovation activities of the Ukrainian industry
Source: authors' own research results.

3. Results and discussion

3.1 Macroeconomic indicators that influence the development of the Ukrainian industry

The fundamental provisions of the national economy development and the industry's innovation activities served as theoretical and methodological basis of the research. In the process of work, we used methods of analysis and synthesis to find the best solutions concerning the choice of priority areas of the industry's innovation development. A factor method helped us to determine the relative and absolute degree of the influence of factors of innovation activities on the industry's development. Economic and statistical modelling employing linear, power and multiple regression assisted us in determining the influence of each selected factor of the industry's innovation potential on the volume of sold industrial

products. We applied the least squares analysis to define and analyse deviations of the indices of innovation activities of industrial enterprises.

The index of industrial and technological development of the country is an integral part of the factors of the national competitiveness of the economy. To identify the changes in the industrial process we have to analyse the dynamics of the industrial production index, which influences the indices of economic growth of the country. For instance, in 2014 the production was 10.1% higher than in 2013, while in 2015, it was 13% higher than in the previous year, but in 2016 the growth was only 2.8%. The increase in the industrial index in 2016 was mostly brought about by such industries as blacksmithing, moulding, pressing, forming, powder metallurgy (143%); sugar factory (36.2%); manufacture of rubber products (34%); manufacture of computers, electronic and optical products (26%); manufacture of electric engines, generator units and electric transformers (24.2%); manufacture of batteries and accumulators (39.8%).

Having compared the data with the change of GDP for the same period, we can conclude that the increase in the industrial index lags behind the gross domestic product index; it shows the decrease in the growth rate of essential branches (Figure 2).

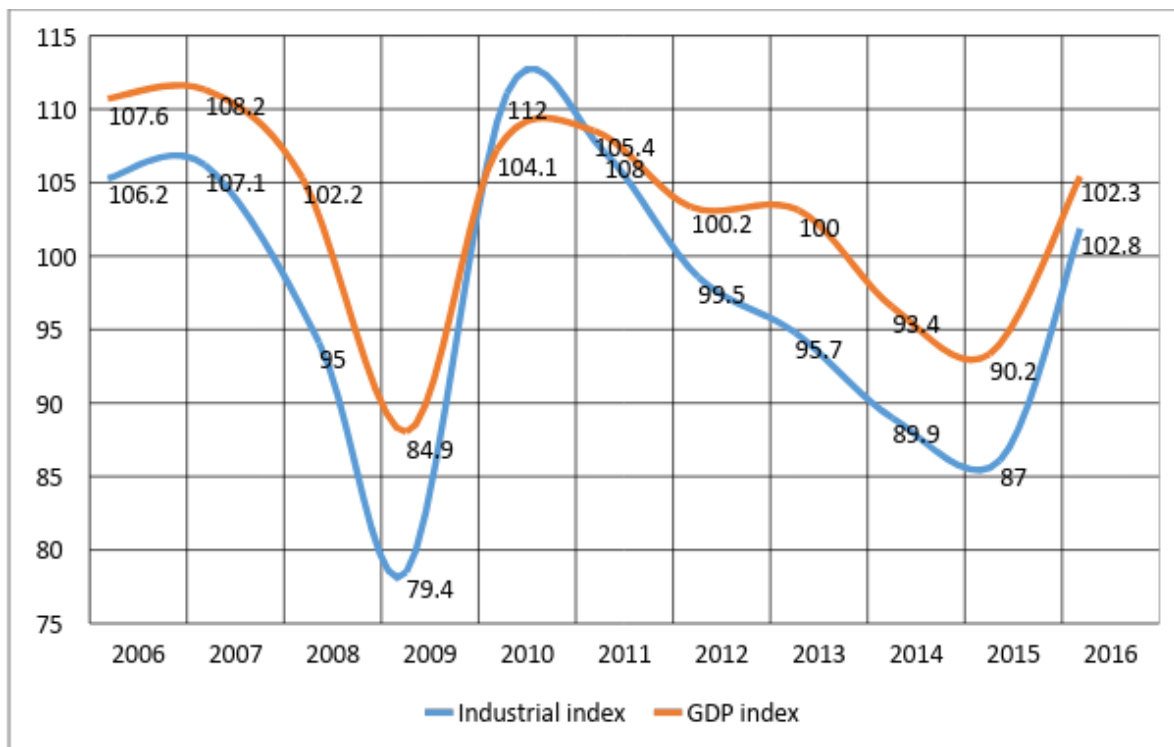


Figure 2. The dynamics of the gross domestic product index and the industrial index of Ukraine, 2006-2016

Source: *authors' own research results*

If we talk about macroeconomic indicators that influence the Ukrainian industry development, then it is worth comparing such indicators of competitiveness as direct foreign investments and the capital outflow. If the manufacture of industrial products is promising, the volume of incoming investments will show a stable growth; otherwise, a decrease in investments in production will reflect a high risk of investments. The total volume of direct

foreign investment in the economy of Ukraine in 2016 was \$37.6 billion, which is 4.1% more than in the previous year. 92 countries made investments; major investors were Cyprus with an investment of \$9.6 billion, the Netherlands - \$5.7 billion, the Russian Federation - \$4.3 billion, the United Kingdom - \$2 billion, which is 57% of the total investment. At the same time, during the period from 2009 to 2016, Germany has made a stable reduction in investments from \$6 billion to \$1.6 billion, which is almost four times less over seven years.

Although in 2016, there was an increase in investments; unfortunately, Ukraine is not yet an investment attractive economy. It is obvious that the outflow of money is currently associated with economic uncertainty, weak protection of property rights, a complicated procedure of issuing permits and licenses, the organization of tax system, the deterioration of the political situation and a complicated situation in Donetsk and Luhansk regions. Therefore, foreign investors prefer to invest in new markets, such as China, Singapore.

Meanwhile, in 2016, Ukraine sent \$6.3 billion abroad. According to the State Statistics Service of Ukraine, most of the Ukrainian businesses that are engaged in investment abroad invest in scientific and technical activities, finance and insurance. On the other hand, the funds that go to Ukraine are mostly directed at the financial sector and the mining industry. That is, Ukraine stimulates the technical progress of other countries, while it stays a production and raw material economy.

Table 1. Direct investments in the economy of Ukraine, 2010-2017 (million of American dollars)

| Year | Direct investment in the economy of Ukraine | Direct investment in Ukrainian professional, scientific and technical activities | Direct foreign investment in the Ukrainian industry | Direct Ukrainian investment in other countries' economies | Direct Ukrainian investment in professional, scientific and technical activities of the world | Direct foreign investment from Ukraine in the world's industry |
|------|---|--|---|---|---|--|
| 2010 | 38 992.9 | 1 133.1 | 16 473.7 | 5 760.5 | 5 325.7 | 92.4 |
| 2011 | 45 370.0 | 1 182.0 | 18 693.8 | 6 402.8 | 5 881.0 | 127.7 |
| 2012 | 48 197.6 | 2 072.5 | 17 303.8 | 6 435.4 | 5 865.1 | 136.6 |
| 2013 | 51 705.3 | 2 831.0 | 18 031.1 | 6 568.1 | 5 881.9 | 149.7 |
| 2014 | 53 704.0 | 4 006.8 | 17 681.4 | 6 702.9 | 6 030.6 | 174.5 |
| 2015 | 40 725.4 | 2 634.5 | 12 419.4 | 6 456.2 | 5 968.6 | 132.5 |
| 2016 | 36 154.5 | 2 222.6 | 9 893.6 | 6 315.2 | 5 953.2 | 109.6 |
| 2017 | 37 655.5 | 2 196.2 | 9 550.2 | 6 340.6 | 5 966.4 | 114.0 |

Source: *authors' own research results according to the data of State Statistics Service of Ukraine, 2014-2016*

The report of Global Financial Integrity on the topic "Illegal export of capital from countries" states that over 10 years (2004-2013) more than \$116 million was withdrawn from Ukraine abroad.

If we look at the investment statistics by region, the leader of the investments attracted in 2016 undoubtedly is Kiev with \$21.4 billion, which accounts for 57% of all foreign investments in Ukraine this year. Dnipropetrovsk region received \$3.4 billion, Donetsk region received \$1.6 billion, Kharkiv region got \$1.6 billion, Kyiv region received \$1.5 billion, Lviv

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region got \$1.5 billion, Odessa region received \$1.3 billion, and Poltava region got \$1 billion. Each of the rest of the regions managed to attract less than \$1 billion of investment. The absolute outsider is Ternopil region, where foreign investors sent only \$48 million since the beginning of the year. At the same time, it is interesting that the largest outflow of capital was recorded from the war-ravaged Donetsk region, \$5.9 billion from the beginning of the year. This is 93.6% of all investments sent from Ukraine abroad. In general, Ukrainian business sends funds to 47 countries, but more than 96.2% of this money goes to offshore Cyprus.

Attracted foreign investments allow the recipient country to gain a range of benefits. Improvements in the balance of payment, the transfer of modern technologies and knowledge, the complex resource exploitation, the development of export potential and a decrease in the level of dependence on import, the achievement of a social and economic effect (an increase in the employment level, the development of social infrastructure etc.) are among them. At the same time, foreign investments use has potential hazards for the country, such as over-exploitation of resources and environmental pollution, a rise in the level of dependence of the country on foreign capital, a fall in the competitiveness level of national producers, the transfer of capital abroad (Bezzub, 2017)

It is commonly known that the country's volume of trade in advanced technology products is an important factor of the innovative capability of the country (Mel'nyk, 2011). The export of advanced technology products is a determinant of economic growth of such countries as China, Singapore, and Kazakhstan. For example, the priority of the development of advanced technologies in Singapore has promoted economic growth and the GDP of the country has increased over the last 25 years by 6.6 times, while the GDP of Ukraine during this period has grown only by 1.2 times. Thus, the export of advanced technology products is an indicator of the assessment of the efficiency of innovation and the implementation of the country's innovation strategy (Levkivs'kyj, 2016).

Table 2. The export of advanced technology products in Ukraine and other countries, 2000-2016 (% of total exports)

| Country | Year | | | | | | | | | | |
|------------------------|------|------|------|------|------|------|------|------|------|------|------|
| | 1990 | 2000 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Singapore | 40 | 63 | 49 | 48 | 50 | 45 | 45 | 47 | 47 | 49 | 67 |
| The Philippines | - | 73 | 66 | 66 | 55 | 46 | 49 | 49 | 49 | 53 | 55 |
| Kazakhstan | - | 1 | 22 | 30 | 34 | 25 | 30 | 37 | 37 | 41 | 30 |
| France | 17 | 25 | 20 | 23 | 25 | 24 | 25 | 26 | 26 | 27 | 27 |
| Korea | 18 | 35 | 28 | 29 | 29 | 26 | 26 | 27 | 27 | 27 | 27 |
| China | - | 19 | 26 | 28 | 28 | 26 | 26 | 27 | 25 | 26 | 25 |
| Germany | 12 | 19 | 13 | 15 | 15 | 15 | 16 | 16 | 16 | 17 | 17 |
| Ukraine | - | 5 | 3 | 6 | 4 | 4 | 6 | 6 | 7 | 7 | - |
| The Russian Federation | - | 16 | 6 | 9 | 9 | 8 | 8 | 10 | 11 | 14 | 11 |

Source: *authors' own research results according to the data of the World Bank*

According to the World Bank, in 2016, top-10 main exporters of advanced technology products were China (\$496 bln., 25% of total export), Germany (\$189 bln., 17% of total export), North America (\$177 bln., 19% of total production), the USA (\$153 bln., 20% of total production), Singapore (\$126 bln., 67% of total production), Korea (\$118 bln., 27% of total production), France (\$103 bln., 27% of total production), Japan (\$92 bln., 16% of total export), Great Britain (\$68 bln., 21% of total production), Malaysia (\$55 bln., 43% of total

production) and Switzerland (\$54 bln., 27.8% of total production). In comparison, Ukraine exported \$1.3 bln. of advanced technology products, that is 7% of total production (Figure 3).

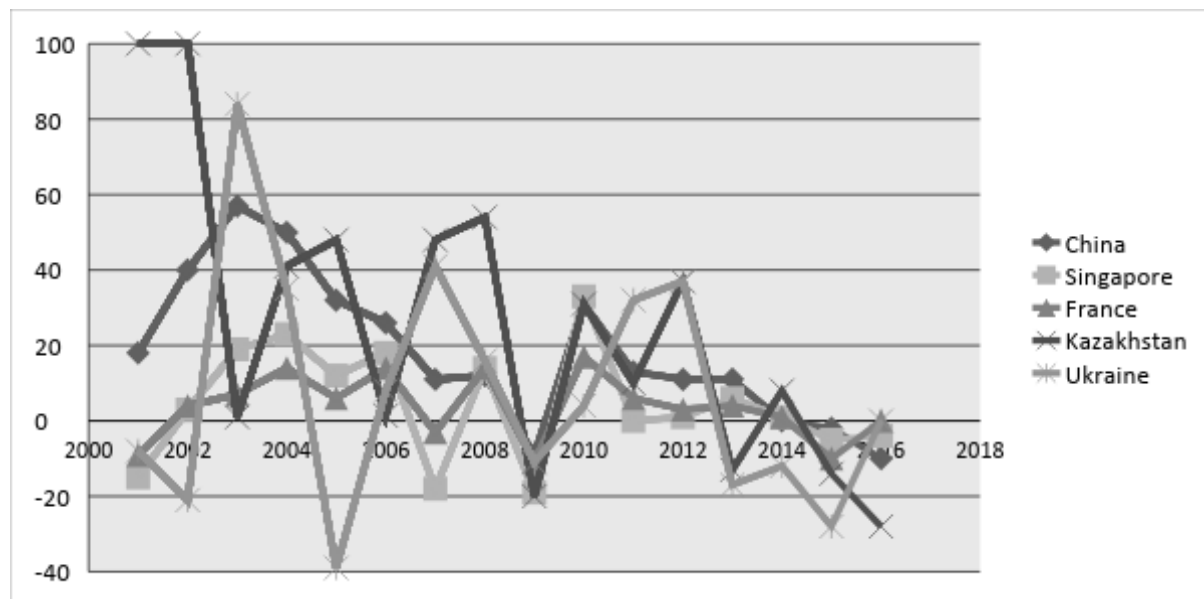


Figure 3. Dynamics of growing rates of exporting advanced technology products in Ukraine and other countries, 2001-2016

Source: authors' own research results according to the data of the World Bank

However, it is worth mentioning that to ensure further dynamic economic development with significant growth rates as well as a stable share of STEM-specialists, we need to either dramatically increase intellectual potential of the specialists or shift to the new phase of economic development, when the development is determined by other factors and technologies. Therefore, the question is whether the economy will be innovative or based on other determinants (Pivniak, 2016).

The dynamic development of the world economy and constant changes taking place in the Ukrainian economy necessitate the harmonization of the measurement of how efficiently one implements the industry's innovation potential with the benchmarks for the development of industrial activities. Due to structural changes and new technologies, the process of production becomes more efficient, the vulnerability of the economy to cyclical fluctuations decreases, the level of technological modernization of the economy, which is based on the transition from a labour-intensive to technology-intensive economy, rises (Figure 4) (United Nations: Industrial Development Report, 2016).

In view of this, it is essential to choose adequate methods, models, criteria and indicators of evaluating the dependence of the industry's efficiency on the level of innovation activities of the industrial area. In addition, those criteria, methods and indicators should meet the modern requirements of economic development of the global market system, take into account the specifics of the Ukrainian economy development and reflect the interrelation of economic security with the competitiveness of the state. It is worth mentioning that the UN report pays much attention to scientific and technological progress and industrial innovation.

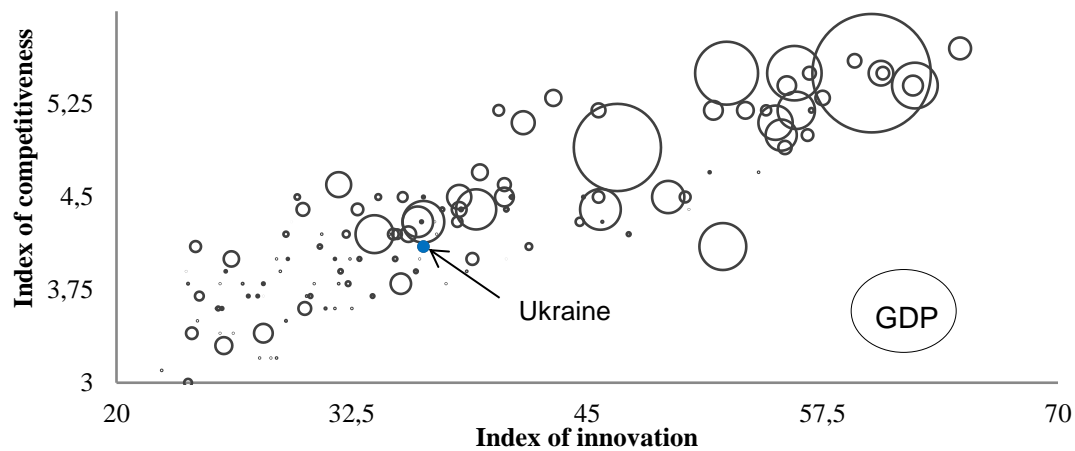


Figure 4. The level of dependence of the world economies' competitiveness on the development of innovations, 2016

Source: *authors' own research results*

3.2 Data analysis

Despite the increase in 2017 by 1.6% in the number of industrial enterprises that carried out innovation activities (834 enterprises or 18.9% of industrial enterprises of Ukraine), the problem of financing for innovation activities remains unresolved due to the limited budget funds within the framework of state innovation policy (Figure 4). As a rule, financial resources are directed not at mastering new highly efficient developments and start-ups, but at the maintenance of state innovation funds, the implementation of targeted innovation programmes and innovation projects within the framework of programmes of state support for innovation (Khovrak, 2013).

The conducted research shows that during 2016, enterprises spent 23.2 billion UAH on innovation, including 19.8 billion UAH on the purchase of machinery, equipment and software, 2.4 billion UAH on internal and external research and development, 0.1 billion UAH on the acquisition of existing knowledge from other enterprises or organisations and 0.9 billion UAH on other innovation activities (design, training, marketing and other related activities). The main source of financing for innovation expenses is own funds of enterprises – 22.0 billion UAH or 94.9% of the total amount of innovation expenses, and they are mainly directed at the purchase of equipment and other fixed assets, while there is minimum spending on acquiring technology and conducting own researches.

It should be noted that in 2016, 4139 innovation types of products were introduced by innovatively active industrial enterprises, 978 of those products were new exclusively for the market, and 3161 were new only for the enterprise. Of the total number of introduced products, 1305 units comprised new types of machinery, equipment, devices, apparatus, etc., 22.3% of them were new for the market. The largest number of innovation types of products was introduced at the enterprises manufacturing machinery and equipment, food products, metallurgical production (State Statistics Committee of Ukraine).

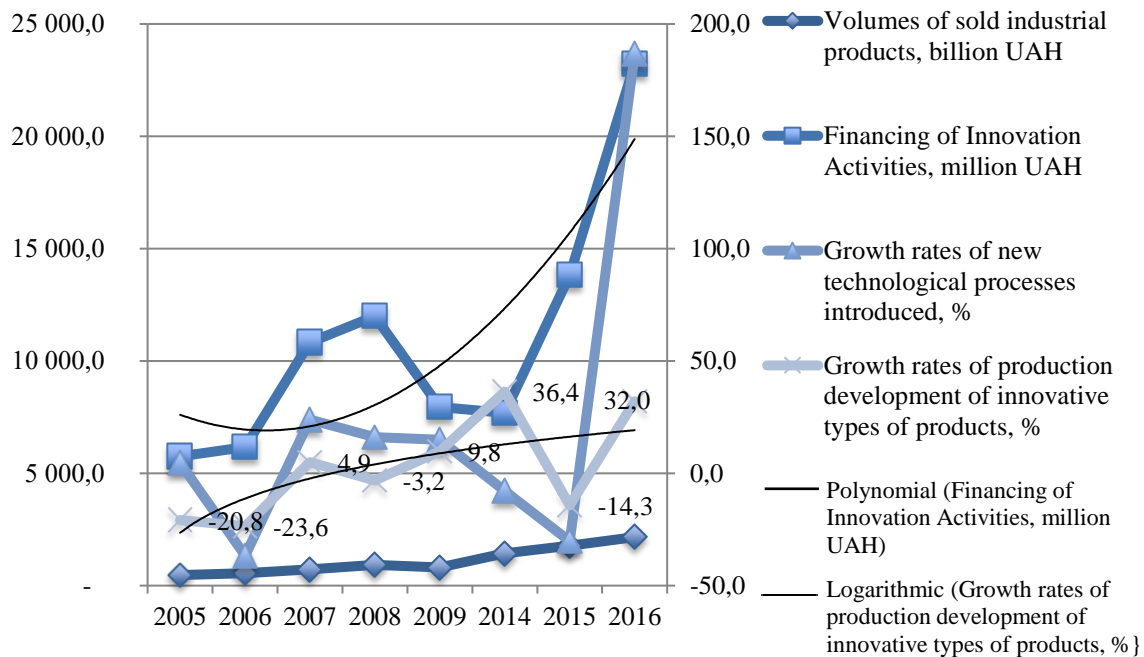


Figure 5. The efficiency of implementing the innovation potential of the Ukrainian industry, 2005-2016

Source: Authors' own research results according to the data of State Statistics Service of Ukraine, 2014-2016

The last five years there has been a decline in the activities of the Ukrainian innovation policy. It is demonstrated not only by a decrease in the number of industrial enterprises engaged in innovation activities, but also by the unstable number of enterprises that implement innovations, as well as by a fall in the share of innovation products in their general production. This fact raises serious concerns about further development of the domestic industry, since the competitiveness of an enterprise in general and of the products it produces depends on the technical level of equipment and its compliance with the pace of scientific and technological progress.

Based on the calculations of the impact of financing for innovation activities on the the volume of sold industrial products, we have the following linear model: $Y = 479811,75 + 61,95 X_1$, which shows the impact of the increase in financing for innovation activities by 1 UAH on the increase in industrial products' revenue by 61.95 UAH (Figure 6).

Thanks to the performed calculations of the impact of newly introduced technological processes on the industrial products' revenue, we obtained the following linear model: $Y = 409064,3 + 394,85 X_2$. It shows the impact of the increase in the introduction of new technological processes by 1 unit on the increase in the revenue of industrial products by 394.85 UAH (Figure 7).

For the factor of the introduction of new technological processes, we obtain the following indices of accuracy of the performed calculations and efficiency of using the linear form of dependence: $r = 0.5006$; $R^2 = 0.2506$; $A = 40.01\%$, which suggest that this equation can be used as linear regression to predict the impact on the industrial products' revenue.

Proceeding from the calculations of the influence of the mastered manufacture of innovation types of products on the revenue of industrial products, we have the following

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linear model: $Y = -455656.93 + 531.95 X_3$. It shows that the increase in mastering the manufacture of innovation types of products by 1 unit makes an impact on the increase in the volume of sold industrial products by 531.95 UAH (Figure 8).

| Year | Y | X ₁ | X ₁ *Y | (Y-Y*) ² /Y |
|------|-------------|----------------|-------------------|------------------------|
| 2005 | 468562,60 | 5751,60 | 2694984650,16 | 0,7844 |
| 2006 | 551729,00 | 6160,00 | 3398650640,00 | 0,5613 |
| 2007 | 1428839,10 | 10821,00 | 15461467901,10 | 0,1950 |
| 2008 | 806550,60 | 11994,20 | 9673929206,52 | 0,5162 |
| 2009 | 1043110,80 | 7949,90 | 8292626548,92 | 0,0679 |
| 2010 | 1322408,40 | 8045,50 | 10639436782,20 | 0,2603 |
| 2011 | 717076,70 | 14333,90 | 10278505710,13 | 0,9075 |
| 2012 | 1367925,50 | 11480,60 | 15704605495,30 | 0,1293 |
| 2013 | 917035,50 | 9562,60 | 8769243672,30 | 0,1692 |
| 2014 | 1776603,70 | 7695,90 | 13672564414,83 | 0,4616 |
| 2015 | 1305308,00 | 13813,70 | 18031133119,60 | 0,0232 |
| 2016 | 2158030,00 | 23229,50 | 50129957885,00 | 0,1108 |
| Sum | 13863179,90 | 130838,40 | 166747106026,06 | 4,19 |

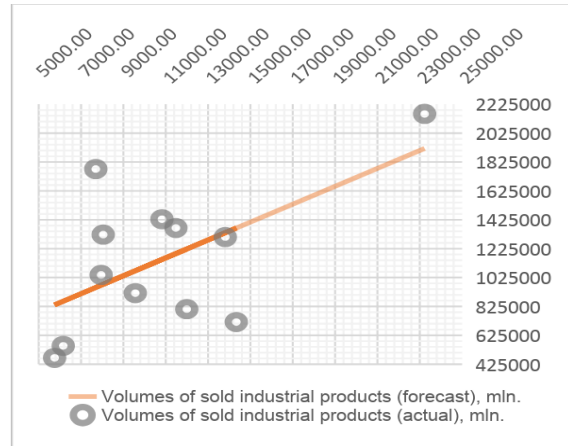


Figure 6. Linear regression of the influence of financing for innovation activities on the industrial products' revenue in Ukraine, 2005-2016

Source: authors' own research results

| Year | Y | X ₂ | X ₂ *Y | (Y-Y*) ² /Y |
|------|-------------|----------------|-------------------|------------------------|
| 2005 | 468562.60 | 1808.00 | 847161180.80 | 1.40 |
| 2006 | 551729.00 | 1145.00 | 631729705.00 | 0.56 |
| 2007 | 1428839.10 | 1419.00 | 2027522682.90 | 0.32 |
| 2008 | 806550.60 | 1647.00 | 1328388838.20 | 0.31 |
| 2009 | 1043110.80 | 1893.00 | 1974608744.40 | 0.11 |
| 2010 | 1322408.40 | 2043.00 | 2701680361.20 | 0.08 |
| 2011 | 717076.70 | 2510.00 | 1799862517.00 | 0.95 |
| 2012 | 1367925.50 | 2188.00 | 2993020994.00 | 0.07 |
| 2013 | 917035.50 | 1576.00 | 1445247948.00 | 0.12 |
| 2014 | 1776603.70 | 1743.00 | 3096620249.10 | 0.38 |
| 2015 | 1305308.00 | 1217.00 | 1588559836.00 | 0.32 |
| 2016 | 2158030.00 | 3489.00 | 7529366670.00 | 0.17 |
| Sum | 13863179.90 | 22678.00 | 27963769726.6 | 4.80 |

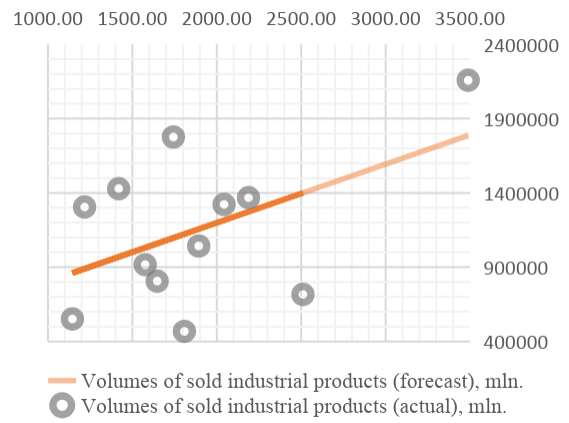


Figure 7. Linear regression of the influence of newly introduced technological processes on the industrial products' revenue in Ukraine, 2005-2016

Source: authors' own research results

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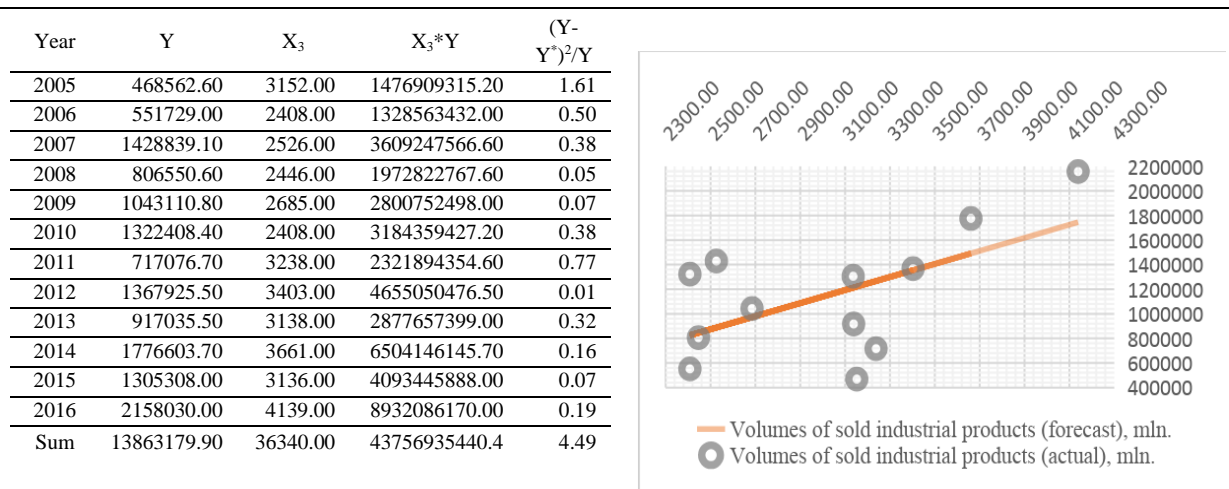


Figure 8. Linear regression of the influence of the mastered manufacture of innovation types of products on the industrial products' revenue in Ukraine, 2005-2016
Source: authors' own research results

Considering the fact that the main task of this stage of the research is to establish the most effective form of the dependence of the volume of sold products on the factors of innovation activities, then it is necessary to build a power model.

Based on the calculations of the impact of financing for innovation activities on the revenue of industrial products, we have obtained power models. These models demonstrate the impact of the increase in financing for innovation activities by 1 UAH on the increase in the volumes of sold industrial products by 150.73 UAH; the increase in the introduction of new technological processes by 1 unit on the increase in the industrial products' revenue by 422.19 UAH; the increase in the development of innovation types of products by 1 unit on the increase in volumes of sold industrial products by 345.9 UAH (Figure 9, 10, 11).

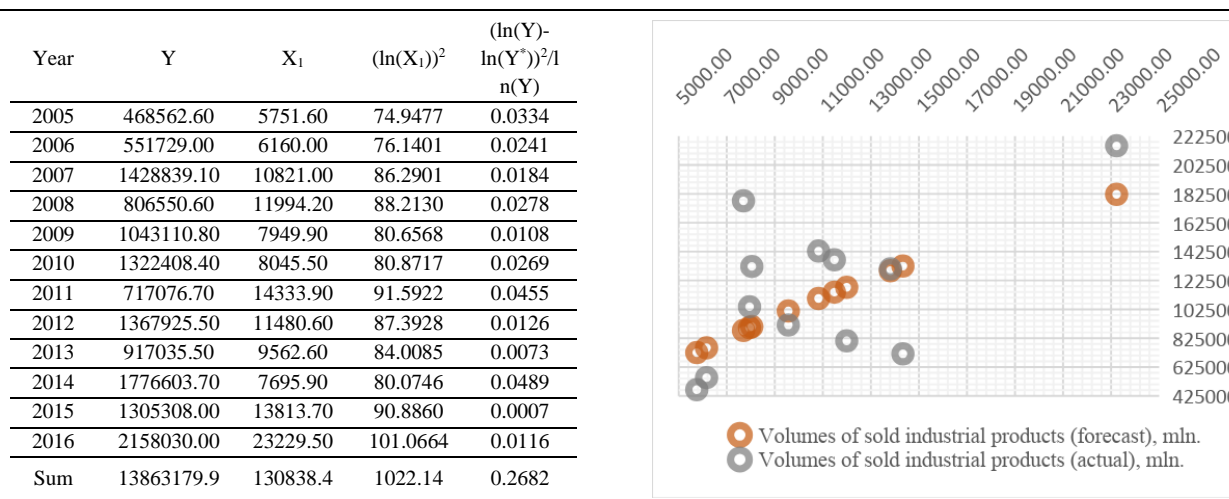


Figure 9. Power regression of the impact of financing for innovation activities on the industrial products' revenue in Ukraine, 2005-2016
Source: authors' own research results

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| Year | Y | X ₂ | (ln(X ₂)) ² | (ln(Y)-ln(Y*)) ² /ln(Y) |
|------|------------|----------------|------------------------------------|------------------------------------|
| 2005 | 468562.60 | 1808.00 | 56.2496 | 0.0620 |
| 2006 | 551729.00 | 1145.00 | 49.6061 | 0.0296 |
| 2007 | 1428839.10 | 1419.00 | 52.6743 | 0.0311 |
| 2008 | 806550.60 | 1647.00 | 54.8594 | 0.0158 |
| 2009 | 1043110.80 | 1893.00 | 56.9409 | 0.0026 |
| 2010 | 1322408.40 | 2043.00 | 58.0975 | 0.0113 |
| 2011 | 717076.70 | 2510.00 | 61.2782 | 0.0421 |
| 2012 | 1367925.50 | 2188.00 | 59.1475 | 0.0110 |
| 2013 | 917035.50 | 1576.00 | 54.2085 | 0.0045 |
| 2014 | 1776603.70 | 1743.00 | 55.7018 | 0.0377 |
| 2015 | 1305308.00 | 1217.00 | 50.4689 | 0.0309 |
| 2016 | 2158030.00 | 3489.00 | 66.5427 | 0.0240 |
| Sum | 13863179.9 | 22678.0 | 675.7755 | 0.3026 |

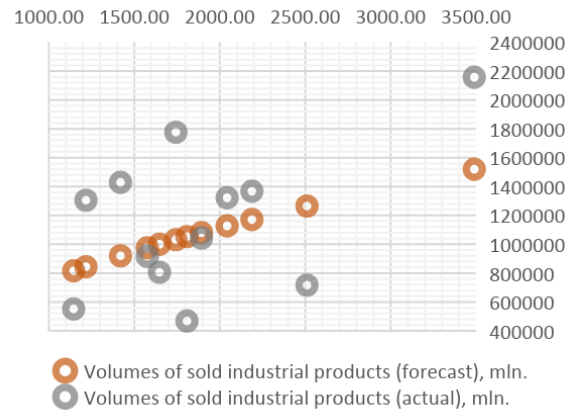


Figure 10. Power regression of the impact of newly introduced technological processes on the industrial products' revenue in Ukraine, 2005-2016

Source: authors' own research results

| Year | Y | X ₃ | (ln(X ₃)) ² | (ln(Y)-ln(Y*)) ² /ln(Y) |
|------|------------|----------------|------------------------------------|------------------------------------|
| 2005 | 468562.60 | 3152.00 | 64.8958 | 0.0667 |
| 2006 | 551729.00 | 2408.00 | 60.6304 | 0.0305 |
| 2007 | 1428839.10 | 2526.00 | 61.3777 | 0.0348 |
| 2008 | 806550.60 | 2446.00 | 60.8745 | 0.0031 |
| 2009 | 1043110.80 | 2685.00 | 62.3379 | 0.0079 |
| 2010 | 1322408.40 | 2408.00 | 60.6304 | 0.0334 |
| 2011 | 717076.70 | 3238.00 | 65.3302 | 0.0353 |
| 2012 | 1367925.50 | 3403.00 | 66.1361 | 0.0080 |
| 2013 | 917035.50 | 3138.00 | 64.8241 | 0.0142 |
| 2014 | 1776603.70 | 3661.00 | 67.3301 | 0.0203 |
| 2015 | 1305308.00 | 3136.00 | 64.8138 | 0.0113 |
| 2016 | 2158030.00 | 4139.00 | 69.3591 | 0.0239 |
| Sum | 13863179.9 | 36340.0 | 768.5401 | 0.2895 |

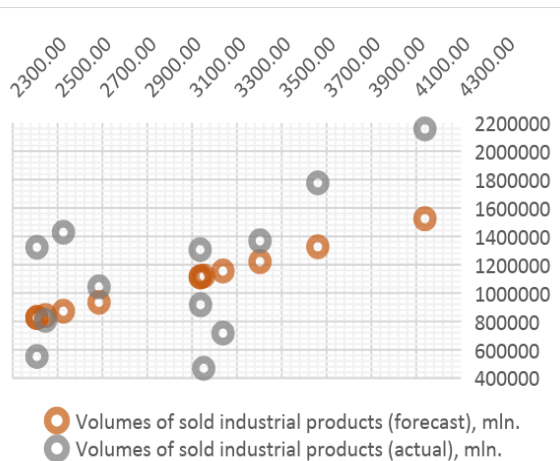


Figure 11. Power regression of the impact of mastered manufacture of innovation types of products on the industrial products' revenue in Ukraine, 2005-2016

Source: authors' own research results

We have also studied the possibility of the existence of multiple regression. After analyzing the influence of the factors of innovation activities on the volume of sold industrial products, we obtain the following equation of multiple regression:

$$Y = -269122.324 - 621.8479X_1 + 603.5009X_2 + 1380.8018X_3,$$

In this case, the average approximation error is 270.55%, which suggests that this equation

cannot be used as multiple regression to predict the impact of the factors of the industry's innovation activities on the industrial products' revenue in Ukraine.

Thus, the power dependence shows higher accuracy than the linear one, whereas the multiple one is of little value; therefore, the power dependence should be used when predicting the innovation development of the Ukrainian economy. Since the index of the volume of manufacturing innovative products makes a major impact on the total volume of sales, then, in this case, it is the most appropriate to use this particular model for forecasting. The obtained results of analysing the innovation development indices, calculated according to each factor of linear, power and multiple models, allowed establishing the degree of the influence on the index of the revenue of industrial products, where the most influential factor was financing for innovation activities and the least influential – the introduction of new technological processes.

Conclusions

Under modern circumstances in the national economy, the innovation development is crucial for forming the industry's competitive positions. In this regard, we have proven the dependence of the industry's efficient functioning on innovation activities.

The theoretical part of the article explains that the development of the country's economy depends on the industrial products' revenue, which in its turn is connected with a number of indices of the industry's innovation activities. The main indices are the amount of trade in high-tech goods, the production volume of innovative types of products, the volume of the new technological processes implementation, the volume of financing for innovation activities, the volume of the direct foreign investments, etc.

We have examined the linear, power and other composite regression by means of the chosen specific model. Thus, we have found the correlation between the amounts of sold industrial products and the main indices of innovation activities.

The goal is to find the most important factor of innovation activities with the main impact. It allows choosing the most appropriate directions of the innovation development in the Ukrainian industry, which ensures high effectiveness with the lowest investments. The developed countries such as China and Singapore are examples of the practical implementation of innovative development models. Industry's innovation activities are one of the possible ways to increase the overall competitiveness of the country's economy.

The proposed approach allows determining the best models of the industry's innovation development, as well as identifying possible opportunities for managing the industry's competitiveness on the international market.

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