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ORIGINAL ARTICLE

# Impact of public expenditure on education on economic growthin the southern macro region of Peru, during the period 2003-2021

## Impacto del gasto público en educación sobre el crecimiento económico en la región macro sur del Perú durante el periodo 2003-2021

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**Abstract**

The present research work aims to determine the impact of public spending on education on economic growth in the southern macro region of Peru during the period 2003 to 2021, covering the regions of Puno, Tacna, Arequipa, Moquegua, Apurímac, Cusco and Madre de Dios. The data used come from the statistical area of the Ministry of Economy and Finance, the National Institute of Statistics and Informatics and the Educational Quality Statistics of the Ministry of Education. The methodological approach adopted is hypothetical-deductive, non-experimental with a panel-type design; the estimation of the model was carried out using the Generalized Least Squares Feasible panel data technique which reveals significant quantitative relationships between the analysis variables. In general terms, the main findings indicate that a 1 % increase in public educational spending correlates with a 0.12 % increase in economic growth. Furthermore, when breaking down the impact of public spending by different levels of initial education - primary, secondary and higher - a 1 % increase generates an increase of 0.13 %, 0.14 % and 0.069 % respectively on economic growth. Furthermore, it is highlighted that investment in physical capital has a positive effect on economic growth. In conclusion, total public spending on education and spending by educational levels exhibit a positive and significant impact on economic growth, highlighting the strategic importance of government investment in education as a fundamental catalyst for economic growth.

***Keywords:*** Economic Growth, Public Spending on Education and Investment in Physical Capital.

**Resumen**

El presente trabajo de investigación tiene por objetivo determinar el impacto del gasto público en educación sobre el crecimiento económico en la macro región sur del Perú durante el periodo 2003 al 2021, abarcando las regiones de Puno, Tacna, Arequipa, Moquegua, Apurímac, Cusco y Madre de Dios. Los datos utilizados provienen del área estadística del Ministerio de Economía y Finanzas, Instituto Nacional de Estadística e Informática y Estadística de Calidad Educativa del Ministerio de Educación. El enfoque metodológico adoptado es hipotético-deductivo, no experimental, con diseño tipo panel. La estimación del modelo se llevó a cabo mediante la técnica de mínimos cuadrados generalizados factibles de panel de datos, el cual revela las relaciones cuantitativas significativas entre las variables de análisis. En términos generales, los principales

hallazgos indican que un incremento del 1 % en el gasto público educativo genera un aumento del 0.12 % en el crecimiento económico. Además, al desglosar el impacto del gasto público por los niveles educativos inicial-primaria, secundaria y superior, se observó que un incremento del 1 % genera un aumento sobre el crecimiento económico de 0.13 %, 0.14 % y 0.069 %, respectivamente. Asimismo, se destaca que la inversión en capital físico sostiene un efecto positivo sobre el crecimiento económico. En conclusión, el gasto público total en educación y el gasto por niveles educativos exhiben un impacto positivo y significativo en el crecimiento económico. Se destaca la importancia estratégica de la inversión gubernamental en la educación como un catalizador fundamental para el crecimiento económico.

*Palabras clave:* crecimiento económico; gasto público en educación; inversión en capital físico.

## 1. Introduction

In the early 1950s, the relevance of workers in the economic sphere and their importance for the productive unit was recognized due to all the knowledge, know-how and skills that workers contribute, and we began to speak of human beings as a crucial factor in business production and economic growth (Cardona et al., 2007). Economic theory indicates that education has become a fundamental issue and, from the theoretical perspective of human capital, education has been interpreted as an investment process that leads to the improvement of the productive skills of participants in the economy; as a result, there is an increase in their income streams (Riomaña, 2011). Education is considered one of the primary objectives of governments in both highly developed and developing nations because of its effect on reducing unemployment and poverty rates, which in turn leads to an improvement in the quality of life. (Acuña et al., 2021). Thus, education is identified as an integral part of a nation's economic growth, because it prepares, enables and fosters research and, in turn, contributes to the improvement of a state's productive processes, which results in an increase in competitiveness (Gómez and Zárate, 2011). In this sense, Pardo (2006) argues that education becomes an essential element for the accumulation of human capital and a factor that influences economic development (Abanto, 2021). That is, education becomes a competitive advantage and growth in society. (Guarnizo, 2018). The investments made in education are one of the tools most used by states or governments to achieve the development of a country (Gómez and Zárate, 2011). The importance of this lies in improving the welfare of people through the production or facilitation of goods and services that are highly valued (Bravo et al., 2021). The aim is to avoid the shortage of qualified human resources that derives from weak educational incentives in the marketplace (Pérez and Cucarella, 2016). Since the current market has generated many productive changes and countries with low levels of human capital face the so-called new world order (technology and information), in view of this concern, governments are seeking to have more human capital with high added value (Coello and Pérez, 2005). Therefore, state spending on education is one of the most significant tools in the fiscal policy of governments due to the flexibility of being managed by the state and its great effect on the economy and society, considering public spending on education as a fiscal instrument that reduces economic backwardness, increases productivity and improves income (Pereyra, 2002). Over the past 50 years, the expansion of the education system has brought about a significant transformation in the societies of OECD member countries. In 1961, higher education was a privilege reserved for the few and many young people did not have access to secondary education in several countries. Today, the vast majority of the population completes secondary education and, in some countries, up to half of the population could have a higher education degree (Morales et al., 2011). At the OECD average level, the proportion of people who at least completed secondary education increased from 45% to 81%, while those who obtained higher education grew from 13% to 37% (Morales et al., 2011). For the Peruvian case, during the period between 1950 and 2017, public financing of education presented three distinctive stages: a first phase of increased spending coinciding with the general growth of state intervention from the 1950s to the early 1970s and an expansion of enrollment, especially in secondary education, which was previously limited to a small elite; a second stage of three to four decades marked by limited public funding in

accordance with a deep national crisis and the massive expansion of the education system in a context of population growth; finally, a period of recovery of public investment levels per student that begins in the middle of the first decade of the 21st century and is related to economic expansion. In addition, between the years 1999 to 2015 there was a notable increase in financial resources within the public budget in Peru, especially destined to the educational function, indicating a substantial growth in real terms and experiencing a faster growth than the gross domestic product. According to data presented by the Educational Statistics Unit of the Peruvian Ministry of Education (ESCALE), there has been a positive real increase in most educational levels between 2015 and 2021. Meanwhile, at the level of Peru's southern macro region, the trend of public spending on education is increasing between the years 1999 to 2021 in the entire group of regions that make up southern Peru.

Therefore, the present research study aims to determine the impact of public spending on education on economic growth in the southern macro region of Peru during the period 2003-2021, where the southern macro region of Peru comprises the regions of Puno, Cusco, Arequipa, Moquegua, Apurimac, Tacna and Madre de Dios. It is worth mentioning that the study considers a general objective and four specific objectives that support the results of this research objective. To this end, it is based on the hypothesis that public spending on education is positively and significantly related to economic growth in the southern region of Peru. To this end, a panel data analysis methodology is proposed and a model is estimated using panel data estimators (fixed effects or random effects) under a static panel. Consequently, the article begins with a literature review on the effect of public spending on education on economic growth. It continues with the research methodology and an empirical proposal of the impact relationship between the variables of analysis. Subsequently, it proceeds with the methods and materials used; finally, it continues with the results obtained and the corresponding conclusions of the selected model.

## 2. Literature review

Several papers have addressed the effect of education on economic growth, but few research papers address the effect of public education spending on economic growth at the macro level. The work by Coello and Perez (2005) for the Mercosur and CAN countries, in their conclusions, emphasizes that education is an essential pillar for economic growth. As for the results, they find that Bolivia, Brazil, Colombia, Ecuador and Venezuela do not show a positive relationship between the factors studied; however, Argentina, Uruguay, Paraguay and Peru show significant results, indicating that state disbursement in education boosts economic growth in some way in the Mercosur and CAN countries. Likewise, Gómez and Zárate (2011)in their study for 11 Latin American governments with a correlational approach, find that in the context of Latin America there is a direct connection between public educational spending and GDP per capita in the countries of Chile, Costa Rica, Cuba, El Salvador, Peru and Uruguay, concluding that the greater the investment in education, the greater the growth in GDP per capita; while for Argentina, Brazil, Mexico, Panama and Colombia the results show the opposite behavior. In addition, Forero (2020) in his research for Latin America, also concludes that public spending on education by the government has a positive impact on economic growth in Latin America from the 1990s to the present, mentioning that countries with higher spending on education have higher levels of per capita income. Also, Aycardi (2016) for the same area of study, concludes that public spending on education has a positive impact on economic growth, emphasizing that the resources allocated specifically to secondary education are more relevant to economic growth, becoming a major tool of government fiscal policy. For its part, in the work carried out by Baquerizo and Alcántara (2019) and Mendoza and Pérez (2019) on "the influence of public education spending on economic growth in the central region of Peru" between the periods 2001-2016 and 2001-2018, respectively , the authors concluded that government disbursements in education in the central region of Peru present a positive and significant impact on economic growth, stating that countries with more prioritized spending in the education sector boost economic growth and increase productive capacity; as a result, they obtain high incomes that increase and improve human capital. Likewise,

in the work of Mendoza and Perez (2019), who also study the effects generated by public spending broken down by primary, secondary and tertiary educational components on economic growth for the central macro region of Peru, they conclude that to a large extent education spending, especially spending on primary and secondary education, determines economic growth to a greater extent, but in general these expenditures by educational components increase economic growth. Also, Zegarra (2018), in his work conducted for the Junín region, considers that the per capita income of a region or country is determined by government spending on human capital stock and by investment in physical capital. The findings obtained from the OLS regression, show that there is a direct effect of 0.36% in per capita income on economic growth when educational spending increases by 1%. Also 1 % increase in gross fixed investment generates a direct effect of 0.19% on economic growth in the Junín region between 2001 and 2015. Also, Alvarado et al. (2019) find for Ecuador that public spending on education and gross domestic product reflect a significant positive relationship, emphasizing that investment in education is a very relevant factor to boost economic development in Ecuador. In turn, Ordoñez et al, (2018) in their results, indicate that the illiteracy rate and public spending on education are the factors that have a significant impact on GDP per capita, since spending on education favors economic growth per capita. In addition, Odior (2011) in research conducted for the Nigerian economy for the long term, concludes that a greater orientation of public spending towards the improvement of educational services will promote economic growth. On the other hand, Aguirre (2020) in his research conducted for Educador through the econometric application of ordinary least squares, highlights that gross fixed capital formation is one of the most influential variables in GDP, as is the economically active population variable; however, investment in higher education has a negative relationship with economic growth. The author mentions that this is due to the low quality of investment in higher education. Likewise, Vega (2017) and Vega (2019)for the case of Mexico, based on statistical evidence, find as a result in both investigations that educational spending has no impact on economic growth in the Mexican case, indicating that the theory of human capital is not universal. Lugo (2012), also for the Mexican case, concludes that state intervention does not translate into increased levels of development or economic growth, emphasizing that spending on education should be of higher quality, particularly for students at the basic level.

## 3. Theory and model of the effect of human capital on economic growth

Schultz (1961) is a pioneer in referring to and developing the term human capital and in integrating human capital as a complementary component within the neoclassical theoretical framework of development. In his work "Human Capital: Investments in Education and Opportunity Costs" he argued that human capital is a set of skills and knowledge acquired through education and training, which generate an increase in productivity and income. He proposes that education should be considered as an investment and not as consumption, since it is analogous to investment in physical capital, which in the long term generates returns and economic benefits. The central point is to consider the importance of education and training in economic development, considering individuals as investors who make rational decisions to maximize their returns throughout their lives. Becker (1964) formally investigates, consolidates and specifies "the theory of human capital", considering educational training as an investment, which helps to increase the productivity and income of individuals and their human capital in an efficient manner, a necessary force to generate economic growth. Becker's main finding was to conceptualize education and training as investments in human capital, changing the traditional perspective and highlighting the importance of these intangible elements in economic and individual development. Becker et al. (1990) indicate that in order to generate more human capital there must be an improvement or greater investment in the educational system that generates returns and economic growth. (Cardona et al., 2007). Therefore, Giraldo and Estupiñan (2013) mention that educational training, which is offered by the government (academic system), and work experience are the means by which human capital is obtained or accumulated (Baquerizo & Alcántara, 2019).. Lucas (1988), from a macroeconomic approach, indicates that human capital plays a special role in economic growth because

of its positive externality, which generates much higher social benefits than private ones. According to Lucas, human capital in terms of knowledge and skills acquired through education is fundamental for the overall economic progress of a society and individuals. Therefore, the stock of human capital is considered a decisive technology, research and development generator for modern economies, enabling technological development and new products that are fundamental for economic growth. Thus, "Lucas states that the growth of human capital is determined by two factors: the quality of education and the percentage of time people devote to study". In short, Lucas' theory indicates that an increase in investment in education and training can lead to a sustained increase in productivity and, consequently, in long-term economic growth. The exact relationship between human capital and output may vary in different models and specific economic contexts. Mankiw, Romer and Weil (11992) modify the Solow model to add human capital, allowing for a closer fit to reality. This reflects that a given rate of human capital stock and higher levels of investment in physical capital stock tend to lead to higher levels of income per person and human resources at the same time, which is reflected in income. In addition, there is some relationship between the accumulation rates of human capital and physical capital, so it is necessary to consider both, because the exclusion of one of them distorts the coefficient estimates in the empirical studies. Therefore, the correlation between economic growth and human capital in the extended model is understood as: "given an initial value of GDP per capita, a country's growth rate is positively related to the initial human capital" (Mendoza & Perez, 2019). The following is a synthesis of the adapted Solow-Swan theoretical model developed by Sorensen and Whitta-Jacobsen (2005), which provides an understanding of the relationship between education and economic growth of the Solow model with human capital.

The model is similar to Solow's model, with the same economic agents: a profit-maximizing representative and profit-maximizing consumers. In this model, government participation can also be considered as an exercise possibility. A production function with human capital, where consumers each year have the power to decide a fraction of their income to accumulate human resources, assuming that each unit of production can be used for physical capital investment, human capital or consumption. Also, human capital presents its own rental rate because the worker is not separated from human capital, so in the labor market it will be traded no longer as "unit of raw labor man-years, rather man-years endowed with a level of human capital or education"; hence the total human capital stock (Ht), where each worker at work (Lt) with a human capital (ht), $h_t = |\frac{H_t}{H_t}$ indivisible with the worker (in other words, adding an additional labor force is understood as hiring an additional unit of labor equipped with (ht)) . Finally, the new approach integrates the human resource in the production process and the accumulation of education by consumers. Sorensen and Whitta-Jacobsen (2005) propose the following production relationship involving the human capital factor. Production function with human capital: It is shown that in period "t", the quantities of physical capital (Kt) and of human capital (Ht) are determined by past accumulation and the assumed production function is as follows

$$Y_t = K_t^{\alpha} H_t^{\varphi} (A_t L_t)^{1-\alpha-\varphi} \quad 0 < \alpha < 1, 0 < \varphi < 1, \alpha + \varphi < 1 \tag{1}$$

Where:

- $A_t$ • At is the technological variable and is given by g a constant rate of technological progress and $g > -1$, where for the period "t" es $A_t = A_0(1 + g)^t$.
- • The production function presents constant yields in the three production factors $K_t$, $H_t$, $L_t$. And it should be possible to double production by doubling the factor inputs; that is, by hiring 2Lt of workers instead of $L_t$, which implies that physical capital doubles and human capital doubles, which implies that there are diminishing returns to reproducible capital inputs $\alpha + \varphi < 1$.

According to the replication argument, hiring one more marginal unit of labor now means a unit endowed with the average amount of ht of human capital per worker. A firm cannot increase the

input of raw labor Lt, without proportionally increasing that of human capital input $H_t = h_t L_t$ when calculating the marginal product of labor; therefore, we must consider a $h_t$, $(H_t)$ as given.

Inserting $H_t = h_t L_t$ into Equation 1 we have the following production function:

$$Y_t = K_t^{\alpha} h_t^{\varphi} A_t^{1-\alpha-\varphi} L_t^{1-\alpha} \tag{2}$$

Based on the steady state analysis, it is now possible to find the steady state growth trajectories of the most interesting variables, such as $k_t$, $h_t$ y $\gamma_t$. For example, for $\gamma_t = \tilde{\gamma}_t A_t$ the strady state is: $H_t = h_t L_t$

$$\gamma_t^* = A_t \left( \frac{s_k^{1-\varphi} s_H^{\varphi}}{n + g + \delta + ng} \right)^{\alpha/(1-\alpha-\varphi)} \left( \frac{s_K^{\alpha} s_H^{1-\alpha}}{n + g + \delta + ng} \right)^{\varphi/(1-\alpha-\varphi)} \tag{3}$$

Where A grows according to $A_0(1 + g)^t$. According to the steady state of the Solow model with human capital, the long-run per capita income elasticity with respect to the rate of investment in physical capital is $s_K$ in physical capital is $\alpha/(1 - \alpha - \varphi)$ and with respect to the rate of investment $s_H$ in human capital is $\varphi/(1 - \alpha - \varphi)$ (Sorensen & Whitta, 2010).

For the empirical analysis, logarithms are first applied to both sides of the equation, where $ng = 0$;.

The following is obtained:

$$ln\gamma_t^* = lnA_t + \frac{\alpha}{1 - \alpha - \varphi}[lns_K - ln(n + g + \delta)] + \frac{\varphi}{1 - \alpha - \varphi}[lns_H - ln(n + g + \delta)] \tag{4}$$

Finally, the present empirical model shows that the higher the investment, the higher the production, concluding that production is not only conditioned by the investment in physical assets, but also by the investment in human resources.

## 4. Materials and method

The objective of this research is to determine the impact of public spending on education on economic growth. To complete this objective, the "Macro Southern Region of Peru (MRS)" is considered as the geographical location of the study. Although the Peruvian MRS is not currently considered a political and administrative territory of Peru, it presents and embodies a spatial functionality and dynamism that is in constant movement and interaction with economic, social and political elements. Peru's southern macro region has the following demographic and economic aspects. In terms of demographics, according to the 2005 National Housing and Population Census (CNVP), the southern macro region of Peru has more than 4.5 million inhabitants, which represents 17.2% of Peru's entire population. The regions of Puno, Cusco and Arequipa have the largest populations, with a percentage of 27.7%, 26% and 25.3%, respectively, comprising 80% of the total MRS. The remaining 20 % of the population lives in 4 regions: Apurimac, Madre de Dios, Moquegua and Tacna. Table 1 below shows more characteristics of the demographic scope of the study.

Regarding economic aspects, Table 2 shows that, in the MRS, in the years 2012 and 2021, the Apurimac region registered an average annual growth of 13.5 %, surpassing the other regions. This growth was due to commercial mining production, being its main economic activity with the highest representation, specifically, 58.2%. Meanwhile, in the regions of Tacna, Arequipa, and Puno, in the same period, the gross value added grew by an average of 4.9%, 3.6% and 2.3 % per year, respectively. On the other hand, the average annual growth rates of the regions of Moquegua and Cusco are 1 % lower than the aforementioned regions: 1.5 % and 1.6 %, respectively. Finally, the Madre de Dios region presented a negative value of -1.3 % with respect to average annual GVA growth between 2012 and 2021.

**Tabla 1.** Demographic situation of the southern macro region of Peru

| Departments | Surface area Km2 | Total population 2005 | Population % share | Density (In-hab/km2) |
|---|---|---|---|---|
| Apurímac | 20 895.79 | 405 759 | 1.38 | 19.42 |
| Arequipa | 63 345.39 | 1 382 730 | 4.71 | 21.83 |
| Cusco | 71 986.5 | 1 205 527 | 4.10 | 16.75 |
| Madre de Dios | 85 300.54 | 147 070 | 0.50 | 1.72 |
| Moquegua | 15 733.97 | 174 863 | 0.60 | 11.11 |
| Puno | 71 999.00 | 1 172 697 | 3.99 | 16.29 |
| Tacna | 16 075.89 | 329 332 | 1.12 | 20.49 |

Source: Own elaboration

**Tabla 2.** VGross Value Added 2012 – 2021 by department MRS (values at constant 2007 prices)

| Región | Apurímac | Arequipa | Cusco | Madre de Dios | Moquegua | Puno | Tacna |
|---|---|---|---|---|---|---|---|
| Activities | Average annual growth 2012 - 2021 | | | | | | |
| Agriculture, Livestock, Hunting and Forestry | 2.3 | 2.3 | 0.8 | 2.8 | 1.4 | 3.6 | 4.9 |
| Fisheries and Aquaculture -10.1 -14.4 -10.8 -16.8 -4.4 10.6 10.5 | -10.1 | -14.4 | -10.8 | -16.8 | -4.4 | 10.6 | 10.5 |
| Oil, Gas and Mineral Extraction | 49.6 | 4.8 | 1.4 | -13.4 | -0.2 | -0.2 | 6.9 |
| Manufacturing | 0.8 | -0.2 | 0.3 | 0.5 | 1.6 | -0.8 | 1.1 |
| Electricity, Gas and Water | 6.8 | 2.3 | 9.7 | 6.2 | -0.8 | 4.9 | 2.7 |
| Construction | 4.1 | 6.9 | 0.6 | 2.9 | 6.4 | 1.9 | 5.0 |
| Trade | 1.9 | 3.2 | 2.1 | 2.0 | 3.0 by | 2.1 | 2.5 |
| Transportation, warehousing, courier | 1.5 | 1.8 | 1.8 | 0.4 | 0.7 | 2.1 | 1.3 |
| Lodging and restaurants | -1.4 | 0.0 | -2.4 | -3.0 | 0.0 | -0.5 | -0.1 |
| Telecommunications and other | 8.1 | 8.6 | 8.1 | 7.0 | 9.4 | 11.1 | 9.5 |
| Public administration and defense | 5.1 | 5.1 | 4.3 | 5.4 | 2.8 | 4.5 | 3.6 |
| Other services | 4.4 | 3.9 | 3.0 | 3.9 | 4.1 | 3.3 | 3.3 |
| Gross Value Added | 13.5 | 3.6 | 1.6 | -1.3 | 1.5 | 2.3 | 4.9 |

Source: Own elaboration

The methodology applied in this research work is hypothetical-deductive with a quantitative approach, with a non-experimental-longitudinal methodological design, since data and information collection is used to verify the hypotheses on possible relationships between variables by means of statistical and econometric analysis. In reference to the study population and sample, the present work considers as the study population the 7 regions of the macro southern Peru: Puno, Arequipa, Tacna, Cusco, Moquegua, Madre de Dios and Apurimac, during the period 2003-2021. As a non-probabilistic sample, due to the fact that the research work considers the 7 regions of the southern macro region of Peru, a period of 19 years is studied, from 2003 to 2021, totaling 133 observations for each variable analyzed. In other words, the sample is equal to the population. The information for the analysis is from secondary sources, which has facilitated the collection of information and data during the study period from 2003 to 2021. These data have been obtained from various sources, including: a) Central Reserve Bank of Peru (BCRP), b) Ministry of Economy and Finance (MEF) economic transparency, c) National Institute of Statistics and Informatics (INEI) and d) Educational Quality Statistics (ESCALE) of the Ministry of Education. In the present work, balanced panel data will be used, consisting of 7 cross-sectional units and 19 time periods from 2003 to 2021. This is processed in logarithms for ease

of interpretation when finding the elasticities of the variables with respect to the dependent variable. Based on the above, the variables used in this study are detailed (Table 3).

**Tabla 3.** Study variables

| Variable | Type of variable | Source of data |
|---|---|---|
| Economic Growth | Dependent, quantitative | INEI |
| Public Spending on Education | Independent, quantitative | ESCALE |
| Public Investment in Physical Capital | Independent, quantitative | MEF |
| Private Investment in Physical Capital | Independent, quantitative (control variable) | INEI |
| Public Spending on Early and Primary Education | Independent, quantitative | ESCALE |
| Public Spending on Secondary Education | Independent, quantitative | ESCALE |
| Public Spending on Higher Education | Independent, quantitative | ESCALE |

Source: Own elaboration

With the fundamental purpose of determining the impact of public spending on education on economic growth in the MRS of Peru, the econometric methodology of panel data is used because of the construction and conformation of the data collected and because of the purpose of the study, which is to determine the presence of cause-and-effect economic relationships between the variables. For the econometric analysis process and the analysis of the relationship between the variables, the Stata 16 statistical package will be used.

### *4.1 Specification of the general panel data model*

The general model is expressed as a classical linear regression model and is an extension of it and is represented as:

$$Y_{it} = \alpha_{it} + \beta_1 x_{1it} + \beta_2 x_{2it} + \beta_3 x_{3it} + \cdots + \beta_k x_{kit} + U_{it} \quad ...(a)$$
$$Siendo: i = 1, \ldots, n; t = 1, \ldots, t \tag{5}$$

Where: $x_{1it}, x_{2it}, x_{3it}, \cdots, x_{kit}$ is the vector with k x 1 formed by the data of the regressors of the k regressors of the cross-sectional observations (individuals) i in a temporal space t (time period), $\alpha$ is the vector that intersects and can have between 1 and n+t parameters, $\beta$ vector of k of the parameters, and $u_{it}$ is the completely random stochastic perturbation value; it also considers the constant term of the model an ordinate at the origin, which means the effects of all the variables not included in the model. Therefore, the model has as total sample n x t.

Panel data models are commonly used in these types of analysis. The present model is an example of the models to be estimated, where the structure of the model will be as follows:

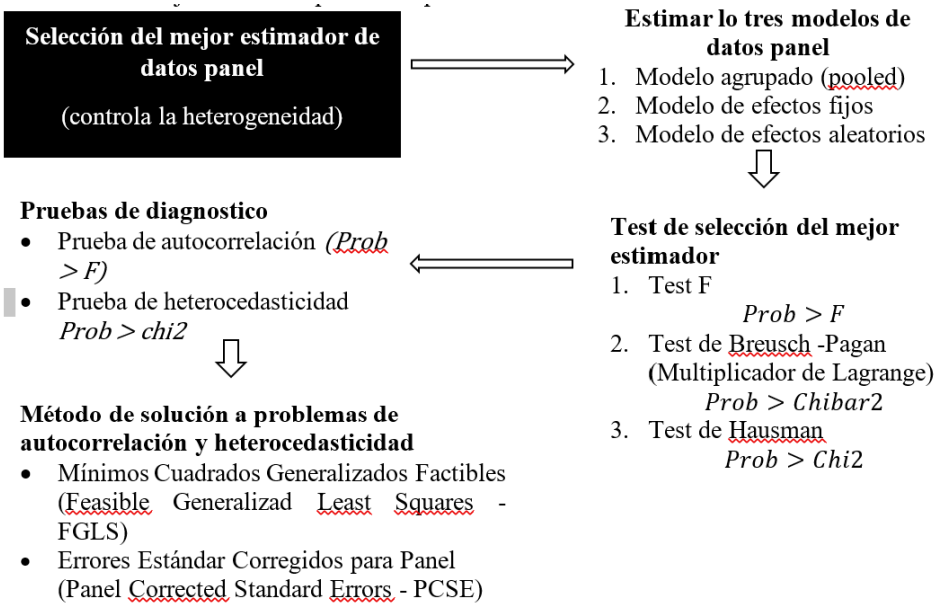
$$ln(PBI\_per) = \beta_0 + \beta_1(lnGasto_{Pub_{Edu_{it}}}) + \beta_2(lninvPr_{Capital_{Fisico_{it}}}) + \epsilon_{it}$$
$$i = 1, 2, 3, 4, 5, 6, 7(regiones) \tag{6}$$
$$t = 2003, \ldots\ldots\ldots\ldots, 2021(periodo)$$

Where: $ln(PBI\_per)$ = Economic growth of the region during period t.
$ln(Gasto_{Edu_{Pub}})_{it}$ = Logarithm of public spending on education by region in period t.
$ln(invPr_{Capital_{Fisico}})_{it}$ = Logarithm of private investment in physical capital by region in period t.

$\beta_0, \beta_1 \gamma \beta_2$ = Intercept and parameters of the independent variables $\epsilon_{it}$ = Intercept and parameters of the independent variables

In order to determine the final results, it must be taken into account that a process of choosing the best estimator will be carried out. The panel data model presents different models such as the pooled model, the fixed effects model and the random effects model. For this, different selection tests and diagnostic tests have to be applied to choose the most appropriate panel model that best explains the relationship between the variables of analysis, for which the following selection process was followed.

**Figure 1.** Selection of the best estimator for panel data




Source: own elaboration.

For the present research, this selection process was carried out to determine the best estimator to show the impact of public spending on education on economic growth.

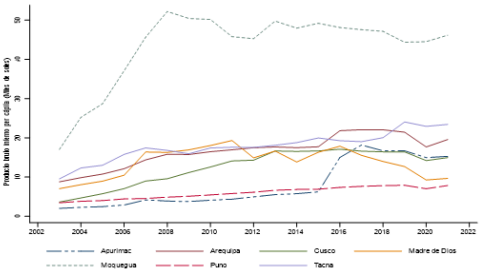
## 5. Results

In order to accept or refute the corresponding research objective, first of all, a graphic analysis of each of the variables included in the study was carried out to determine their behavior during the period 2003 to 2021, in order to determine their trend or behavior. Figure 2 shows the trend of the different variables by group of regions at the level of Peru's southern macro-region between 2003 and 2021. In general, all variables show a positive upward trend in the southern region of Peru. For example, GDP per capita by group of regions showed a clear positive upward trend. The average annual gross domestic product per capita in the MRS of Peru was S/. 16,840 per person between these years. In the case of public investment in physical capital in education by group of regions, there was also a positive upward trend in all the regions that make up southern Peru. In addition, the annual average of public investment in physical capital in education was S/ 78 million, where the Cusco region in 2013 presented the highest point in terms of public investment.

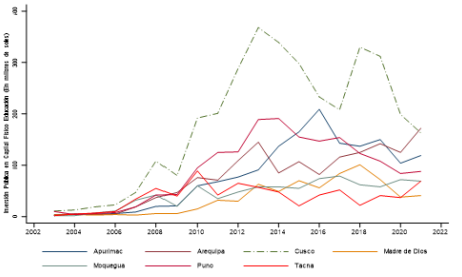
As for physical capital in education, it was S/. 368 million; meanwhile, the region of Madre de Dios had the lowest point in 2005. As for private investment in physical capital, it can be observed that during the period of analysis there is a clear positive upward trend, with an annual average of private investment in physical capital of around S/ 670,744. Also, Figure 2 shows the total public spending on

**Figure 2. Evolution of each of the study variables over the period 2003–2021**

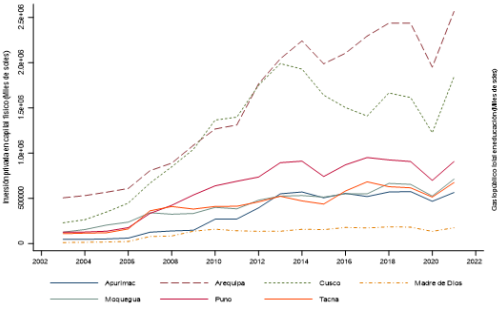
*Evolución del producto bruto interno per cápita por grupo de regiones de la MRS del Perú 2003-2021*



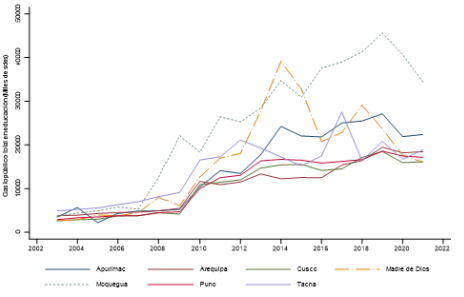

*Evolución de la inversión pública en capital físico por grupo de regiones de la MRS del Perú 2003-2021*



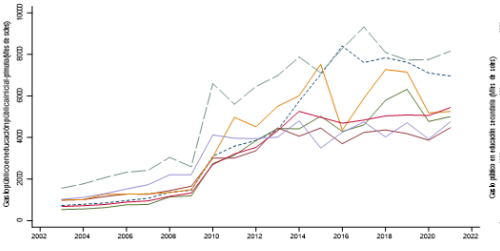

*Evolución de la inversión privada en capital físico por grupo de regiones de la MRS del Perú 2003-2021*



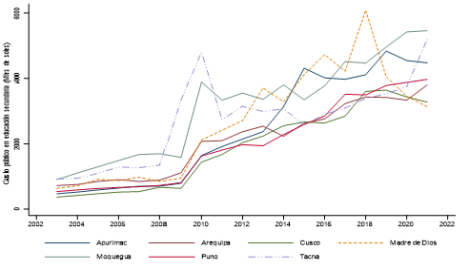

*Evolución del gasto público total en educación de las regiones de la macro sur del Perú*



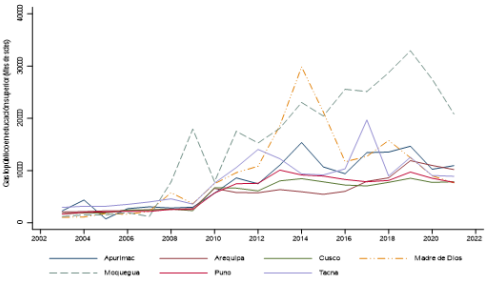

*Evolución del gasto público en educación inicial - primaria de las regiones de la macro sur del Perú*



*Evolución del gasto público en educación secundaria de las regiones de la macro sur del Perú 2003-2021.*




*Evolución del gasto público en educación superior de las regiones de la macro sur del Perú*




Source: own elaboration.

education and by educational levels, which includes initial-primary, secondary and higher education, where a clear increasing trend is observed in terms of spending on education per student in real terms

for the case, as well as by group of regions and at the level of the southern region of Peru, which indicates that the government has been increasing its spending on education, which is a positive aspect for the economy at the regional and national levels.

### *5.1 Descriptive statistics*

From the statistical point of view, at the general level, Table 4 shows concretely balanced data, which are made up of 7 cross-sectional observations in the regions of Puno, Tacna, Moquegua, Arequipa, Cusco, Madre de Dios and Apurimac, with 19 annual observations between 2003 and 2021. In terms of descriptive characteristics, the average expenditure on education in the southern macro-region was 16,000 soles per student between the initial-primary, secondary and higher education components, which make up public spending on education. It should also be noted that private investment in physical capital averaged S/. 670,743.8, while public investment in physical capital in education averaged S/. 78.30 million in the southern macro region of Peru. In addition, by educational component at the general level, it is observed that the average public expenditure in initial-primary, secondary and higher education was S/ 3,760, S/ 2,412 and S/ 8,399 per student, respectively.

**Tabla 4. Descriptive statistics of the variables**

| Variable | Obs. | Min | Max | Media | Standard deviation |
|---|---|---|---|---|---|
| $PBI_{per}$ | 133 | 2033 | 52187 | 168435 | 1263218 |
| $InvPl_{Capital_{Fisico}}$ | 133 | 2 | 368 | 78.30 | 77.87 |
| $InvPr_{Capital_{Fisico}}$ | 133 | 10 756 | 2 565 634 | 67 0743.8 | 617 468.8 |
| $Gasto_{Pub_{Edu}}$ | 133 | 2 211 | 45 612 | 14 572.44 | 9 806.22 |
| $Gasto_{Edu_{IP}}$ | 133 | 537 | 9 321 | 3 760.68 | 2292.93 |
| $Gasto_{Edu_{SE}}$ | 133 | 368 | 6 084 | 2 412.44 | 1 422.53 |
| $Gasto_{Edu_{SUP}}$ | 133 | 771 | 32 923 | 8 399.28 | 6617.55 |

Source: Own elaboration

To continue with the estimation of the panel data models for each objective, the best estimation method between ordinary least squares (OLS) and panel data was tested and determined by means of the Breusch-Pagan test (Lagrange multiplier), which was run for all the econometric models proposed. The following results were obtained:

**Tabla 5. Choice between ordinary least squares or panel data model.**

| General Objective | Specific Objective 1 | Specific Objective 2 | Specific Objective 3 | Specific Objective 4 | |
|---|---|---|---|---|---|
| Breusch and Pagan Test (*ML*)(*Prob > chibar2*) | 0.0000* | 0.0000* | 0.0000* | 0.0000* | 0.0000* |
| Note. * significance level at 1 %. | | | | | |

Source: Own elaboration

According to the results in Table 4, it can be observed that the values of the p-value obtained from the Breusch-Pagan ML test are highly significant and less than <0.05indicating that the H0 and the alternative is admitted, resulting in the existence of unobserved heterogeneity, which confirms that the panel data estimation method should be used instead of OLS as it is more efficient for the present data study.

## 6. Model estimation

Next, econometric estimates are developed to determine whether public spending on education has an impact on economic growth in the case of the southern macro region of Peru. It is worth mentioning that five different econometric models were estimated, which are:

- **Model 1: General objective**
  $lnPBI_{per_{it}} = \beta_0 + \beta_1 lnGasto_{Pub_{Edu_{it}}} + \beta_2 lninvPr_{Capital_{Fisico_{it}}} + \epsilon_{it}$
- **Model 2: Specific Objective 1**
  $lnPBI_{per_{it}} = \beta_0 + \beta_1 lninvPl_{Capital_{Fisico_{it}}} + \beta_2 lninvPr_{Capital_{Fisico_{it}}} + \epsilon_{it}$
- **Model 3: Specific Objective 2**
  $lnPBI_{per_{it}} = \beta_0 + \beta_1 lnGasto_{Edu_{IP_{it}}} + \beta_2 lninvPr_{Capital_{Fisico_{it}}} + \epsilon_{it}$
- **Model 4: Specific Objective 3**
  $lnPBI_{per_{it}} = \beta_0 + \beta_1 lnGasto_{Edu_{SE_{it}}} + \beta_2 lninvPr_{Capital_{Fisico_{it}}} + \epsilon_{it}$
- **Model 5: Specific Objective 4**
  $lnPBI_{per_{it}} = \beta_0 + \beta_1 lnGasto_{Edu_{SUP_{it}}} + \beta_2 lninvPr_{Capital_{Fisico_{it}}} + \epsilon_{it}$

For each econometric model, the selection process of the best estimator is considered. For this purpose, three models will be estimated, including the pooled model, the fixed effects model and the random effects model. Based on the results of each one, firstly, the F test will be applied, which allows the selection of the best estimator between fixed effects and the grouped model; secondly, the Breush-Pagan test will be applied using the Lagrange multiplier statistic, which allows the selection between random effects and the grouped model. Finally, the Huasman test is performed with the two estimators selected in the two previous tests; the best estimator between the two models is selected and one of them is chosen as the analysis model. It is worth mentioning that this process was carried out for each equation previously mentioned.

Table 6 shows the econometric results of the selected models for each equation or objective. Based on the results obtained for model 1: general objective, from the entire selection process, the best estimator was the fixed effects model, where it can be observed that total public spending on education is positively related to economic growth and is statistically significant. Regarding the second model, with the findings obtained it was possible to identify that public investment in physical capita has a directly proportional relationship with economic growth; however, the result is not significant, which, based on previous studies, is due to the low quality of investments, poor management of spending, corruption, among others. Finally, with respect to the analysis of educational spending by initial-primary, secondary and university educational levels, it is observed that the relationship with economic growth is positive and statistically significant at 5%, as shown in Table 6.

After the selected models, it is important to evaluate and apply diagnostic tests to each model, which include the autocorrelation test and the heteroscedasticity test. All the econometrically estimated models shown in Table 6 were analyzed one by one by diagnostic tests to determine if the selected models present these problems or violations to the model assumptions. To do so, first, for each model, the Wooldridge test was applied to detect the presence of first-order autocorrelation in the panel data set. Based on the results obtained, it could be observed that the probabilities of the F value of the test are low and are significant at the accepted level of 5%, which rejects the null hypothesis and concludes that all the estimated or selected models present first order autocorrelation. Secondly, we proceeded to run the heteroscedasticity test to determine this violation. The modified Wald test was then run. Regarding all the results obtained from the test for each selected model, it was found that the probability values of the test are significant at the conventional level of 5%, rejecting the null hypothesis and identifying heteroscedasticity in each of the selected models. Therefore, steps should be taken to correct these two identified problems. After diagnostic testing of the models, violations were identified for each selected regression model. To remedy both identified problems, the implementation of an adjusted model that incorporates the corrections jointly is proposed. According to Marquez and Aparicio (2005) they proceed to correct them using the feasible generalized least squares (FGLS) model, an estimator that solves the autocorrelation and heteroscedasticity problems jointly. Table 7 shows the results obtained for the estimated parameters of each of the selected models that present autocorrelation and heteroscedasticity problems, which are corrected by the FGLS estimator or model.

The results obtained show the following:

**Tabla 6.** Selection models for each model or objective

| Variables | Selected models<br>Estimated parameters | | | | |
|---|---|---|---|---|---|
| | Model 1 Fixed Effects | Model 2 Random Effects | Model 3 Random Effects | Model 4 Effects Fixed | Model 5 Effects Fixed |
| *Constant* | 3.8530*<br>(0.000) | 3.8833*<br>(0.000) | 4.5238*<br>(0.000) | 4.2878*<br>(0.000) | 3.6901<br>(0.000) |
| $lnGasto_{Pub_{edu}}$ | 0.05922<br>(0.348) | | | | |
| $lninvPl_{Capital_{Fisico}}$ | | 0.0523<br>(0.205) | | | |
| $lnGasto_{edu_{IP}}$ | | | 0.1982*<br>(0.002) | | |
| $lnGasto_{Pub_{SE}}$ | | | | 0.1643*<br>(0.009) | |
| $lnGasto_{edu_{SUP}}$ | | | | | -0.0080<br>(0.864) |
| $lninvPr_{Capital_{Fisico}}$ | 0.3915*<br>(0.000) | 0.3610*<br>(0.000) | 0.2599*<br>(0.000) | 0.3045*<br>(0.000) | 0.4522*<br>(0.000) |
| $R-sq(within)$ | 0.6648 | 0.6662 | 0.6789 | 0.6807 | 0.6625 |
| $R-sq(between)$ | 0.0107 | 0.0012 | 0.0508 | 0.0335 | 0.0044 |
| $R-sq(overall)$ | 0.1370 | 0.1076 | 0.2247 | 0.1987 | 0.1050 |
| $Wald-(chi-sq)$ | | 242.28 | 253.05 | | |
| $Prob > chi2$ | | (0.000) | (0.000) | | |
| $F-conjunta$ | 122.97 | | | 132.16 | 121.69 |
| $Prob > F$ | (0.0000) | | | (0.0000) | (0.0000) |
| *Numberofobs* | 133 | 133 | 133 | 133 | 133 |
| *Numberofgroups* | 7 | 7 | 7 | 7 | 7 |

Nota.Nivel de significancia: $*\rho < 0.01 \; **\rho < 0.05 \; ***\rho < 0.1$

Source: Own elaboration

- Regarding the first model or general objective, it was observed that total public spending on education has a positive and statistically significant impact on economic growth. The elasticity value obtained of 0.12 gives us to know that if the government starts spending 1 % more on education, economic growth will increase by 0.12 % for the case of the southern macro region of Peru, considering the other variables ceteris paribus.
- In the case of the investment in physical capital variable, the result is that the impact generated by the following variable is directly proportional to economic growth, where a 1% increase in state investment in physical capital generates an economic growth of 0.04%. However, it is worth mentioning that this result is not consistent; that is, it is not significant. According to previous research, this is due to inefficient investment, government corruption, poor expenditure management, among other aspects.
- On the other hand, the results obtained from the econometric estimations by educational levels of education expenditure on economic growth show that the impact of public education expenditure at the initial-primary, secondary and higher education levels is directly proportional and statistically significant, with an effect on economic growth of 0.13 %, 0.14 % and 0.069 %, respectively, when the variables education expenditure increases by 1 %.
- With respect to the individual significance of each of the variables, it can be observed that they present an individual significance of 5% in the variables of total public expenditure on education, public expenditure on initial-primary education, public expenditure on secondary education and public expenditure on higher education; meanwhile, the variable public investment in physical capital is not statistically significant at any level of significance.
- Finally, the overall or joint significance of each of the corrected models is highly significant at 1%.

**Tabla 7.** Modelos corregidos mediante FGLS

| Variables | FLGS Estimated parameters | | | | |
|---|---|---|---|---|---|
| | Model 1 General Objective | Model 2 Specific Objective 1 | Model 3 Specific Objective 2 | Model 4 Specific Objective 3 | Model 5 Specific Objective 4 |
| *Constant* | 5.1392* (0.000) | 5.3913* (0.000) | 5.1957* (0.000) | 5.1665* (0.000) | 5.4509* (0.000) |
| $lnGasto_{Pub_{edu}}$ | 0.1261* (0.006) | | | | |
| $lninvPl_{Capital_{Fisico}}$ | | 0.0400 (0.111) | | | |
| $lnGasto_{edu_{IP}}$ | | | 0.1318* (0.006) | | |
| $lnGasto_{Pub_{SE}}$ | | | | 0.1353* (0.003) | |
| $lnGasto_{edu_{SUP}}$ | | | | | 0.0691** (0.048) |
| $lninvPr_{Capital_{Fisico}}$ | 0.2371* (0.000) | 0.2513* (0.000) | 0.2399* (0.000) | 0.2441* (0.000) | 0.2566* (0.000) |
| *Numberofobs* | 133 | 133 | 133 | 133 | 133 |
| *Numberofgroups* | 7 | 7 | 7 | 7 | 7 |
| *Wald*(*chi*2) | 67.44 | 64.76 | 69.49 | 71.81 | 62.32 |
| *Prob* > *chi*2 | (0.000) | (0.000) | (0.000) | (0.000) | (0.00) |

Nota.Nivel de significancia: $*\rho < 0.01 * * \rho < 0.05 * * *\rho < 0.1$

Source: Own elaboration

## 7. Discussion

In light of the results, it is concluded that there is a positive and significant impact of 0.12 % of total public spending on education on economic growth in the southern region of Peru, which implies that, if the government spends 1 % more on education, this will generate an increase in economic growth of 0.12 %. Similarly, Baquerizo and Alcántara (2019) and Mendoza and Pérez (2019), both applying the Panel EGLS (Cros-section South) method, conclude that public spending on education contributes 0.14 % and 4.26 %, respectively, to economic growth in the central region of Peru. Similarly, this is consistent with the findings of Zegarra (2018) who, using the multivariate econometric model estimated by OLS, finds a directly proportional relationship of 0.36 % with economic growth in the Junín region. On the other hand, Alvarado et al., (2019), using an OLS model, identifies a positive and statistically significant relationship where the elasticity between both variables is 0.34 % for the case of Ecuador. In addition, Aycardi (2016), making use of the panel data fixed effects model, finds that total spending on education has a positive and significant impact on economic growth, indicating that a 1 % increase in total spending produces a 2.4 % increase in GDP per capita. This coincides with Forero (2020) who uses a dynamic panel generalized method of moments GMM (Arellano-Bond dynamic panel-data estimation) to conclude that the higher the public spending on education, the higher the economic growth. It also coincides with Ordoñez et al., (2018), where an OLS econometric model is used finding a positive and significant effect of 1 %, increasing economic growth by 0.72 %. Finally, with these results it can be affirmed that the more the government spends on education, the more it will contribute favorably to the economic growth of a region or country. Therefore, if a country or region wants to increase its economic growth, it is a necessary, but not sufficient, condition that it invests in the training of its labor force "education" (Terrones and Calderón, 1990). However, it disagrees with what is established by Vega (2017 and 2019), who using the causality test in the Granger sense finds a negative effect between public spending on education and economic growth. He indicates that the human capital theory is not universal, which would be due to poor management of spending by the government. Similarly, Lugo (2012) uses an OLS model and concludes that state intervention does not result in increased levels of economic development. Regarding the effect of investment in physical

capital on economic growth, the results found in the study show that investment in physical capital positively influences economic growth by 0.040 %, when this variable increases by 1 %. In comparison, Mendoza and Pérez (2019), applying the Panel EGLS (Cros-section South) method, conclude that a 10 % increase in private investment generates a 0.95 % increase in economic growth in the central region of Peru. Similarly, Alcántara and Baquerizo (2019), also applying the Panel EGLS method (Cros-section South), find that a 10 % increase in private investment contributes to a 1.67 % increase in economic growth. These results affirm the importance of private investment in a region or country. In contrast, Zegarra (2018), using a multivariate econometric model estimated by OLS, finds that public investment in physical capital has a positive and significant influence on economic growth in the Junín region. Meanwhile, in the case of the effect of public spending on early-primary education on economic growth, there is evidence of a positive and significant relationship between economic growth and public spending on early-primary education, with a 1 % increase in spending on early-primary education generating a 0.13 % increase in economic growth in the southern macro region of Peru. Similarly, Mendoza and Pérez (2019), using the Panel EGLS (Cros-section South) method, find that public spending on early-primary education generates an effect of 3.37% on economic growth, if spending on early-primary education increases by 10% in the case of the central region of Peru. In contrast, Aycardi (2016), using the fixed effects panel data model in his work for the Latin American region, disagrees with the results found, where he identifies a negative effect with economic growth, indicating that it is due to the scarcity of data. In relation to the impact of public spending on secondary education on economic growth, the results show that with a 1 % increase in government spending at the secondary level, economic growth in the southern region of Peru will increase by 0.14 %, one point higher than at the initial-primary level. Comparing with Mendoza and Perez (2019), who conduct their research for the central region of Peru, they find that public spending made at the secondary level generates an increase of 3.13 % in economic growth, if the government increases its spending by 10 %, indicating that advancement in education enhances the increase in a person's productive ability, amplifies his or her capacity to learn and access information. Similarly, Aycardi (2016), in his analysis of the effect of public spending on education on economic growth in Latin America between 1998 and 2012, finds that the only spending that is significant and has a positive impact is at the secondary level, where he reaffirms that the results found highlight the need to invest and strengthen the basic levels of education. With this background and findings, we can infer that spending on educational levels is fundamental to increase individual productivity and provide people with the necessary skills to innovate and adapt to new technologies, which can boost economic growth in the long term. In summary, although there is positive correlation between secondary education spending and economic growth, more research is needed to fully understand this relationship and how the impact of secondary education spending on economic growth can be maximized. Finally, regarding the effect of public spending on higher education on economic growth, the results obtained show that a 1 % increase in spending at the higher level generates a 0.069% increase in economic growth. Comparing with the findings of Alcántara and Barreto (2018) using panel data models, they find that for every 1 % of spending invested in university higher education, gross domestic product increases by 0.85 %, while for every 1 % of spending invested in non-university education, GDP increases by 0.19 % in Peru. With this, they affirm the positive relationship between economic growth and public spending on higher education on economic growth. Likewise, Mendoza and Perez (2019), using the Panel EGLS (Cros-section Sur) method in their research for the central region of Peru, find that a 10 % increase in spending on higher education by the government generates an increase in economic growth of 1.84 % thanks to the expenditure made at this educational level. Finally, Gonzales and Fabian (2022), using a multivariate vector autoregressive (VAR) econometric model and the ordinary least squares (OLS) method, conclude that public spending on university higher education positively influences economic growth and is statistically significant for the case of the province of Callao. With these results, it is affirmed that government spending on higher education does contribute favorably to explaining economic growth. In summary, these studies support the notion that public spending on education is

a strategic investment that has a positive impact on economic growth. Therefore, it is important to strengthen human capital formation in all its stages or educational processes to generate the capacity for a nation's human capital to compete and prosper in a constantly evolving global environment. Education not only increases labor productivity, but also promotes innovation, adaptability and equal opportunities, creating a solid foundation for sustainable and equitable economic growth.

## 8. Conclusions

In relation to the main objective of the research, it has been possible to conclusively establish a positive and significant relationship between public spending on education and economic growth in the southern macro region of Peru during the period 2003-2021. The elasticity obtained of 0.12, according to the econometric analysis, strongly reinforces the notion of the positive impact of public spending on education on economic growth. This result not only has academic relevance, but also has direct implications for governmental public policy decision making, emphasizing the urgent need to strengthen education spending as an essential engine for economic progress and growth at the regional or national level. Regarding the effect or impact of public spending by initial-primary, secondary and higher education levels, it is concluded that spending by levels of education has a net positive effect on economic growth, indicating that for each increase of 1 % in public spending on education at the initial-primary, secondary and higher education levels, economic growth will increase by 0.13, 0.14 and 0.069 %, respectively. These results not only add to the existing body of knowledge, but also establish a solid basis for the creation of public policies aimed at strengthening spending at the educational levels, based on the impact that each one has on economic growth as an effective strategy to promote sustainable economic growth and improve the quality of life of the population. In conclusion, the research underlines and highlights that public spending on education has a positive and significant impact on economic growth. As the government invests more in the education sector, its influence on economic progress increases, contributing to the nation's competitiveness and prosperity. It also highlights the importance of investing in education from the earliest levels of education to higher education, given its positive effect on economic growth by enriching human capital. In other words, nations that prioritize and reinforce this investment are better equipped to face future challenges, building a path towards a more promising future.

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## Authorship contrubution

Nélida Paredes Mamani: Conceptualization, Data curation, Formal analysis, Writing – original draft.

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The author declare that she has no conflict of interest

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