

Impact of Competitiveness on Peru's Economic Growth: 2016-2022

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Abstract

The objective of this research is to empirically analyze and determine the impact of competitiveness on economic growth in Peru during the period 2016 – 2022, applying the correlation analysis and Ordinary Least Squares (OLS) methodology. According to the results obtained, labor productivity and infrastructure productivity have a significant positive impact on the Gross Domestic Product, being essential to improve efficiency and productive capacity in key sectors, thus boosting economic growth. However, productivity in the use of science, technology and digitalization shows a negative impact, with a decrease of 0.00075% in the Gross Domestic Product, emphasizing the critical importance of boosting investment in research and development (R&D), enhancing technological infrastructure, and implementing robust regulatory policies to maximize the country's economic development. Finally, it is determined that competitiveness exerts a significant positive impact on the economic growth of Peru, evidenced by a coefficient of 4.614% with respect to the Gross Domestic Product. This underlines the importance of strengthening competitiveness to promote sustainable and robust economic development in Peru. However, the need for additional research is identified to better understand the factors behind the negative impact on productivity of science, technology and digitalization employment. It is recommended to carry out studies that analyze in detail the factors that influence these variables to strategically improve these aspects and optimize their contribution to sustainable development.

Keywords: Labor Productivity, Infrastructure Productivity, Productivity in the Use of Science, Technology and Digitalization, Economic Growth, Productivity, Sustainable Development.

INTRODUCTION

The research problem focuses mainly on the scarcity of products and services of low quality and productivity, which highlights the persistent structural causes of poverty. Productivity emerges as a crucial factor that influences competitiveness and, therefore, sustainable development. It is argued that competitiveness is essential to strengthen economic activities, which in turn contributes to improving the quality of life of the population. Therefore, to foster development, it is imperative to increase productivity in various sectors and thus boost economic growth.

As already mentioned, Peru presents structural problems such as poverty, unfair distribution of wealth, poor management of the system, citizen insecurity and a deficient educational system, among others.

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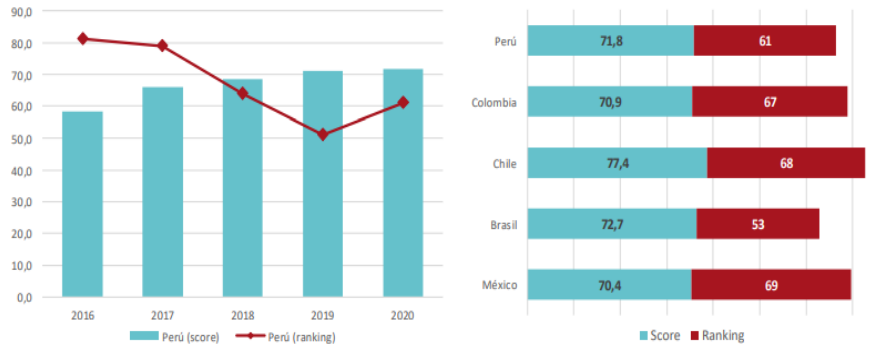
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On the other hand, in accordance with the national competitiveness policy, it establishes that to achieve productivity and competitiveness, objectives related to physical and technological infrastructure, human resources, technological changes, digitalization, strengthening of the country's institutions, fundamentally regarding the administrative system and human values for the development of commendable actions. Of these objectives, Peru has fundamentally advanced in the fight against corruption and respect for institutions to achieve competitiveness. All this will undoubtedly allow the formulation of national strategic objectives and policies, at the educational level, technological changes, infrastructure, innovation; so that the country can be competitive and achieve development. On the other hand, in compliance with the objectives of sustainable development by the member countries of the agreement. Agenda 2030, approved by the international



community in 2015, is established through the sustainable development index. The international ranking of its position as a developed country according to this index, the country has gone from a position of 81 to a position of 61, in comparison, with 149 countries in the first case and 166 countries in the second case. Without a doubt, Peru is achieving positive results in certain sustainable development objectives, raised by the 2030 agenda agreement, which is how in Latin America, Peru is first among other countries in the region.

Figure 1. Peru: sustainable development index 2016-2020, and sustainable development index, according to selected countries 2020.

Source: CEPLAN.

On the other hand, productivity constitutes an indicator that defines competitiveness and that significantly impacts the gross domestic product and the development of the country. Productivity undoubtedly represents a deficiency in the application of production factors. According to Figure 1, the level of competitiveness of the countries is evident, their progress or growth is analyzed; taking into account the elements that define productivity.

The competitiveness index reflects a score that indicates the position of a country; between the poor ones with a score of zero and the efficient countries that achieve the best scores for competitiveness results, are rated with a score of one hundred. According to this index, Peru reached approximately a level of 61.7% in 2019, between 2016 and 2019 it was in 67th place, considering 138 states; Even making progress, it needs to grow in the elements or factors that constitute productivity and improve competitiveness; (12 factors represent the indicated index).

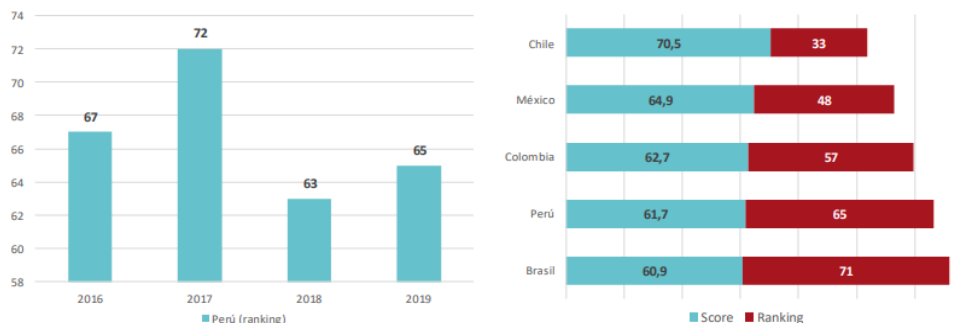


Figure 2. Peru: Global Competitiveness Index 2016 – 2019, and Global Competitiveness Index according to selected countries 2019

Source: CEPLAN.

Productivity constitutes an element, an indicator of competitiveness that affects development, meaning a measure of efficiency in the application of the elements or factors of production.

According to figure 2, it is observed that in the years of analysis 2016-2019, growth is generated reaching 24%, however, in the face of labor, institutional problems, regulatory problems and others, they have prevented the achievement of better results. results in the following years. Ceplan (2021). Likewise, it is noted regarding total factor productivity (TFP), it was 0.2% in the years 2016 - 2020, which implied lower economic growth for these years.

Finally, this article is formulated taking into account the following scheme: the first section refers to the approach, description, evaluation and analysis of the problem or problem to be investigated. The second section deals with the literature review and which in turn contains the theoretical framework or empirical literature; It will undoubtedly be the fundamental basis for the conceptualization of the variables, which will allow the study to be deepened. The third section presents the database obtained and accumulated for the analysis and the econometric methodology. The fourth section deals with the analysis of the descriptive and econometric results. In the fifth section, the testing of hypotheses was presented. Then the discussion of the results and finally the conclusions and recommendations were presented.

Having formulated the approach and description of the problem, we point out background and theories that explain from various points of view the conception regarding competitiveness, productivity, sustainable development, economic growth, labor productivity, infrastructure productivity, science, technology and digitalization productivity, also about the Gross Domestic Product (GDP).

LITERATURE REVIEW

Review of Empirical Literature

Regarding the background on Competitiveness and Sustainable Development ; Horta, R. & Albertoni , N. and Camacho, M. (2020), present an image about the evolution of the concept of competitiveness. Fundamental basis on prices, cost, productivity, competitiveness, quality, capabilities also based on social and environmental costs, and happiness. The authors, in their work Competitiveness of Uruguay in a New Global Context, present the following questions: Why this study? The answer is because it generates knowledge about competitiveness in Uruguay in times of crisis due to COVID-19 and the reality of global trends. Roberto Horna in his scientific article “A look at competitiveness in times of Covid-19”, succinctly explains the conceptual evolution of the word territorial competitiveness in which he gives importance to regions. On the other hand, Diaz, D. & Álvarez B. and Ojeda M. (2020), express that the higher the level of regional competitiveness, the level of well-being will also be high, which implies the participation of all institutions to achieve improving the standard of living of the community, which should be the state policy of the countries. For their part, Morales, D. & Pérez, F. (2020), state that the advancement of technology has generated challenges for countries and if these technological changes are not considered, competitiveness and the drive for development will not be achieved. Likewise, Sarmiento, Y. and Delgado, M. (2020), affirm that competitiveness are elements and strategies so that a region can generate the conditions of values through the company and also satisfy the demands of the community. According to this conception, competitiveness would be an instrument to achieve sustainable development. Likewise, Alvarado, R. and Jiménez, C. (2020), maintain that the greater the indication of competitiveness, they positively influence regional development, which will allow public policies to be established that promote development. Also Arévalo, J. (2024). It recommends significantly increasing spending on research and development accompanied by policies that promote research and development and getting the private sector to invest in technology and digitalization, so that companies generate greater productivity, with the aim of boosting economic growth. On the other hand, Medeiros, V. & Gonçalves, L. and Camargos , E. (2019), expressed that the countries that achieved their competitiveness were due to the application of economic resources and constituent elements of innovation

such as patents and within These are investments in research, in technological changes, in training, in infrastructure, in health and education. For his part, Pérez, F. (2020), mentions that it is quite complicated to maintain competitiveness and sustainable development due to large economic, social and political blocks and economic imbalances. For this reason, those responsible for the administration and management of the institutions must establish associative management mechanisms to promote competitiveness and sustainable development. In this regard, Mancheno, M. and Albán, M. (2019), confirm that, for a country to be competitive and generate sustainable development, it is necessary that it can transform the economic situation through knowledge, education, and investment, with clear and orderly laws. Likewise, García, V. and Granda G. (2020) maintain that the agreements of the 2030 agenda for sustainable development are the path to global sustainability and institutions have a significant role in achieving such an objective and counting with the benefits of such results. And for consensus between organizations, it is necessary that there be a relationship between sustainability and business competitiveness. For his part, Ruiz, B. (2021), states that in practice it is evident that competitiveness positively and directly influences the economic growth of Peru. Statement that is based on the results of the contrast of the hypotheses that show the direct correlation between competitiveness and development, consequently the proportional increase in competitiveness will generate an increase in economic growth through the Gross Domestic Product, which is reflected in economic development. Likewise, CEPLAN (2022), through the third objective of the National Development Strategic Plan, related to economic growth and sustainable development, maintains that through employment, infrastructure, investments in technological changes and transformation digitally, the well-being of the population will be achieved. After the conceptual support of the competitiveness and sustainable development variables, we present the comprehensive theoretical support about the productivity indicators considered in this study such as labor productivity, infrastructure productivity, science, technology and digitalization productivity.

Regarding Labor Productivity, Braun (2024) mentions that the slowdown in productivity is underestimated when aggregate hours are used instead of labor input to calculate productivity compared to the growth rate. Furthermore, he established in his study that a high percentage (39%) of the average quarterly growth rate of labor productivity can be attributed to increases in education and experience, with the conceptualization that not all hours are equal, the confidence that added hours will influence changes in the quality of hours worked. Then, Galle (2024) expresses that taking into account the neoclassical production function, which when using hours instead of work, is considering that all hours are equal, which will determine that both growth and productivity will be affected by changes in the education and experience levels of the workforce. It was shown that the cyclical behavior of labor input is different from that of added hours, so labor input is less volatile and maintains a minimal correlation with the real gross domestic product, in addition the average annual growth rate of labor productivity differs significantly when labor input is used instead of added hours. For their part, Shen & Zhang (2024) express that in relation to objective eight, sustainable development, of the 2030 Agenda agreement, they propose the promotion of full employment and productivity, which includes intelligent production factors, such as robots. on the internet at every level of human activity, in Big Data; those who are transforming the labor market; situation that has generated great discussions regarding where technology will direct humanity and how artificial intelligence will transform the relationship between human beings and employment, and whether the productivity resulting from these advanced relationships will lead to large-scale structural unemployment and Finally, the authors point out that the objective is to answer to what extent AI will continue to affect the labor market, increasing labor productivity, changing the structure of capital and deepening the division of labor.

Regarding Productivity in Infrastructure, Faria, Prado & Ferreira (2021) express that government investments in infrastructure influence the creation and location of new companies, which generates effects on productivity. On the other hand, the rates of companies, especially informal ones, and the taxes of formal companies affect production and economic well-being. Government investments in infrastructure undoubtedly impact positively on the productivity of the infrastructure, therefore affecting the long-term growth rate of the economy, as mentioned by Barro (1990) in the so-called endogenous growth models. Productivity is determined by transportation infrastructure (roads, airports, public transportation), causing long-term economic growth. Similarly, Gupta & Krishnamurti (2018) express that productivity favorable to

workers influences the creation of values, which is evident in the results of applying or evaluating a sample of more than 25,000 observations from companies in 56 countries, which apply regulations and labor protection, that is, they adopt practices favorable to employees, companies achieve benefits. Along the same lines, Zhang & Ji (2018) examine whether infrastructure investments have a short- or long-term impact on economic growth, using evidence from China. It analyzes how infrastructure affects productivity and economic growth over time, providing valuable information for planning and evaluating infrastructure investment policies.

About the Productivity of Science, Technology and Digitalization, Salas (2024) evaluates the efficiency of undergraduate academic programs in Spanish public universities, using data envelopment analysis and time estimates for obtaining the degree. It examines how the efficiency and duration of programs impact the productivity of universities, with the aim of improving the quality and effectiveness of higher education in Spain. Likewise, Salvatore (2019) examines the growth prospects of the gross domestic product and employment of the US, based on labor productivity, the labor force and international trade; Faced with changes in technology, they showed that the lower growth of the US economy in the periods 2000-2018 has its cause in the decrease in the growth of labor productivity, the labor force and investments, consequently the Labor productivity, labor force, are the factors that positively impact the potential growth of the US. For his part, Hangl (2024) examines investments in software and to what extent it impacts the economic success of companies, which operates in the Austrian Prime Market and to test the hypotheses they carried out a longitudinal study that included 10 years of evaluation. to the financial statements of the businesses considered in the analysis. On the other hand, the data analysis was carried out with the panel methodology. The regression analysis applied to all companies revealed a correlation between software expenses and economic success. The regression models were calculated independently in financial and non-financial companies, evidencing the correlation between investments in software and the economic success of the analysis companies. Consequently, investments in knowledge-intensive intangible assets such as research and development, software or licenses; influence productivity growth in developed countries.

Review of Theoretical Literature

In this part of the research, the review of the theoretical literature is considered, basically regarding or referring to the variables, dimensions and indicators of the research, such as the competitiveness variable, which has productivity as its dimension and its indicators such as labor productivity, infrastructure productivity, science, technology, digitalization productivity and the development variable whose dimension is economic growth and its Gross Domestic Product (GDP) indicator. All these theoretical bases will allow generating consistency in the research. In this regard, Whitman W. (1960), is the greatest exponent of the theory of modernization, maintains that the economies of countries go through 5 moments to achieve their development, among which we have the following stages: traditional, transition, measurement, maturity and mass consumption.

On the other hand, we have the dependency conception that expresses that underdeveloped countries depend directly on developed countries, the dependency theory was promoted by Raúl Prebich in the sixties, theories, models that try to explain the difficulties that countries fundamentally face. underdeveloped to achieve sustainable development, it is necessary to eliminate this relationship between the metropolis and the periphery to achieve sustainable development, as expressed. Frank, A. G. (1967). There is also the theory of political ecology that considers that through the interrelation between the environment and the economy, sustainable development can be achieved; this theory was presented by Blaikie, P., & Brookfield, H (1987). For his part, Adam Smith (1723-1790), in his work "The Wealth of Nations" exposes his theory of absolute advantage, where he maintains that countries will be able to produce and export goods based on productivity, meaning quality, minimum costs and efficiency, and achieve exchange with other efficiently produced goods. David, R. (1817), developed the theory of comparative advantage at the beginning of the 19th century, stating that it is in the interests of a country to produce according to its greatest comparative advantages or minor comparative advantages.

On the other hand, Vernon, R. (1966), exponent of the product life cycle theory, maintains that products go through 3 stages; production, growth and maturity, in the production stage the product is made in the country

where it was invented. During the growth stage, the good is produced in other countries to meet global demand. During the maturity stage, the good is produced taking into account the lowest costs in relation to other countries. For his part, Porter, M. (1990), in his diamond theory, states that there are 4 significant elements that determine national competitiveness: the conditions of elements or factors such as human capital and natural wealth, also related conditions. with companies such as infrastructure and human resources and also interrelated industries, business strategies and structures. Likewise, Gómez, JA (2021), presents a synthesis of competitiveness theories and their historical evolution. The theoretical currents that deal with the topic of competitiveness are evaluated, identifying the elements that affect the competitiveness of companies. Also Clavijo S., & Ros, J. (2015), when discussing growth and competitiveness and restriction in Latin America, express that the validity or approval of the hypotheses depends on the correlation of export growth between growth of imports, with the growth rate subject to increases in exports and imports. For their part, García JA, & Sánchez, MP (2019), express that the effects of the competitiveness of economic growth are significant as long as there is a correlation between the variables. This case was carried out in the European Union using an econometric model to determine the impact and interrelation of competitiveness and economic growth. Finally, Medeiros, CA (2016), explains concepts and indicators to establish competitiveness based on the performance of countries' industrial exports.

METHODOLOGY AND MODEL

The present study adopts a non-experimental design, it is observational with an evaluative, quantitative, longitudinal and correlational approach. The variables are related and the events are described as they were observed, using an econometric analysis for systematic valuation. The data analyzed corresponds to historical values of competitiveness, productivity, growth and economic development in Peru during the period 2016-2022. The population or universe of study includes the set of these values related to the aforementioned aspects.

The sample is represented by the variables competitiveness, Gross Domestic Product (GDP) and productivity. These variables come from secondary sources, collected from government institutions such as the Central Reserve Bank (BCR), Ministry of Economy and Finance (MEF), National Institute of Statistics and Informatics (INEI), World Bank (WB), International Monetary Fund (IMF) and other reliable sources.

To collect the information data, we analyze and review the official documents and carry out the following activities: Selection of the information accommodation document, application of the chosen collection instrument, obtaining information on the study variables, competitiveness and development and applied the chosen information to statistical software for analysis and results. On the other hand, the characteristics of the present research study do not allow tabulation of values since data obtained from primary sources was not applied. The data evaluation was carried out in a descriptive manner, which allowed the development of the data in the established years of the study, which were organized into tables and figures through the use of SPSS. With the processed data, econometric analysis was applied through the Eviews software and the application of statistical correlation techniques on the variables.

The study covers the periods 2016 – 2022 in Peru, presenting a descriptive, longitudinal observational and evaluative design. The analysis variables include competitiveness and sustainable development, with dimensions and indicators of productivity and economic growth.

RESULTS

The results highlighted the importance of competitiveness and its impact on sustainable development (economic growth) in Peru during the period 2016-2022. In addition, a detailed analysis has been carried out in various dimensions and indicators, such as Labor Productivity, Infrastructure Productivity, Productivity in Science, Technology and Digitalization, as well as the Gross Domestic Product.

Competitiveness and its Relationship with the Gross Domestic Product

In Figure3, it is observed that the variable Gross Domestic Product (GDP) follows a normal distribution, while the probability associated with the Jarque- Bera statistic is 0.780300, and is greater than the significance level of 0.05, for this reason, The null hypothesis of normality in the variables was rejected.

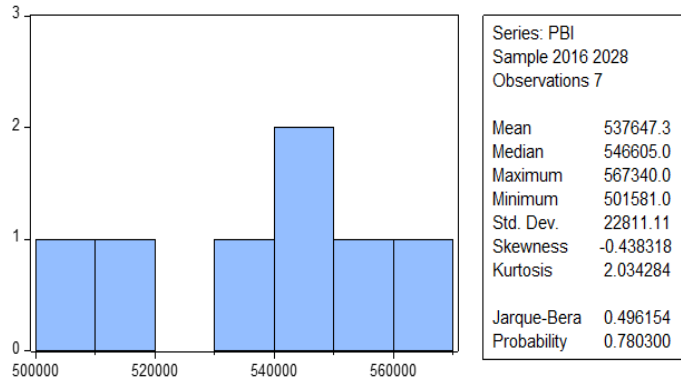


Figure 3.Descriptive statistics and the GDP Histogram

Source: self-made.

On the other hand, as seen in Figure 4, the Competitiveness variable (COMP) follows a normal distribution, with a probability associated with the Jarque- Bera statistic of 0.254086, which exceeds the significance level of 0.05. Therefore, in this case the null hypothesis is also rejected and the alternative hypothesis is accepted.

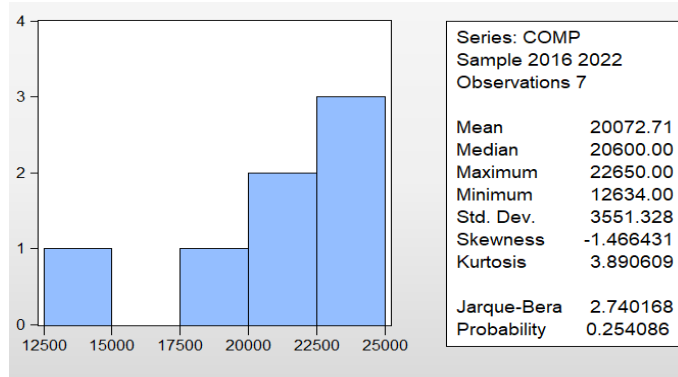


Figure 4.Descriptive statistics and the COMP Histogram

Source: self-made.

Then, through the Linear Regression Model by ordinary least squares (OLS), the relationship that exists between the GDP variable and COMP was also determined, which is represented by the following equation:

$$PBI = 4.6140666727 * COMP + 445030.44369$$

Table 1. GDP and COMP regression result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COMP	4.614067	1.998433	2.308842	0.0690
C	445030.4	40648.55	10.94825	0.0001
R-squared	0.516008	Mean Dependent var		537647.3
Adjusted R-squared	0.419210	S.D. dependent var		22811.11
S.E. of regression	17384.25	Akaike info criterion		22.59947
Sum squared resid	1.51E+09	Schwarz criterion		22.58402
Log likelihood	-77.09816	Hannan-Quinn criter.		22.40846
F-statistic	5.330752	Durbin-Watson stat		1.647522
Prob(F-statistic)	0.069007			

Source: self-made.

Table 1 shows the estimate of the regression model, and it is also observed that the coefficients are significant at the level of individual significance since the probability associated with the t statistic is 0.0001 with a R^2 , whose value reaches 0.516008, which determines that the model does not present positive autocorrelation problems, as long as the Durbin-Watson Stat statistic contains a value of 1.647522. The coefficients are significant in a particular and specific way. Taking into account the results of the general hypothesis, it is concluded that competitiveness positively influences the economic growth of Peru in the years 2016-2022.

Finally, it is concluded that there is a direct linear relationship between GDP and COMP, as long as the null hypothesis of the general hypothesis is rejected and that if this model does not have COMP values, it will have a GDP of 445030.4 in the established period, on the other hand if competitiveness increased by 1%, the gross domestic product would increase by a value of 4.614067.

As we can see, the results show a coefficient of 4.614067 for the competitiveness variable, with respect to GDP, this being positive, which indicates that both variables present a direct relationship. With this, we reject the null hypothesis (it does not correlate positively with GDP) of the statistical hypotheses and accept the alternative hypothesis that indicates that competitiveness is positively related to Peruvian economic growth, in the period 2016 – 2022. Now Let's see the correlation of the competitiveness variable and the Gross Domestic Product (GDP) through the correlation matrix.

Table 2. Correlation Matrix (Pearson correlation coefficient) of GDP and COMP

INDICATORS	GDP	COMP
GDP	1	0.718
COMP	0.718	1

Source: self-made

The correlation value of both variables is 0.718, which shows that the variables are positively correlated and the correlation is almost perfect, while its value is very close to unity in absolute value. Next we apply the analysis taking into account White's test:

F-statistic	0.801387	Prob. F(2,4)	0.5097
Obs*R-squared	2.002475	Prob. Chi-Square(2)	0.3674
Scaled explained SS	1.207056	Prob. Chi-Square(2)	0.5469

Table 3. Table 3.White test results

Source: self-made.

According to the White test , there is no heteroscedasticity, since the P- value of the test statistic is 0.5469 and is greater than 0.05, consequently the null hypothesis of homoscedasticity is rejected. By having a probability of 50.97% and with which we reject the null hypothesis and accept the alternative hypothesis that says that there is no heteroskedasticity in the variables. Finally, we perform the analysis through the Lagrange multiplier test:

F-statistic	3.700549	Prob. F(2,3)	0.1549
Obs*R-squared	4.980982	Prob. Chi-Square(2)	0.0829

Table 4.Lagrange test results

Source: self-made.

Table 4 shows the results of the multiplier test with two lags, but the optimal lag for the test must be found based on the lowest value of the Akaike Information Criterion of the auxiliary model of the test. After performing the test for different lags, we conclude that the optimal lag is five, considering this to perform the test.

The results of the Lagrange multiplier test show a probability of 15.49%, with which we reject the null hypothesis and accept the alternative hypothesis that says that there are no autocorrelation problems in the variables. Regarding the estimates, we present the projections of the variables.

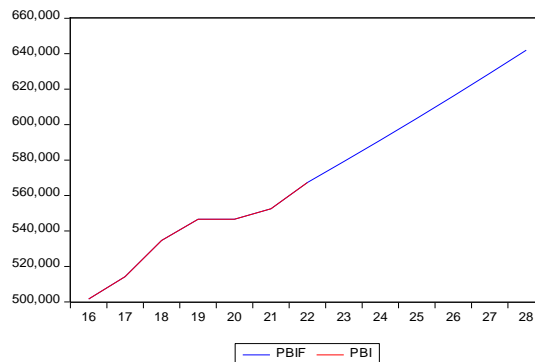


Figure 5. Forecast: GDP

Source: self made

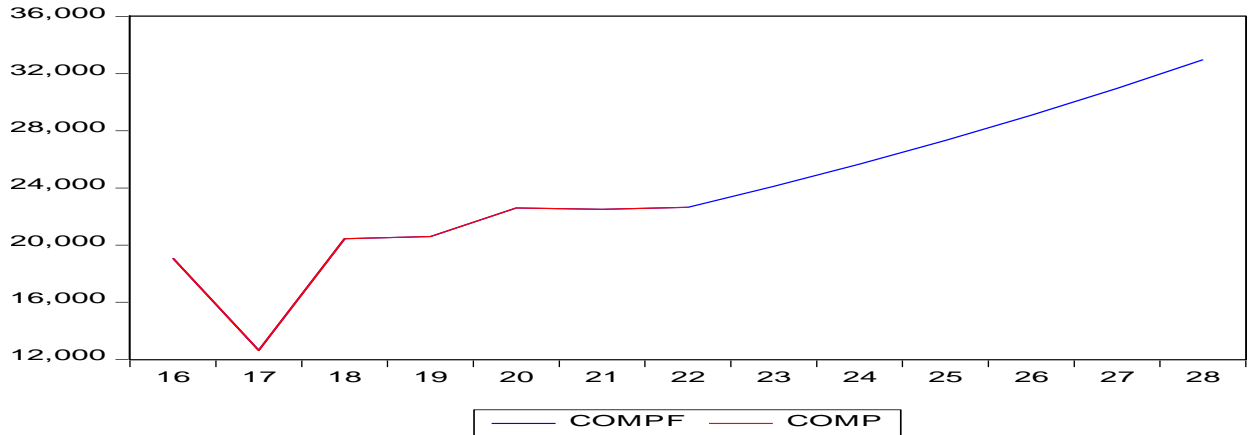


Figure 6. Forecast: Competitiveness

Source: self made

The predictions from 2023 to 2028 can be seen in figures 5 and 6; the competitiveness variable is projected to continue with the same trend. On the other hand, to make a forecast for future data in the variables, the forecast function was used in the regression to obtain the projection of the variables for the period, in this case we are projecting the variables until 2028.

Once this is obtained, the variables are graphed along with their projection, to see the behavior they would have in the future. The behavior of the variables is shown with respect to the trend they had according to the regression carried out, a growing character in the case of GDP and Competitiveness.

Productivity and its Relationship with the Gross Domestic Product

The values of labor productivity, infrastructure, science, technology and digitalization will be highlighted, with respect to the gross domestic product, in the periods 2016-2022.

Labor Productivity and its Relationship with the Gross Domestic Product

We present the information and analysis of Labor Productivity (LP) and its relationship with the Gross Domestic Product (GDP):

Figure 3 shows the descriptive statistics and the histogram of the GDP variable indicating a normal distribution, contrasted and validated with the Jarque- Bera test . With respect to the PL and its relationship with the GDP, once the relationship between both has been established, we present the figure of the descriptive statistics of the variable (PL).

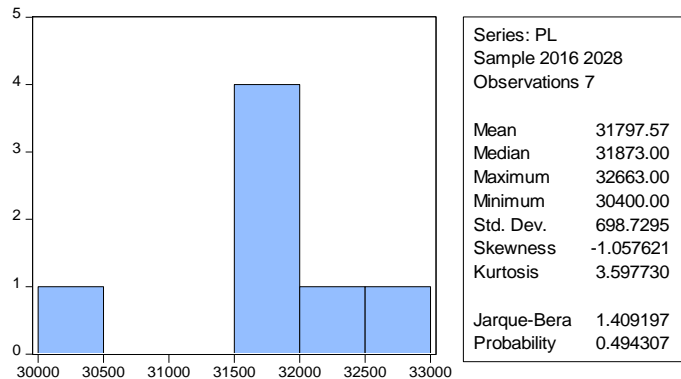


Figure 7. Descriptive statistics and the PL Histogram

Source: self made

In Figure 7, we observe that it follows a normal distribution, while the probability associated with the Jarque-Bera statistic is 0.494307 and is greater than the significance level of 0.05. The results show a Jarque- Bera probability of 49.43%, with which we reject the null hypothesis and accept the alternative hypothesis that says that there is not enough evidence to say that a normal distribution in the residuals is not followed. Then we present the correlation matrix:

Table 5. Correlation Matrix (Pearson correlation coefficient) of GDP and PL

INDICATORS	GDP	P.L.
GDP	1	0.742
P.L.	0.742	1

Source: self-made.

Table 5 shows the correlation of the LP and GDP variables, the value of the correlation of both variables is 0.742, demonstrating that there is a positive correlation and it is almost perfect as long as its value is close to unity in absolute value.

The correlation between the analyzed variables is estimated based on the linear regression model, taking into account the equation:

$$PBI = -232758.3 + 24.22844 * PL$$

Table 6. GDP and PL regression result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PL	24.22844	9.785496	2.475954	0.0561
C	-232758.3	311219.4	-0.747891	0.4882
R-squared	0.550778	Mean dependent var		537647.3
Adjusted R-squared	0.460933	S.D. dependent var		22811.11
S.E. of regression	16748.18	Akaike info criterion		22.52492
Sum squared resid	1.40E+09	Schwarz criterion		22.50947
Log likelihood	-76.83723	Hannan-Quinn criter.		22.33391
F-statistic	6.130350	Durbin-Watson stat		1.298489
Prob(F-statistic)	0.056119			

Source: self-made.

As we can see in table 6, the results show a coefficient of 24.22844 for the PL variable, with respect to GDP, this being positive, which indicates that both variables present a direct relationship. With this, we reject the null hypothesis, and accept the alternative hypothesis that indicates that the PL is positively related to Peruvian economic growth, in the period 2016 - 2022. On the other hand, according to the estimation of the linear regression model by ordinary least squares (OLS). All coefficients are significant since they show a T-statistic greater than 2 in absolute value, in addition the level of global significance is significant, since the probability associated with the F statistic is 0.000005.

Then the R² is high with a value of 0.550778 and the model presents positive autocorrelation, since the Durbin-Watson statistic presents a value of 1.298489, therefore the coefficients are significant in a particular and specific way. In addition, White's heteroskedasticity test was applied .

F-statistic	0.368863	Prob. F(2,4)	0.7128
Obs*R-squared	1.089992	Prob. Chi-Square(2)	0.5798
Scaled explained SS	0.495489	Prob. Chi-Square(2)	0.7806

Table 7. White test results

Source: self-made.

The results show a probability of 0.7128, with which we reject the null hypothesis and accept the alternative hypothesis that says that there is no heteroscedasticity in the variable.

According to White's heteroskedasticity test , heteroskedasticity exists, while the P- Value of the test statistic is 0.7806, it is greater than 0.05, which is why the null hypothesis of homoskedasticity is rejected. We then continue with the analysis through the Lagrange multiplier test .

Table 8.Lagrange test results

F-statistic	0.408040	Prob. F(2,3)	0.6970
Obs*R-squared	1.496971	Prob. Chi-Square(2)	0.4731

Source: self made

The results of the Lagrange multiplier test show a probability of 82.21% (obtained from the Lagrange multiplier test with residue (-1)), and a probability with two residues of 0.6970, with which we reject the null hypothesis and accept the alternative hypothesis which says that there are no autocorrelation problems in the variables. The results are also obtained through the application of the Lagrange multiplier test with two lags. The most appropriate thing is to find optimal lags for the test based on the lowest value of the Akaike information criterion of the auxiliary model of the test. Furthermore, the test was carried out for different lags, resulting in the optimal lag being five (5), taking this result to carry out the test. Finally, the forecasts of the GDP and PL indicators were analyzed:

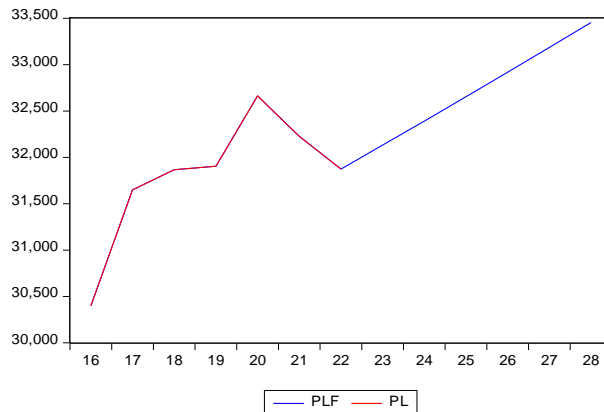


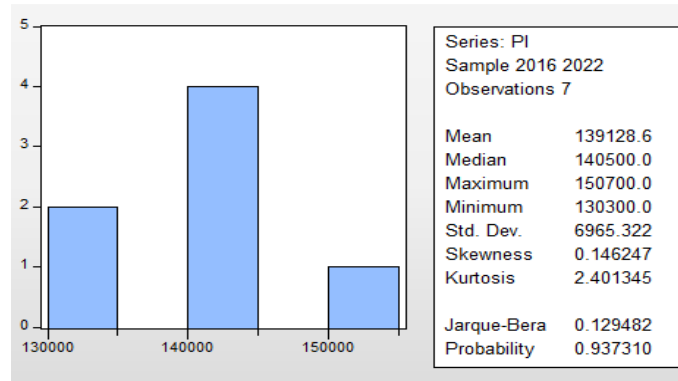
Figure 8: Forecast: Labor Productivity

Source: self made

For this second case, we have the GDP with respect to the PL, and as we can see, the data are not completely adjusted as in the first case, but they still present a similar trend. In this case, it would be a growing trend, which would indicate that the growth of Labor Productivity would positively impact economic growth.

Infrastructure Productivity and its Relationship with Economic Growth

No. 9 is shown below , which facilitates the analysis of the correlation between GDP and Infrastructure



Productivity (IP) through the normality of errors test.

Figure 9.Descriptive statistics and the PI histogram

Source: self-made.

According to the figure, the PI variable follows a normal distribution while the normal probability associated with the Jarque- Bera statistic is 0.937310 and is greater than the significance level of 0.05. The results show a Jarque- Bera probability of 93.7310%, so we reject the null hypothesis and accept the alternative hypothesis that says that there is enough evidence to say that a normal distribution is followed in the residuals. Then we present the analysis of the correlation of the variables involved, taking into account the correlation matrix:

Table 9.Correlation Matrix (Pearson correlation coefficient) of GDP and PI

INDICATORS	GDP	PI
GDP	1	0.722
PI	0.722	1

Source: self-made.

This matrix shows the correlation of the variables or indicators PI and GDP, the value of the correlation of both variables is 0.721998 which means that the indicators are positively correlated and it is almost perfect because its value is close to unity in absolute value, having Taking this correlation into account, it can be estimated by combining the simple linear regression model as a basis, represented by the equation:

$$PBI = 208676.199287 + 2.36451135126 * PI$$

Table 10. GDP and PI regression result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PI	2.364511	1.013351	2.333358	0.0669
C	208676.2	141137.5	1.478531	0.1993
R-squared	0.521282	Mean dependent var		537647.3
Adjusted R-squared	0.425538	S.D. dependent var		22811.11
S.E. of regression	17289.28	Akaike info criterion		22.58852
Sum squared resid	1.49E+09	Schwarz criterion		22.57306
Log likelihood	-77.05981	Hannan-Quinn criter.		22.39751
F-statistic	5.444558	Durbin-Watson stat		1.312246
Prob(F-statistic)	0.066931			

Source: self-made.

The respective table shows the estimation by ordinary least squares (OLS) in which it is observed that all the coefficients are significant, firstly, it presents T-statistic greater than two (2) in absolute value, on the other hand, it must be The global significance level is significant since the probability associated with the F statistic is 0.066931, it R² is also high with a value of 0.521282. The model presents positive autocorrelation since the Durbin-Watson statistic has a value of 1.312246. Without a doubt, the coefficients are significant in a particular and specific way, in addition, as we can see a coefficient of 2.364511 for the PI variable, with respect to GDP, this being positive in nature, which indicates that both variables present a direct relationship, and with it We reject the null hypothesis, and we accept the alternative hypothesis that indicates that IP is positively related to Peruvian economic growth in the period 2016-2022. Regarding White's heteroscedasticity test, it is presented below:

Table 11. White test results

F-statistic	0.188646	Prob. F(2,4)	0.8350
Obs*R-squared	0.603351	Prob. Chi-Square(2)	0.7396
Scaled explained SS	0.174722	Prob. Chi-Square(2)	0.9163

Source: self-made.

According to the White test , there is no heteroskedasticity, while the p- value of the test statistic is 0.9163 (Pro. Chi-Square.2) and is greater than 0.05, so the null hypothesis of homoskedasticity is rejected, and it is also observes a normal distribution of the variables because the probability associated with the Durbin-Watson Stat statistic is 1.226783 and with a White probability of 0.8350 and 0.1226783, it is greater than the significance level of 0.05, therefore the null hypothesis of normality is rejected. In the variable, on the other hand, the PI presents a normal distribution, because the probability associated with the Jarque- Bera statistic is 0.129482, and is greater than the significance level of 0.05; Therefore, the null hypothesis of normality in the variable is rejected, accepting that there is heteroscedasticity in the variable greater than 5%. The correlation analysis was also carried out through the Lagrange multiplier test :

Table 12. Lagrange test results

F-statistic	0.256433	Prob. F(2,3)	0.7892
Obs*R-squared	1.021976	Prob. Chi-Square(2)	0.5999

Source: self made

The results of the Lagrange multiplier test with two lags show a probability of 0.7892, with which we reject the null hypothesis and accept the alternative hypothesis that says that there is autocorrelation in our variables. But it is necessary to find the optimal lag for the test based on the lowest value of the Akaike information criterion, of the auxiliary model of the test. After performing the test for different lags, it is concluded that the optimal lag is 5, which will be considered to perform the test. Regarding the forecast of the GDP and PI indicators, figure10 is presented.

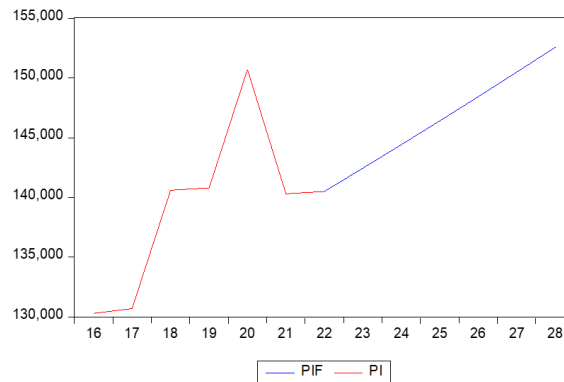


Figure10: Forecast: Infrastructure Productivity

Source: self made

In figure 10, we visualize a situation similar to the analysis of the projection of the Labor Productivity indicator, in the case of GDP, related to Infraestructure Productivity, there is a similar trend, having a positive relationship for these variables in the projections to the year 2028.

Productivity in Science, Technology and Digitalization and its Relationship with Economic Growth

The following figure shows the descriptive statistics and histogram of Productivity in science, technology and digitalization (PCTD):

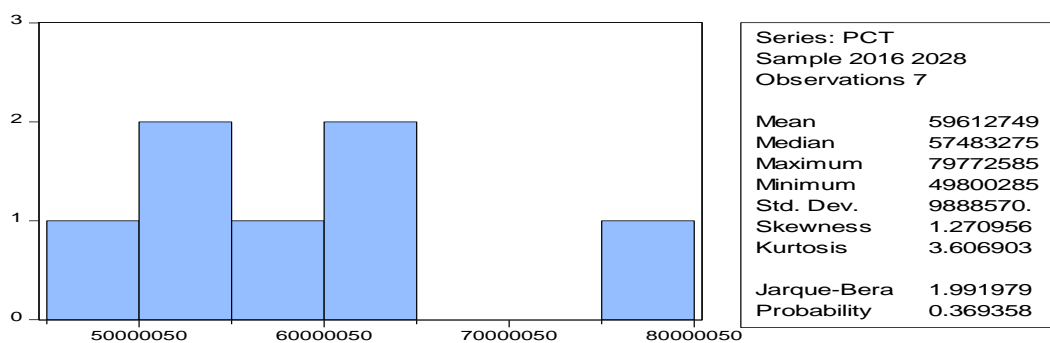


Figure 11.Descriptive statistics and the PCTD histogram

Source: self made

The results show a Jarque- Bera probability of 36.93%, with which we reject the null hypothesis and accept the alternative hypothesis that says that there is not enough evidence to say that a normal distribution in the residuals is not followed.

Table 13 shows the correlation of the PCTD variable and GDP, the value of the correlation of both variables is -0.326764.

Table 13. Correlation Matrix (Pearson correlation coefficient) of GDP and PCTD

INDICATORS	GDP	PI
GDP	1	-0.327
PI	-0.327	1

Source: self-made.

Table 13 shows that the variables are negatively correlated. Furthermore, it is evident that the correlation is not perfect, since its values are very far from unity in absolute value.

Analyzing the correlation between the variables, the simple linear regression model was estimated, taking into account the equation:

$$PBI = 582582.5 - 0.000754 * PCTD$$

Table 14. GDP and PCTD regression result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PCT	-0.000754	0.000975	-0.773106	0.4744
C	582582.5	58804.35	9.907132	0.0002
R-squared	0.106775	Mean dependent var		537647.3
Adjusted R-squared	-0.071870	S.D. dependent var		22811.11
S.E. of regression	23616.60	Akaike info criterion		23.21224
Sum squared resid	2.79E+09	Schwarz criterion		23.19679
Log likelihood	-79.24285	Hannan-Quinn criter.		23.02123
F-statistic	0.597693	Durbin-Watson stat		0.409598
Prob(F-statistic)	0.474403			

Source: self-made.

Table 14 shows a coefficient of -0.000754 for the PCTD variable, with respect to GDP, this being negative, indicating that both variables present an inverse relationship, with which we accept the null hypothesis that indicates that the PCTD It is not positively related to the economic growth of Peru, in the period 2016-2022. Then we present White's Heteroskedasticity Detection test.

Table 15. White test results

Heteroskedasticity Test: White			
F-statistic	0.037791	Prob. F(2,4)	0.9633
Obs*R-squared	0.129815	Prob. Chi-Square(2)	0.9372
Scaled explained SS	0.032358	Prob. Chi-Square(2)	0.9840

Source: self-made.

The results show a White probability of 96.33% (Table 15), with which we reject the null hypothesis and accept the alternative hypothesis that says that there is no heteroskedasticity in our variables. The correlation analysis was also carried out through the Lagrange multiplier test:

Table 16. Lagrange test results

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	3.850675	Prob. F(2,3)	0.1484
Obs*R-squared	5.037631	Prob. Chi-Square(2)	0.0806

Source: self-made.

The table shows the results of the Lagrange multiplier test with two lags, however, the optimal lag for the test must be found based on the lowest value of the Akaike Information Criterion of the auxiliary model of the test. After performing the test for different lags, it is concluded that the optimal lag is five, so this value is used to perform the test. Finally we present the GDP and PCTD forecasts, through figure12.

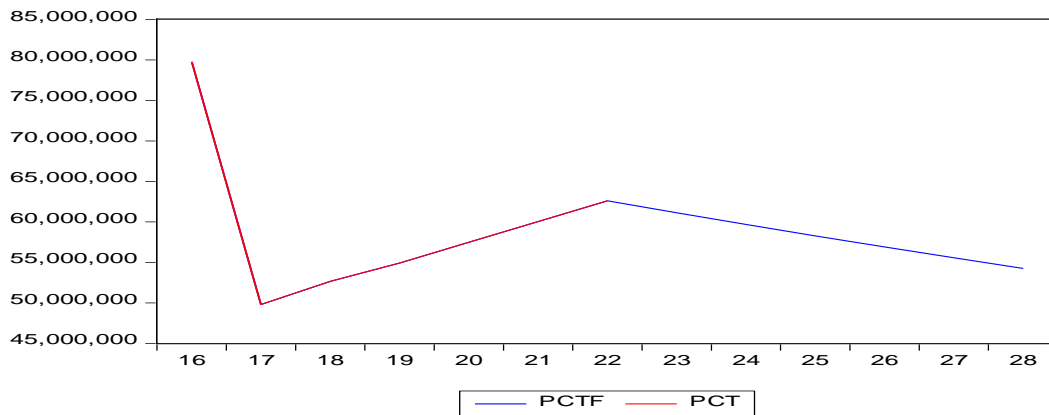


Figure 12. Science, Technology and Digitalization Forecast

Source: self-made.

In Figure12, it is observed that the line that represents the prediction estimate has a negative trend, which agrees with the result obtained in the regression. This indicates that the trend estimated in the model is being followed, which in this case shows an inverse relationship between the variables GDP and Productivity of Science, Technology and Digitalization in the projections to the year 2028.

DISCUSSIONS AND CONCLUSIONS

In this study, the level of influence of competitiveness on sustainable development was examined, and the effect of productivity on economic growth was also evaluated, through the analysis of the indicators labor productivity, infrastructure productivity, productivity in science, technology, digitalization and Gross Domestic Product in Peru during the period 2016-2022.

For this, the model was implemented, through the Eviews software, results were obtained from the heteroskedasticity test, the Lagrange multiplier (LM) test, the Normality of Errors test, and the Pearson Correlation Matrix; All this with the purpose of choosing the best estimate that explains the results obtained. We have that labor productivity and infrastructure productivity significantly and positively influence the gross domestic product. Regarding the productivity of science, technology, digitalization, the results obtained reflect negative and significant impacts on the growth or increase of the Gross Domestic Product. Regarding competitiveness, the results obtained are contrasted with research related to the topic, thus we have García J. A, & Sánchez, MP (2019). They express that the competitiveness variables significantly influence the economic well-being of the community, this result was evidenced in the European Union, using an econometric model to determine the impact and correlation in both variables. The present study is related to our research since we show that the competitiveness variable has a positive impact on the sustainable economic development of Peru in the years 2016 - 2022. The direct linearity of competitiveness is confirmed (labor productivity, infrastructure productivity, employment productivity of science, technology digitalization), with sustainable development (economic growth. GDP), likewise García, V. and Granda G. (2020) highlight that the agreements of the 2030 Agenda for sustainable development are fundamental and underline the role crucial that private companies play in its achievement and the associated benefits.

Likewise, C EPLAN (2022), regarding Peru's strategic development plan to 2050, presents the third national strategic objective that considers productivity and competitiveness to achieve the well-being of the community. Also in this regard, the OECD states that there is a direct and positive relationship between spending on research and development with the growth of the Gross Domestic Product. The concluded results present similarity to the results of our research study, because competitiveness, which presents productivity as a dimension and this presents labor productivity and infrastructure productivity as indicators, has a positive effect on the sustainable development of the Peru in the period 2016 - 2022. Also, Porter ME (1990) proposes the diamond theory, which includes key elements such as human capital, infrastructure and industries, while Gómez, JA (2021) offers a synthesis of competitiveness theories and their historical evolution, evaluating theoretical currents and factors that influence business competitiveness. This approach is similar to our study, which examines similar elements, variables and indicators, finding a positive correlation between employment and infrastructure productivity, favorably impacting the economic growth and sustainable development of Peru from 2016 to 2022.

In conclusion, the Gross Domestic Product in the analysis period 2016-2022 had a significant and positive impact on economic well-being, on the other hand, labor productivity, infrastructure productivity, boosted competitiveness and therefore economic growth, while Productivity in science, technology and digitalization does not contribute to well-being, which has a negative impact as there are no policies that promote science, technology and innovation. The correlational analysis has shown that the elements of competitiveness are positively interrelated with economic growth (GDP) and the sustainable development of the country. Therefore, the conclusions of the research study are as follows:

The correlational analysis of the factor "Labor Productivity (PL)" shows a positive interrelation with the gross domestic product (GDP) indicator, which means that in the face of an increase in labor productivity of 1%, the level of development of Peru will improve by through the gross domestic product by 24.22%.

The correlational analysis of the "Infrastructure Productivity (IP)" factor, shows a direct and positive interrelation with the gross domestic product indicator, meaning that with an increase in infrastructure productivity of 1%, the level of development in Peru will increase through of the Gross Domestic Product (GDP), at 2.3645%.

The correlational analysis of the "Productivity of Science, Technology and Digitalization (PCTD)" factor shows an inverse interrelation with the Gross Domestic Product (GDP) indicator. and therefore with sustainable development. Which means that with an increase in the productivity of science, technology and digitalization by 1%, the level of development in Peru will decrease through the Gross Domestic Product. (GDP) at -0.00075%.

Finally we have the conclusion regarding the correlational analysis of the competitiveness variables (labor productivity, infrastructure productivity, science, technology and digitalization productivity) and the sustainable development variable (GDP). The positive impact of competitiveness on the sustainable development of Peru is evident in the years 2016 - 2022, the existence of a direct linear relationship of competitiveness with sustainable development is seen. By rejecting the null hypothesis of the general hypothesis and having the econometric model an explanatory capacity of (4.614 %). It is concluded that, with sufficient information in the study period, the variables competitiveness and sustainable development can operate as explanatory variables and explained variable, which is why HO is rejected and we accept H1.

The present research presents several limitations, such as the limited and incomplete availability of data on certain variables and indicators, which affects the balanced application of the model. Furthermore, the analysis period is restricted to the years 2016-2022, excluding previous and subsequent periods due to the lack of available information on the relevant variables and indicators.

Therefore, it is recommended for future research to analyze the factors related to productivity in science, technology and digitalization that may influence economic well-being in Peru. This would allow us to obtain a more detailed perspective of the impact of Productivity in Science, Technology and Digitalization (PCTD), as well as evaluate other productivity indicators to determine which of them has the greatest influence on

economic development. Based on this analysis, it could be recommended to significantly increase improvements in Productivity in Science, Technology and Digitalization (PCTD), accompanied by policies that promote this area to promote economic growth.

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