

Innovation and Labor Productivity: Empirical Studies of Industrial Enterprises in Ukraine

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Abstract

The development of the industrial sector of Ukraine is impossible without the growth of labor productivity on the basis of improving the qualitative characteristics of the fixed assets and human resources involved, as well as the expansion of innovative activity of industrial enterprises. The study aims to deepen the empirical discussion in two directions: conducting a comparative analysis of the productivity of industrial enterprises in individual EU countries and Ukraine; substantiation of the need for the transition of industrial enterprises from growth based on capital accumulation to growth based on innovation. The aim of the article is to substantiate the directions of increasing the level of labor productivity by increasing the innovative activity of industrial enterprises. To study the productivity of industrial enterprises, data from Eurostat and the State Statistics Service of Ukraine for 2017 and individual indicators for 2010-2018 are used. The method of comparative analysis of the main indicators affecting the productivity of industrial enterprises of Germany, France, Italy, Hungary, Poland, Slovenia, Slovakia and Ukraine is applied. According to the results of the analysis, it has been determined that labor productivity at Ukrainian enterprises is much lower than in the studied group of countries. A comparative analysis of the factors that influence the size of labor productivity has led to the conclusion that ensuring productivity growth at processing enterprises in Ukraine cannot be ensured by the increase in the volume of attracted resources. It has been concluded that the growth of labor productivity based on innovation should be oriented towards enhancing the dynamics of the cost of innovation; improving the structure of innovative spending directions towards increasing the share of expenditures on financing of internal and external research development; expanding the list of sources of financing innovative activity of industrial enterprises by increasing the volume of attracted financial resources from Ukrainian and foreign investors.

Keywords: Labor productivity, industrial enterprises of Ukraine, innovative activity, capital investments

Introduction

The main indicator that allows evaluating the productivity of industrial enterprises is the indicator of labor productivity – a general indicator that characterizes the efficiency of labor resources use in the production of industrial goods.

In a broad sense, labor productivity is the efficiency of useful labor that determines the effectiveness of its use in a specific period of time, under conditions that exist during that period. The characteristics of the efficiency and effectiveness of useful work are influenced, on the one hand, by the qualitative characteristics of the labor resources involved in the process (their qualifications, professional and moral abilities, psychological mood, etc.), on the other – the conditions of use of labor resources (the state of the means of labor and technology, working conditions, etc.).

Depending on the specifics of the industry and the labor parameter (the amount of time spent or the number of employees involved), labor productivity is characterized by the ratio of the volume of production in physical, labor or value terms to the time spent on its production, or the number of employees involved.

Labor productivity growth, as a factor in the development of the industrial sector, can occur through: investing additional capital and attracting additional labor; the impact of technological change and the expansion of innovative activities of industrial enterprises.

Due to the lack of research to justify the relationship between innovation activity and labor productivity at the level of industrial enterprises of Ukraine, this study aims to deepen the empirical discussion in two directions: conducting a comparative analysis of the productivity of industrial enterprises in individual EU countries and Ukraine; substantiation of the need for the transition of industrial enterprises from growth based on capital accumulation to growth based on innovation.

Brief Literature Review

A considerable amount of foreign research on the importance of the identified areas of industry development argues that the expansion of innovation provides an explanation for more than half of the variation in productivity (Cassiman & Golovko, 2011; Huergo & Jaumandreu, 2004; Isabel Martínez Martín, Miguel Sánchez Galindorez, César & Lopez, César Rosa Santero Sánchez, 2019; Tsai & Wang, 2004; Alfredo D'Angelo & Alessandro Baroncelli, 2019; Wakelin, 2001). Some scholars (Griffith, Huergo, Mairesse & Peters, 2006) argue that post-war growth in Europe has largely been based on capital accumulation, whereas what is needed now is that European countries reorient themselves towards innovation-based growth .

In conditions of capital shortages, problems associated with a shortage of qualified labor resources and a high degree of deterioration of fixed assets in the industrial sector of Ukraine, the influence of the first direction of productivity growth is weak (Sergiychuk, Karas, 2011; Kapinos, 2015; Goncharov, 2014; Semykina, 2010) . The above mentioned allows us to conclude that one of the important factors of the extensive type of economic development of enterprises in the country's industrial sector is the growth of labor productivity based on an increase in their innovative activity.

The purpose

The aim of the article is to substantiate the directions of increasing the level of labor productivity by increasing the innovative activity of industrial enterprises (a significant increase in the number of innovatively active enterprises, an increase in the share of expenses for internal and external research and development, expanding sources of financing innovation in the industrial sector, while maintaining amounts of financing from own funds). The basis of the study is a set of industrial enterprises of Ukraine.

Methods

To study the labor productivity of enterprises in the industrial sector, data from Eurostat and the State Statistics Service of Ukraine for 2017 and individual indicators for 2010-2018 are used. The method of comparative analysis of the main indicators that affect the labor productivity of industrial enterprises in Germany, France, Italy, Hungary, Poland, Slovenia, Slovakia and Ukraine is used. The theoretical basis of the study was the latest articles and publications of scientists who have studied the problem of labor productivity in industry.

Results

To analyze the activities of industrial enterprises, a general indicator used to determine labor productivity is the volume of sales per employed person in the industrial sector.

According to Eurostat (2017), the figure in Germany was 296 thousand euros per employee, in France – 329 thousand euros, in Italy – 258 thousand euros (Table 1).

Table 1: Industrial labor productivity in individual EU countries, 2017 (processing industry)

Indicator	Germany	France	Italy
Number of enterprises	190541	197657	383585
Sales volume, EUR million	2193357,5	1021247,9	965031,0
Number of persons employed	7409552	3103594	3744271
Labor productivity (volume of sales per employee), thousand euros	296,0	329,1	257,7
Labor productivity (gross value added per employed person), thousand euros	79,9	77,4	64,5

Source: Eurostat

The similar indicator calculated for the group of Central and Eastern European countries (Table 2) is much smaller and fluctuates between 121-152 thousand euros.

Table 2: Industrial productivity in individual countries of Central and Eastern Europe and Ukraine, 2017 (Processing industry)

	Hungary*	Poland*	Slovenia *	Slovakia*	Ukraine
Number of enterprises	50809	198757	19376	72563	63309
Sales volume, EUR million	109581,7	321925,9	29353,0	76382,2	1400214,0 (UAH million)** 46673,8 (mln. euro)
Gross value added, EUR million	24176,0	70361,0	8365,7	14075,1	369452,0 (UAH million)*** 12315 (mln. euro)
Number of employed persons	757819	2654823	204929	501318	1250300* ***
Labor productivity (volume of sales per employee), thousand euros	144,6	121,3	143,2	152,4	37,3
Labor productivity (gross value added per employed person), thousand euros	31,9	26,5	40,8	28,1	9,84

Source: Eurostat, State Statistics Service of Ukraine

According to the results of the analysis of the data proposed in the tables, labor productivity at the enterprises of the processing industry of Ukraine is significantly less than for the group of countries with developed economies (see Table 1) and the countries of Central and Eastern Europe (see Table 2).

More correct for analysis is the definition of labor productivity as the value of gross value added per one employed person in industry. Gross value added is the value of gross output excluding the cost of raw materials and other intermediate consumption. Using gross value added as an indicator of the evaluation of the productivity of useful labor, only what is created by the attracted labor resources in the process of economic activity is compared.

For Ukrainian industrial enterprises the gross value added per employed person is only EUR 10 thousand, while in Germany the figure is more than 8 times, in France - 7 times, and in Italy - 6 times. For the countries of Central and Eastern Europe, the excess of value added labor productivity is 2-4 times.

A comparative analysis of the factors that affect the value of labor productivity shows that the main reason for such a situation is the amount of human resources involved (Table 3). If the value added value created by the enterprises of the processing industry in Hungary is 2 times higher than in Ukraine, then the number of attracted labor resources is 40% less. In Slovakian processing industry enterprises, the volume of added value is almost identical to the volume created by Ukrainian enterprises. However, the number of workers in the processing industry is 60% less than in Ukraine (Table 3).

Table 3: Comparative analysis of the factors affecting the value of labor productivity in individual countries of Central and Eastern Europe and Ukraine, 2017 (processing industry)

	Hungary*	Poland*	Slovenia *	Slovakia*	Ukraine
Gross value added, EUR million	2,0	5,7	0,7	1,1	1
Number of persons employed	0,6	2,1	0,2	0,4	1

The main reasons for the low level of labor productivity in the industrial sector of Ukraine are the following:

- 1) a significant proportion and conservation of excess labor resources at state-owned industrial enterprises;
- 2) inefficiency and laboriousness of the technological process in most industrial enterprises;
- 3) a high level of shadowing of industrial production and, accordingly, the lack of factual reliable information on the results of industrial production and the number of people employed in industry;
- 4) lack of a long-term clear strategy for real restructuring of the industrial sector;
- 5) high level of depreciation of fixed assets and low efficiency of the technological process of industrial production;
- 6) weak financial interest of external and internal investors in technological and financial investments;
- 7) low qualifications of the involved labor resources and lack of motivation to improve their quality characteristics.

Consequently, ensuring productivity growth at Ukrainian processing enterprises cannot be ensured by increased labor input. What matters is not so much the increase in their quantitative characteristics but the improvement of their quality and working conditions.

One of the important factors that negatively affect the performance, the level of productivity of the sector, the competitiveness of manufactured products is the lack of capital investment in the development of the industry. Study of the practice of investment activity in the industries of the

Central and Eastern Europe countries (Table 4) shows that the vast majority of capital investments (94-98% of total capital investment) are investments that provide expanded reproduction. It is the focus of the industrial enterprises management on improving the characteristics of fixed assets and their modernization that is a factor in the growth of labor productivity and the effectiveness of economic activity (growth in the volume of added value and the volume of sales of industrial products).

Table 4: Capital investment in industry in individual countries of Central and Eastern Europe and Ukraine, 2017 (processing industry), EUR million

	Gross investment in land	Gross investment in existing buildings and structures	Gross investment in the construction and re-planning of buildings	Gross investment in machinery and equipment
Hungary	26,0	126,3	1652,5	4732,2
Poland	322,4	211,6	3703,9	11443,6
Slovenia	40,3	45,5	340,7	1227,2
Slovakia	47,9	38,7	877,7	2888,9

Source: Eurostat

A comparison of the data proposed in table 4 with statistical data on the volume of costs in the areas of innovative activity of industrial enterprises in Ukraine, indicates their significant thawing (table. 5).

Table 5: Total amount of expenditures by the directions of innovative activity of industrial enterprises of Ukraine, mln

	Capital Investments	Costs of innovation		Including directions			
		UAH million	% of total investment	research and development	acquisition of other external knowledge	purchase of machinery and software	Other expenses
2010	55384,4	8045,5	14,5	996,4	141,6	5051,7	1855,8
2011	78725,8	14333,9	18,2	1079,9	324,7	10489,1	2440,2
2012	91598,4	11480,6	12,5	1196,3	47,0	8051,8	2185,5
2013	97574,1	9562,6	9,8	1638,5	87,0	5546,3	2290,9
2014	86242,0	7695,9	8,9	1754,6	47,2	5115,3	778,8
2015	87656,0	13813,7	15,8	2039,5	84,9	11141,3	548,0
2016	117753,6	23229,5	19,7	2457,8	64,2	19829,0	878,4
2017	143300,0	9117,5	6,4	2169,8	21,8	5898,8	1027,1
2018	199896,0	12180,1	6,1	3208,8	46,1	8291,3	633,9

Source: State Statistics Service of Ukraine

The share of capital investments related to innovation during the analyzed period is in the range of 6-19%, which does not provide the formation of the necessary amount of financial resources for significant updating of fixed assets and improvement of their quality characteristics.

Discussion

Among the set of outlined directions of industrial sector development are the following:

- maintaining and enhancing the dynamics of the volume of expenditures on innovative activities of industrial enterprises, as the basis for ensuring their stable development;
- improvement of the structure of innovation costs directions in the direction of increasing the share of expenses aimed at financing internal and external research;
- a significant factor in the development of the industrial sector and the growth in the volume of manufactured and sold industrial products is the increase in the number of innovatively active enterprises;
- expanding the list of sources of financing the innovative activity of industrial enterprises by increasing the volume of attracted financial resources from both Ukrainian and foreign investors will increase the financial capacity of industrial enterprises and improve the qualitative and quantitative characteristics of their economic activity.

From the point of view of the impact on labor productivity, the so-called innovation process is evaluated when the innovation is introduced in the production process. There are six areas of innovation in the industry (OECD, 2005):

- acquisition and changes of fixed assets and procedures, methods and quality control standards necessary for the production and quality control of a new product or the use of a new process;
- the process of modifications, retraining of personnel in new technologies or in the use of new technology;
- marketing of new products;
- technology acquisition;
- purchase of machinery and equipment;
- design – covers plans and drawings aimed at determining the procedure, technical specifications and operational features necessary for the implementation, development, production and sale of new products and processes.

In general, there are two main problems that arise in determining the impact of innovation on the productivity of industrial enterprises:

- how to measure innovation;
- how to single out the influence of innovations in the totality of factors affecting labor productivity.

A possible solution to the first problem may be to use the costs of industrial enterprises for R&D. A positive point in using this option for measuring the innovative activity of industrial enterprises is the availability of clear statistics and the possibility of comparing results at the level of individual territories of a country or individual countries. The disadvantage is that R&D expenditures are a measure of investments that does not take into account the efficiency and effectiveness of efforts.

Research and development is an important element of the innovation activity of industrial enterprises, since it provides opportunities to maximize the use of their scientific and resource potential. Approximation of innovative activity directly to the production process extends the possibilities to take into account the features of technological, management and other processes at the enterprise level, meets the requirements of increasing their level of efficiency. From the position of stimulating this direction of innovative activity of enterprises in the country's industrial sector, the main goal of industrial policy should be to support (regulatory, patent, licensing, financial, etc.) their activities.

Given the insufficient level of development of the innovation market and the lack of financial resources for the development of national innovation, the vast majority of enterprises in the industrial sector of Ukraine prefer to purchase machinery, equipment and software. This is the simplest version of innovation activity, which provides the shortest period of commercialization of invested financial resources by increasing income from economic activities.

Analysis of the dynamics of innovation activity of industrial enterprises by directions is presented in Table 6.

Table 6: Analysis of the number of enterprises in industry by areas of innovation (2010-2017)

Areas	2010	2012	2013	2014	2015	2016	2017	2018
Internal R&D	224	214	215	189	151	232	130	218
Acquisition of R&D	124	134	114	94	70	103	62	66
Purchase of machinery, equipment and software	840	1096	1082	993	467	590	500	320

Source: State Statistics Service of Ukraine

During the analyzed period, there has been a steady positive dynamics in terms of expenditures in all areas of innovative activity and especially in the direction of the acquisition of machinery, equipment and software. The main reasons are the impact of the exchange rate and the need for a significant upgrade of fixed assets of enterprises of the country's industrial complex. In the structure of expenses during the analyzed period, the largest (in some years 99% of the total) is the share of expenses for the purchase of machinery, equipment and software.

The identified trend, in our opinion, is positive and reflects the growing interest on the part of industrial enterprises in enhancing their own innovative potential and developing internal research activities.

Conclusions of this study

A positive impact on the results of economic activity of industrial enterprises in Ukraine (the volume of sold industrial products and the volume of created added value) of the innovative activity of industrial enterprises is possible only if there are three main conditions: a significant increase in the number of innovatively active enterprises, an increase in the share of expenses for internal and external research and development, expanding sources of financing innovation in the industrial sector, while maintaining amounts of financing from own funds.

Further research will be aimed at exploring the sources of financing the innovative activities of industrial enterprises of the country and finding ways to optimize them.

References

1. Bruno Cassiman & Elena Golovko (2011). Innovation and internationalization through exports. *Journal of International Business Studies*, 42 (1), 56-75. Retrieved from <https://econpapers.repec.org/scripts/redir.pf?u=http%3A%2F%2Fwww.palgrave-journals.com%2Fjibs%2Fjournal%2Fv42%2Fn1%2Fpdf%2Fjibs201036a.pdf;h=repec:pal:jintbs:v:42:y:2011:i:1:p:56-75>.
2. Elena Huergo & Jordi Jaumandreu (2004). How Does Probability of Innovation Change with Firm Age? *Small Business Economics*, 22(3-4), 193-207. Retrieved from https://www.researchgate.net/publication/5158212_How_Does_Probability_of_Innovation_Change_with_Firm_Age.
3. Isabel Martínez Martín, Miguel Sánchez Galindo, César Pérez López & Rosa Santero Sánchez (2019). Impact evaluation of the Innovation Networks program at the Service of Competitiveness. *Spanish Public Treasury / Review of Public Economics*, 229 (2/2019), 59-86. Retrieved from https://www.researchgate.net/publication/335017867_Evaluacion_del_impacto_del_programa_Redes_de_Innovacion.
4. Tsai, Kuen-Hung & Wang, Jiann-Chyuan (2004). R&D Productivity and the Spillover Effects of High-tech Industry on the Traditional Manufacturing Sector: The Case of Taiwan. *The World Economy*, 27, issue 10, 1555-1570. Retrieved from https://econpapers.repec.org/article/blaworld/v_3a27_3ay_3a2004_3ai_3a10_3ap_3a1555-1570.htm.
5. Alfredo D'Angelo & Alessandro Baroncelli (2019). An investigation over inbound open

innovation in SMEs: insights from an Italian manufacturing sample. Retrieved from <https://www.tandfonline.com/doi/full/10.1080/09537325.2019.1676888>.

6. Wakelin, Katharine (2001). Productivity growth and R&D expenditure in UK manufacturing firms. *Research Policy*, 30, issue 7, 1079-1090. Retrieved from <https://EconPapers.repec.org/RePEc:eee:respol:v:30:y:2001:i:7:p:1079-1090>.

7. Griffith, R., Huergo, E., Mairesse, J., Peters, B. (2006). Innovation and Productivity in Four European Countries. *Oxford Review of Economic Policy*, 22, 483-498. Retrieved from <http://personalpages.manchester.ac.uk/staff/rachel.griffith/PublishedPapers/GriffithHuergoMairessePeters2006.pdf>.

8. Serhiychuk, S. & Karas, P. (2011). Labor productivity management at machine-building enterprises. Nikolaev, 144.

9. Kapinos, H. (2015). Basic aspects of management labor productivity at Ukrainian industrial enterprises. *Herald of Khmelnytsky National University: Economics*, 2 (2), 268-273.

10. Temporary Methodological Recommendations for Calculating Labor Productivity as a whole in Economy and by Types of Economic Activity (2008). Ministry of Economy of Ukraine. Retrieved from <http://zakon.nau.ua/doc/?code=v0916665-08>.

11. Goncharov, Y. (2014). Trends and concerns analysis of labor productivity in the whole economy and in some types of industrial activity. *Efektivna ekonomika*. Retrieved from <http://www.economy.nayka.com.ua/?op=1&z=2814>.

12. Semykina, M. (2010). Labour productivity: methodology of measuring, pre-conditions of growth. *Proceedings of Kirovograd National Technical University. Economics*. Retrieved from http://nbuv.gov.ua/UJRN/Npkntu_e_2010_17_72.

13. Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, 3rd Edition. OECD/EC, 2005. Retrieved from <https://doi.org/10.1787/19900414>.

14. Annual detailed enterprise statistics for industry. Eurostat. Retrieved from <https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do>.

15. Volume of industrial products sold by type of activity in 2017. Ukrstat. Retrieved from https://ukrstat.org/en/operative/operative2013/pr/orp/orp_u/orp1217_u.htm.

16. Gross domestic product and gross value added by economic activities. Ukrstat. Retrieved from http://ukrstat.gov.ua/druk/publicat/kat_u/2018/zb/05/zb_krvvpu2017pdf.pdf.

17. Average number of full-time employees by type of economic activity in industry. Ukrstat. Retrieved from http://www.ukrstat.gov.ua/operativ/operativ2018/gdn/Sok_pr/Arch_sok_pr_u.htm

18. The total amount of expenditures in the areas of innovation activity of industrial enterprises. Ukrstat. Retrieved from http://www.ukrstat.gov.ua/operative/menu/menu_u/ni.htm.

19. Statistical collection «Scientific and innovative activity in Ukraine». Ukrstat. Retrieved from http://www.ukrstat.gov.ua/druk/publicat/Archiv_u/16/Arch_nay_zb.htm



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