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THE CORRELATION BETWEEN SOME MACROECONOMIC INDICATORS (INNOVATION, R&D, FDI) AND THEIR IMPACT ON THE INCREASE OF LABOR PRODUCTIVITY

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Abstract

The objective of this study is to investigate the correlation between some macroeconomic indicators for labor productivity growth. In conditions of the current metamorphosis of the national economy, the identification of factors that contribute to the increase of labor productivity becomes a necessity for the survival of countries on the regional and world scale. The knowledge about these factors and their strategic combination contribute to the increase of productivity, of innovative business, which directly leads to the enhancement of well-being in the world economy. Economic growth in the countries of the world is directly proportional to the labor productivity equation, which is dependent on the number of unknowns expressed by its determinants. From this perspective, the author addresses the aspect of economic growth and the heterogeneity of the factors of increasing labor productivity in both national and global economies using the statistical method of correlating factors. The results of the study showed that investment, export, research, and development are factors that have a direct impact on economic growth, thus being possible to establish the strategies that are effective in the development of various national economies.

Keywords: Correlation of Indicators, Productivity, Investment, Export, National Economies

1. Introduction

In the twenty-first century, when the world's economies are undergoing extreme changes at a staggering pace, the main challenge is to ensure economic growth by preserving resources and guaranteeing a decent standard of living for almost eight billion people. Following the metamorphoses of global economic phenomena, developed countries are identified by several specific common features: high living standards, economies based on welfare, a strong and efficient government, higher education development, internationalization of national economies through large corporations.

Porter (2008) argues that a nation is competitive when it has a high productivity rate. Labor productivity is an indicator that proves the level of economic growth, competitiveness, and living standards. Therefore, the living standard of a nation is determined by the productivity of its

economy, which is measured through the value of its goods and services produced by the factors of production. Productivity measures real competitiveness (OECD, 2015).

From this perspective, we will investigate and identify the main factors that contribute to increasing labor productivity in the countries of the world. The main purpose of the research is to identify and establish the heterogeneity of the factors of increasing labor productivity through the analysis of specific types of determinants of labor productivity growth in different stages of the development of national economies. To achieve the proposed goal were established the following main objectives:

- researching theories, establishing, identifying, analyzing the contribution of various economic and social factors to the increase of labor productivity, respectively to the development of states through the process of economic internationalization;
- determining the evolution of labor productivity in world countries, particularly in the United States, the European Union, Japan, Australia, the Republic of Moldova, and its impact on economic growth;
- identifying by the method of correlating the specific determinants for each country, of the factors of increasing or stagnation of labor productivity.

The structure of this article consists of several main parts: Section 2 presents the literature review and the information basis and the methodological and theoretical-scientific support used whereas Section 3 presents the research methodology. Section 4 gives the results obtained in certain countries on the method of correlating macroeconomic indicators. Finally, Section 5 concludes the paper.

2. Literature review

The informational basis of the paper consists of the results of research, empirical studies, and other editorial sources exposed in periodicals and monographs of foreign and domestic authors. In calculating indicators and empirical data, statistical data from the databases of the Organization for Economic Co-operation and Development, the United Nations, the United Nations Conference on Trade and Development, the World Economic Forum, the World Bank, the International Monetary Fund, and Eurostat were used.

As sources of information, served the reports of the Ministry of Economy and Infrastructure of Moldova, the Moldovan Investment Agency, researches conducted by nongovernmental and nonprofit organizations, data of the National Bureau of Statistics of Moldova. Methodological and theoretical-scientific support of the article focuses on the set of theories and concepts aimed at identifying the factors of increasing labor productivity in the countries of the world, in the national economy and fundamental applications drafted by world-renowned authors: Porter (2008); Schwab (2017); Manoilescu (1947); Gwartney and Stroup (1993).

The specialty literature, expressed through the theories and models proposed by economists of all times, identifies several factors that contribute to the increasing of labor productivity. The Figure 1 presents a synthesis of several concepts on the factors that influence the increase of labor productivity. Empirical studies suggest that the growth rate of labor productivity is correlated with the resources available in the national economy, technological progress, and institutions in the form of the degree of democracy and political stability. For instance, the neoclassical theory emphasizes the importance of physical and human capital, assuming that technological influences are exogenous. To remedy the *ad hoc* hypothesis of the exogenous technological influences, growth theory has included the technology in the system as an endogenous factor, suggesting that the accumulation of knowledge can generate increasing returns such as those generated by the accumulation of human capital.
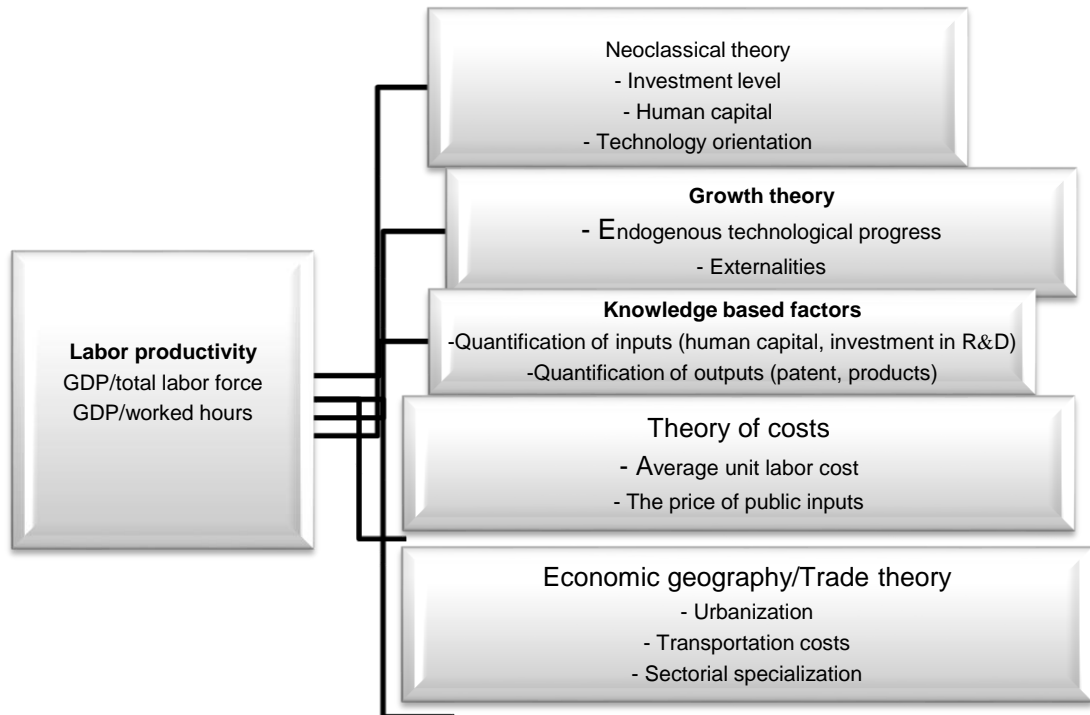
Figure 1. Determinants of labor productivity in different economic meanings
Source: Developed by the author Publication Office of the European Union (2003)

Costs are another possible method to assess labor productivity. The average unit cost is defined as the ratio between labor costs and the unit of production. (Leamer, 1995) Here, the numerator includes both the gross salary and the indirect costs per employee. Consequently, higher costs imply a decrease in productivity.

There are other factors, presents in the Figure 2, which can affect labor productivity, but these cannot be easily approximated quantitatively. This category also includes many government policies, high-tech industrial agglomerations, innovations, investments, or export. (Gouranga, 2005)
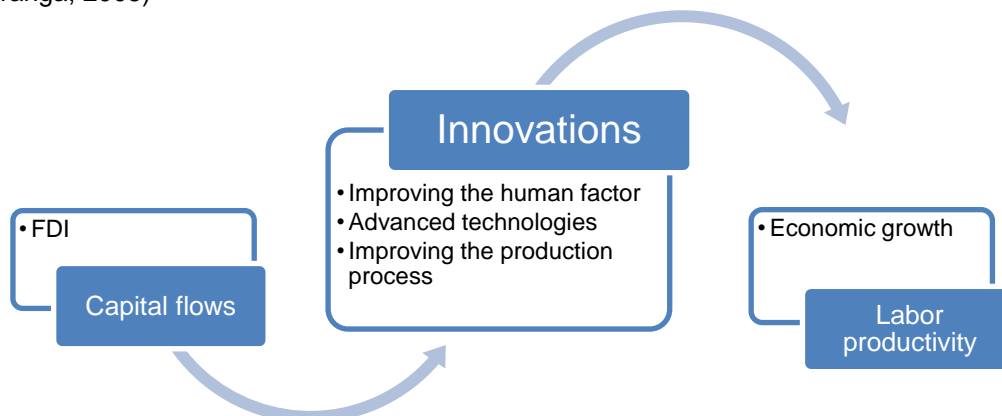

Figure 2. Some factors that contribute to the increasing labor productivity
Source: Das *et al.* (2005)

Empirically speaking, the most wealthy countries or regions have a well-prepared labor force, a high degree of digitalization of the economy, a high share of exports in global trade, a high level of GDP/per capita.

3. Methodology

Economic processes and phenomena emerge and develop as a result of various causes, which can act in the same direction or opposite directions and with different degrees of intensity. As a result, they are bonded by connections, sometimes very complex, which are not known or observed from the beginning but usually get discovered as they are studied. The manifestation of one or another of the processes or phenomena generates effects that can cause the appearance, modification, or cessation of others, thus determining relations of interdependence or causality. From this, we deduce that it is essential to use the statistical method of correlating factors to set more deeply the impact of specific determinants on productivity increase.

Thus, the major scientific problem solved consists of determining the factors of increasing labor productivity at different stages of development of national economies, using the method of correlating economic indicators.

To determine the factors that influence labor productivity, the author correlated several macroeconomic indicators to see to what extent they affect its growth or slow it down. The correlation coefficient is a number that determines the degree of dependence and correlation between two or more indicators. The correlation coefficient (ρ) is a measure that determines the degree to which the movement of two different variables is associated. The most common correlation coefficient, generated by the Pearson product-moment correlation, may be used to measure the linear relationship between two variables. However, in a non-linear relationship, this correlation coefficient may not always be a suitable measure of dependence. The coefficient is in the range of 1 to -1. The possible range of values for the correlation coefficient is -1.0 to 1.0. In other words, the values cannot exceed 1.0 or be less than -1.0, and a correlation of -1.0 indicates a perfect negative correlation, and a correlation of 1.0 indicates a perfect positive correlation. Anytime the correlation coefficient is greater than zero, it is a positive relationship. Conversely, anytime the value is less than zero, it is a negative relationship. A value of zero indicates that there is no relationship between the two variables. The closer the coefficient is to 1, the stronger is the dependence between the indicators (Akoglu, 2018).

The paper presents the analysis of several factors such as innovation, the export of goods and services, foreign direct investment, wages, the export of creative goods through the correlation method, and their impact on productivity in some national economies such as the United States, Japan, European Union, and the Republic of Moldova. The states were chosen based on the economic model criterion used in their development. Thus, it is demonstrated by the correlation method that at different stages of economic development, the impact of productivity increase factors is diverse and specific.

4. Results of research

As mentioned, in our research we chose for analysis four countries United States, European Union, Japan and the Republic of Moldova. The author selected very different countries in terms of economic model: the Anglo-Saxon model, the paternalistic model, the European model and the model of a country in transition, to identify the diversity of economic growth factors (Chistruga and Popa, 2013).

Table 1 includes several factors, which the author considers relevant and correlated them with labor productivity, through the statistical method. Exactly the same indicators were used in the other countries included in the research, but only the results were presented, based on data provided by the World Bank. The author conducted the research, using data for the period 2005-2018.

Table 1. Factors of the increasing labor productivity, via correlation with other macroeconomic indicators in the USA, 2005-2018

Indicators	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2018	Correlation coefficient
Multifactorial productivity, %		0,29	0,28	-0,22	1	2,26	0,11	0,23	0,09	0,25	0,61	0,8122
Export annual increase, %	10,57	13,85	11,91	12,12	-17,97	21,06	15,95	4,26	2,19	2,59	-7,13	0,5944 (2010-2018)
Annual increase of labor productivity (GDP/worked hours), %	1,97	0,8	1	0,8	2,9	2,8	0,21	0,24	0,22	0,24	0,67	
Export of goods and services, mil.$	1286022	1457643	1653547	1841612	1583053	1853606	2127021	2218990	2279938	2343204	2223624	0,9385
FDI inputs, mil $	104773	237136	215952	306366	143604	198049	229862	188427	211501	106614	379894	0,3342
Labor productivity, GDP/worked hours, OECD	57,08	57,54	58,1	58,55	60,24	61,93	62,05	62,2	62,34	62,49	62,89	
Remuneration per hour (labor force wage/ hour), %	3,69	3,85	4,18	2,91	1,92	2,34	2,18	2,06	0,98	2,45	2,71	0,1144
Global Competitiveness Index	4,9	5,4	5,5	5,4	5,3	5,3	5,5	5,4	5,4	5,6	5,5	0,8315
Labor productivity, GDP/employee,$	91234	98076	102313	102207	103084	106148	107168	108350	109210	109314	110354	
FDI index, FDI/per employee, $	692	1510	1365	1938	908	1253	1418	1160	1305	658	2344	0,2952
Expenses on R&D per employee, $	1491	2400	2503	2595	2498	2467	2625	2604	2765	2645	2778	0,8921
Expenses on higher education, per student, $					21768	21909	23987	26543	27923	28905	29456	0,9285

Source: Developed by the author based on World Bank (2020) and United Nations Conference of Trade and Development (2020)

Table 2 presents the results of calculations and research showed that the highest impact on increasing labor productivity in the United States belongs to the degree of innovation of the country, especially the expenses on research and education, with a correlation coefficient of 0.91. In the United States, the emphasis is on the promotion of higher education and the annual increase in the number of employees with higher education diplomas.

Other indicators that have a significant impact on labor productivity are the level of competitiveness and multifactorial productivity, with a correlation index of 0.83 and 0.81. An interesting element is that there is a weak correlation between labor productivity and wages, of 0.11, as well as an average correlation between FDI and productivity, 0.33.

Table 2. The correlation coefficient between labor productivity and other macroeconomic indicators in the USA, 2005-2018

	Determinants of labor productivity						Labor productivity outputs		
	LP/ LPF	LP/ Competitiveness	LP/ Wage	LP/ FDI inputs	LP/ R&D expenses	LP/ Education expenses	LP/ Export	LP/Creative good export	LP/Exports Annual increase, %
Strong correlation 1-0,5	0,81	0,83			0,89	0,91	0,93	0,95	
Medium correlation 0,3-0,5				0,33					0.50
Weak correlation 0,1-0,3			0,11						
Negative correlation -0,1-0,1									

Source: Developed by the author, using the information from Table 1, World Bank (2020) and UNCTAD (2020)

Japan is an important mega-center in the Asian economic space with cross-cultural differences (Wen-Jhan, 2020). It is the most advanced country in the world in terms of

technological development, and the third country in the world in terms of GDP. Japan is also a major trading force, ranking 4th in terms of global exports (UNCTAD, 2020). It is also a solid financial center, the Tokyo Stock Exchange being one of the most important global financial centers for capitalization and financial transactions. For this reason, we considered it important to establish which indicators need to be correlated in order to find out which have a direct impact on economic growth.

Following the correlation of macroeconomic indicators to identify the factors of increasing labor productivity, in Japan (Table 3), the technological indicator is the one that makes the difference, especially expenses on research and education, with a correlation coefficient of 0.93. In this country, export is another indicator with a significant impact on labor productivity, with a correlation index of 0.73. A specific element of Japan is the negative correlation between labor productivity and wages, of -0.33, and the correlation between FDI and labor productivity is -0.30.

Table 3. The correlation coefficient between labor productivity and other macroeconomic indicators in Japan, 2005-2018

	Determinants of labor productivity						Labor productivity outputs		
	PM/ LPF	PM/ Competitive ness	PM/ Wage	PM/ FDI inputs	PM/ R&D expenses, per employee	PM/ Education expenses	PM/ Export	PM/ ICT goods export	PM/ Export Annual increase, %
Strong correlation 1-0,5					0,93	0,89			0,74
Medium correlation 0,3-0,5							0,44		
Weak correlation 0,1-0,3				-0,25					
Negative correlation -1-1	-0,30		-0,33					-0,27	

Source: Developed by the author based on the data from World Bank (2020), UNCTAD (2020)

The weak correlation of investments is due to several causes. Analyzing foreign direct investment as an important factor in increasing labor productivity, in Japan the situation is more specific. Although foreign investment has increased in Japan in the last ten years, the legislation is stricter, as foreign capital is considered a threat to domestic companies. Likewise, foreign investors face difficulties in recruiting local employees, due to the Japanese perception of seeing the risk of hiring a foreign company.

In Australia, following the correlation method used for the period 2005-2018, positive effects are obtained from a series of indicators on labor productivity (Table 4). Thus, following the correlation of research & development expenses per employee and on education, with labor productivity values, we obtain an index of 0.21 and 0.95, which explains the great importance given to investments in the education of the Australian human factor. The government gives considerable importance in supporting young, creative, and talented people, and the massive expenses per student in the learning-research process explain this (Department of Industry, Science, Energy and Resources of Australian Government, 2015).

After the correlation of several macroeconomic indicators in the Australian economy to identify the factors that increase labor productivity, the economic indicator expressed by exports or the level of investment is the one that makes the difference. There is a strong connection between labor productivity and multifactor productivity, 0.85, and between investments made by the Australian government in education, expressed by a correlation index of 0.95.

Table 4. The correlation coefficient between labor productivity and other macroeconomic indicators in Australia, 2005-2018

	Determinants of labor productivity					Labor productivity outputs		
	LP/ FLP	LP/Wage	LP/FDI inputs	LP/R&D expenses, per employee	LP/Education expenses	LP/Export	LP/ICT goods export	LP/Economic growth (%)
Strong correlation 1-0,5	0,85				0,95	0,53	0,75	
Medium correlation 0,3-0,5			0,36					0,45
Weak correlation 0,1-0,3				0,20				
Negative correlation -1-1		-0,20						

Source: Developed by the author based on World Bank (2020), UNCTAD (2020)

The EU economy is becoming increasingly difficult to manage due to large differences in member countries, and the macroeconomic management process is becoming increasingly complex. Thus, although the standard of living of European citizens has not stopped rising, significant differences in the income level of the population persist. Eastern enlargement has further accentuated these realities, as some Member States have entered the community with a standard of living below the European average. Major discrepancies are found in terms of economic growth and labor productivity in each EU member state (European Commission, 2015).

If we speak about the European Union countries, following the correlation method used for the period 2005-2018, both indicators on labor productivity in Ireland, Belgium, Poland, and Germany obtains a positive effect. In this context, Finland is becoming the exception to the rule, as research and development expenses per worker have been steadily declining between 2005 and 2018, and the impact on increasing labor productivity has been negative. Thus, after the correlation of research & development expenses with the values of labor productivity in Finland, we receive an index of -0.07, being also the explanation for what we mentioned before. In other European countries, the degree of correlation between these indicators is very high. For instance, in Poland 0.94 and 0.82, in Ireland 0.73 and 0.69, in Belgium 0.67 and 0.51, which explains the increased importance given to research, information, and education on increasing labor productivity in the European space. The calculations and research pointed out that the maximum impact on increasing labor productivity in EU28 has the degree of innovation through expenses on research and development, education, employees with a higher education diploma, a high degree of competitiveness, foreign direct investment (Table 5).

Table 5. The correlation coefficient between labor productivity and other macroeconomic indicators in some EU countries, 2005-2018

	LP/FDI inputs	LP/R&D expenses	LP/Education expenses	LP/Economic growth	LP/Export Annual increase
EU28	-0,15			0,75	0,56
Euro Zone				0,73	
Ireland	0,67	0,73	0,65	0,33	
Belgium	-0,30	0,67	0,51	0,71	
Poland	-0,33	0,94	0,82	0,22	
Finland		-0,07	0,54		
Germany		0,54	0,59	0,94	

Source: Developed by the author based on the data from World Bank (2020), UNCTAD (2020)

In the Republic of Moldova, the picture of the factors that contribute to the increasing labor productivity is a little different. As a developing country, the specific level is due to the weak degree of economic development. Using the method of correlating factors, we can determine the factors with the most considerable influence on economic efficiency (Table 6).

Table 6. The correlation coefficient between labor productivity and other macroeconomic indicators in Moldova, 2005-2018

	Determinants of labor productivity						Labor productivity outputs		
	LP/ Remittance	LP/ Training expenses	LP/ Wage	LP/ FDI inputs	LP/R&D expenses	LP/ Education expenses	LP/ Export	LP/ Creative goods export	LP/ICT goods export
Strong correlation 1-0,5	0,85		0,59		0,95	0,66	0,93		0,77
Medium correlation 0,3-0,5		0,33						0,32	
Weak correlation 0,1-0,3									
Negative correlation -0,1-0,1				-0,32					

Source: Developed by the author based on the data from National Bureau of Statistics (2020)

The results of the calculations and research performed with the method of correlation drew a curious picture in the Republic of Moldova. First, it showed that remittances have a major impact on labor productivity, with an indicator of 0.85, and foreign direct investment inputs have an index of -0.32. Thus, being living proof that the migration process dictates the rules of the game in the national economy. Moreover, from an investment point of view, it is not very attractive to foreigners (Popa, 2017).

5. Conclusion

Following the conducted researches, several basic conclusions can be drawn:

- After researching the factors of the increase of labor productivity, the author found that the degree of development of a country depends on the level of productivity and factors of its increase. However, the paradox is that we have economies based on investments with unresolved issues related to production factors, notably infrastructure and human resources education. In conclusion, we cannot reach the level of the economy based on welfare and happiness when we have deficiencies in the primary factors.

- To confirm the theory of the different impacts of some indicators on labor productivity, the author identified a country in each stage of development, making a correlation between the fundamental pillars and labor productivity. Therefore, it is established that in developing countries there is a correlation between productivity and migration, the agricultural sector, while in developed countries, the increase of labor productivity is directly related to the services, information, innovation, and advanced technology area.

- The results of the conducted calculations and research, identified that the greatest impact on increasing labor productivity in the US has the degree of innovation of the country, especially the expenses on research and education, with a correlation coefficient of 0.91, competitiveness and multifactorial productivity with a correlation index of 0.83 and 0.81, and FDI with an average correlation of 0.33. Following the correlation of several macroeconomic indicators in the Japanese economy to identify the factors of increasing labor productivity, the technological indicator is the one that makes the difference, especially expenses on research and education, with a correlation coefficient of 0.93, and exports, with an index of correlation 0.73. At the opposite pole is the correlation between FDI and labor productivity, -0.30. In Australia, there is a strong link between labor productivity and multifactorial productivity, 0.85, and a significant connection between the investments made by the Australian government in education and labor productivity, expressed by a correlation index of 0.95. Meanwhile, the increase of labor productivity in EU28 countries is determined by education, employees with a higher education diploma, a high degree of competitiveness, foreign

direct investment.

- Following the calculations and researches conducted by the author, the method of correlation identified a curious picture in the Republic of Moldova. First, it showed that remittances have a major impact on labor productivity, with an indicator of 0.85, and foreign direct investment inputs an index of -0.32, proving that we have an economy without investments and dependent on remittances. Another interesting aspect is that despite the low expenses on research and education, the correlation index is notable high 0.95 and 0.66, respectively.

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