Obsolescence of Higher Education after 30 Years and its Negative Impact on Economic Growth in OECD Countries

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Abstract: Objective: This research analyzes the impact of higher education in the age groups of 25-34, 35-54 and 55-64 years on economic growth, over the period 2000-2019, in a sample of member countries of the Organization for Economic Cooperation and Development (OECD). In particular, the effects of the first group and of those who finished their higher education 30 years ago are examined. Methodology and data: The statistical estimation considers panel data models by ordinary least squares, cross section, and fixed and random effects. The data comes from the OECD and the World Bank. Results: The main finding is that when disaggregating by age, empirical evidence is found that individuals with higher education between the ages of 25 and 34 have a positive impact on economic growth, while individuals whose ages are between 55 and 64 years present a negative effect due, perhaps, to the obsolescence of the acquired knowledge that in most cases was overcome by the vigorous scientific and technological progress of the last decades. The group of 35-54 years is not significant and it is not possible to make inferences. Limitations: The research is restricted to analyzing only higher education in individuals and graduate studies are not reviewed. Recommendations: Decision makers are recommended to: 1) have a better design of instruments and adequate incentives to increase the coverage and quality of education for young people in order to boost economic growth more strongly, and 2) promote training and updating of the age group from 35 to 54 years to avoid falling into obsolescence. Originality: 1) focuses on 24 OECD countries, 2) has more data available compared to the past, 3) performs panel data analysis allowing for more countries, variables and time periods, 4) and reduces multicollinearity Conclusions: Higher education has a positive effect on the economic growth of the OECD countries in the age group of 25 to 34 years, however, with the passage of time the obsolescence of knowledge occurs, which negatively affects economic growth.

JEL classification: I23, O40, O41, C50, C33.
Keywords: Economic growth, higher education, panel data.

1. INTRODUCTION

The relationship between education and economic growth has been approached from different perspectives. Much of the research on the subject has supported the importance of the educated labor force in economic growth (Guisan *et al*., 1998; Becker and Murphy, 1993). Likewise, the countries with the highest level of education are those that have had the greatest economic growth and development (Neira and Guisan, 2002). In contrast, weak long-term economic growth in developing economies could be linked to low levels of human capital. Education is a tool that allows the improvement of the productive capacity, since the industry benefits from skilled labor, and its productivity directly impacts the quality of the factors of production. Educated human capital is essential for the processes of modernization, division of labor, development of technical knowledge, new forms of organization and the generation of new products, as well as the application and management of technology and innovation together with the organization of human capital have been generators of long-term economic growth (Romer, 1990; Lucas, 1988; Becker, 1993; Parrado, 1995).

Education allows the worker to acquire skills that facilitate and reduce working time. Education not only brings benefits to the industry or productive sectors, but also generates benefits to the social environment. Likewise, education enables the development of individual skills for interaction and integration into the social, economic and political environments. Education also allows obtaining the skills to improve the quality of life of the population. In human capital theory, the training of the labor force has implications for the growth of real income due to knowledge and training. Finally, education enables technological progress, increases productivity, and generates higher wages for the labor force (Barkin, 1971; Sen, 1999).

Both the human capital theory and the endogenous growth theory are relevant to the development of this research and represent an obligatory frame of reference for this study. More schooling means greater benefits for economic growth.

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In this sense, the pioneering work of Becker (1993) indicates that countries that have had significant growth are those that included access to university education for the entire population, particularly the low-income population. Likewise, Lucas (1988) points out that a worker is more productive when he works with other highly qualified workers. Although, the benefit of greater productivity in a more qualified environment shows that education has the same effect in the social environment, since the individual acquires a greater capacity for social, political and economic integration (Sen, 1999). Education is a determinant of the economic growth of a country necessary to increase competitiveness and production, as well as to increase the income of families and their capacities to improve their economic and social well-being.

On the other hand, Rodrigues and Souza (2020) study 37 countries over the period 1990-2010, highlighting differences in the quality of education, represented by student performance in the PISA test. Likewise, the authors use physical capital and human capital as inputs to explain the dispersion of per capita income between countries. Similarly, Ngepah *et al*. (2021) examine the effect of human capital employed on production and its effects on economic growth in 269 municipalities in South Africa over the period 1993-2016. The authors perform panel data causality tests and find two-way causality between human capital and total production, as well as between total employment and total production. The authors suggest that human capital has a positive and significant impact on both total output and economic growth in South Africa.

With respect to the current state of the subject, the present work is distinguished in the following: 1) it focuses on a large sample of economies that belong to the Organization for Economic Cooperation and Development, emphasizing 24 economies (Germany, Australia, Belgium, Canada, Denmark, the Czech Republic, Estonia, France, Greece, Hungary, Italy, Korea, Latvia, Mexico, the Netherlands, Poland, Portugal, Spain, the United Kingdom, the Czech Republic, the Slovak Republic, Sweden, Switzerland, Turkey, and the United States of America); 2) it has a greater availability of data with respect to the past, 3) carries out an analysis of panel data, which allows the use of a greater number of countries, variables and periods, 4) it performs panel data models to reduce multicollinearity and, finally, 5) provides a series of recommendations on educational policy to promote growth are presented.

The objective of this research is to analyze the impact of higher education on economic growth in various OECD economies, specifically, this research will explore what is the role of tertiary education for ages 25-34, 35-54 and 55 -64 years in the growth of the economy in 24 countries during the period 2000-2019. Now the hypothesis of this research is established, specifically, it is stated that higher education (tertiary education) plays an important role in the economic growth of a sample of OECD countries, and over time the obsolescence of knowledge reverses the effect on economic growth. For this, panel data models are used with information from the World Bank and the OECD available in 2021. The econometric packages used are *Stata* and *Eviews*.

The present investigation is organized as follows: section 2 briefly reviews the literature on education and its link to economic growth; Section 3 presents the descriptive statistics of the relevant variables; section 4 establishes the econometric methodology and the specification of the models; section 5 analyzes the empirical results; finally, section 6 gives the conclusions.

2. BRIEF LITERATURE REVIEW ON EDUCATION AND ECONOMIC GROWTH

There are two relevant perspectives in the literature that deal with the links between education and the economy. On the one hand, the microeconomic approach that deals with studying the returns to education for individuals. In this sense, it is worth mentioning the works of Psacharopoulos and Patrinos (2004), Austria-Carlos and Venegas-Martínez (2011), and Aali-Bujari *et al*. (2019). On the other hand, the macroeconomic approach studies the global contribution of education to economic growth that is found in Becker (1983), Becker and Murphy (1993), Barro (1996), Chatterji (1998), Arranz *et al*. (2001), Barro (2002), Al-Yousif (2002), Kuhl-Teles and Andrade (2007), Chandra (2010), Guisán *et al*. (2011), Mehrara and Musai (2013), Breton (2013), Wang and Liu (2016), Liao *et al*. (2019) and Ngepah *et al*. (2021), among others.

On the other hand, Terrones and Calderón (1993) study the effect of the student-teacher ratio on economic growth in 20 Latin American countries over the period 1960-1985. The authors state that educational quality indicators are not significant for economic growth in the region. In addition, they find that the indicator of talents assigned to productive activities (Sciences and Engineering) has a positive and robust relationship with economic growth, in contrast to the indicator of talents (Humanities and Reading) assigned to influence activities has a fragile or null relationship with economic growth in Latin America. The authors also suggest that a higher level of education has positive effects on economic growth. In the same way, Barro (1996) studies around 100 countries in the period 1965-1990, and finds a relevant role of the rate of secondary and higher education for men for economic growth, while female achievement at secondary and higher levels of education does not explain economic growth, possibly due to the low level of female education in higher education in several countries.

Likewise, Chatterji (1998) analyzes 81 countries in the period 1960-1985 and finds that tertiary education is more significant than secondary education for economic growth. Likewise, Barro (2002) examines the relationship between education and economic growth in 43 countries in the period 1960-1995, and finds evidence that primary schooling for women has a negative effect on economic growth. In addition, the author highlights that the quality of education is more relevant for economic growth compared to education coverage. Barro concludes that the quality of education has a positive and particularly strong relationship with economic growth.

Similarly, Al-Yousif (2002) finds a two-way relationship between public spending on education and economic growth for several Arab countries: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates, over the period 1977-2004. The author also finds that this relationship can be negligible or negative in some cases. In addition, the author

Table 1. Descriptive Statistics of the Variables.

Variable	Notation	Average	Deviation	Minimum	Maximum
Gross Domestic Product per capita	pibper	38136.72	12557.4	12904.38	68394.29
Tertiary education 25-34 years	tj	34.89604	12.62797	8.9	69.9
Tertiary education 55-64 years	**ta**	**20.96417**	**9.799792**	**4.5**	**49.8**

Source: Own elaboration with data from the OECD and the World Bank computed with *Eviews*.

obtains evidence that the marginal effect of public spending on basic education on growth crucially depends on public budget constraints, as also suggested by Kuhl-Teles and Andrade (2007). Moreover, Chandra (2010) studies the direction of causality between education spending and economic growth in India in the period 1951-2009, and finds that the causality goes from economic growth to education spending. The direction of the causality of education spending on economic growth does not have an immediate effect (5 or 6 years). The author also suggests that economic growth is the main determinant of government spending on education. Likewise, Mehrara and Musai (2013) analyze the relationship between education and economic growth in 101 developing countries in the period 1970-2010. The authors find causality in the direction of GDP towards education. More specifically, GDP originates investment in education, and education does not have significant effects on GDP or investment in the short and long term. The authors find that greater economic growth leads to an improvement in higher education; although it seems that as the number of enrollments increases, the quality of education decreases. Finally, the authors suggest that formal education systems are not market oriented in most of these countries. This may be the reason why huge investments in education in these developing countries do not generate higher growth.

In the above sense, Wang and Liu (2016) study the links between education and growth in 55 countries during 1960-2009. The authors use panel data and propose four models, the first two apply the average years of schooling and the other two apply the levels of education (higher, secondary and primary). The results show that education has a significant positive impact on economic growth. By levels, higher education is positively significant; however, the primary and secondary levels do not have a significant effect. Given that one of the key aspects of international competition is high-quality human capital, the authors recommend greater public spending on higher education to prevent more adolescents from entering the labor market too early. On the other, the authors highlight the importance of high-quality primary and secondary education in order to reach the tertiary level appropriately. Likewise, Liao *et al*. (2019) perform cointegration and causality test between investment in education and sustainable economic growth of 21 cities belonging to the province of Guangdong, in China, using a data panel for the period from 2000 to 2016. First, they specify a production function model of the Cobb-Douglas type to estimate the contribution of investment in education to economic growth by introducing lags. The authors find that there is causality between education and sustainable economic growth. On the one hand, local investment in education is positive and statistically significant in generating economic growth.

On the other hand, Maneejuk and Yamaka (2021) study the effects of higher education on economic growth in Thailand, Indonesia, Malaysia, Singapore and the Philippines, during the period 2000-2018, using various indicators, such as public spending on tertiary education per student, enrollment rates at the primary, secondary, and tertiary levels, the educated labor force, and the rate of unemployment with advanced education. They estimate panel data models and find that the effect of spending on tertiary education on economic growth in the region does not follow the law of diminishing returns. They also find that an increase in the unemployment of workers with advanced education has an ambiguous effect on economic growth. Finally, the authors find empirical evidence that enrollment rates in secondary and higher education can contribute to the economic growth of the countries they analyze, both at the country and regional levels, and that higher education is the key to sustainable growth. Finally, the authors point out that there is no consensus on the relationship between education and economic growth, although most of the research highlights the relevance of such a relationship.

3. NATURE OF THE DATA AND DESCRIPTIVE STATISTICS OF THE VARIABLES

The information used in this research is obtained from the Organization for Economic Cooperation and Development (OECD) and the World Bank. The dependent variable is the Gross Domestic Product (GDP) per capita in terms of Purchasing Power Parity in USD at constant 2011 prices, while the independent variables are: tertiary education of individuals in the age groups 25-34, 35-54 and 55-64 years expressed as proportions of the total number of individuals with tertiary education in each country. Balanced panel data are available, the period and number of countries are restricted by data availability. The panel includes twenty-four OECD member countries for the period 2000-2019. The sample is restricted to the 24 economies for which information is complete; being available upon request. Table 1 shows the notations of the variables used in this work, which are the real GDP per capita, tertiary education of individuals between 25 and 34 years of age, tertiary education of people between the ages of 55 and 64, as well as their averages, standard deviations, maximum and minimum levels. The group of 35-54 years is not significant and is omitted in this work.

Table **1** shows the statistical information of the variables used in this investigation. The average real GDP per capita for the 24 countries studied is USD 38136.72 per year, the standard deviation of USD 12557.72, the lowest real income per capita corresponds to Latvia (2000), and the highest income per capita corresponds to Switzerland (2019). Regard-

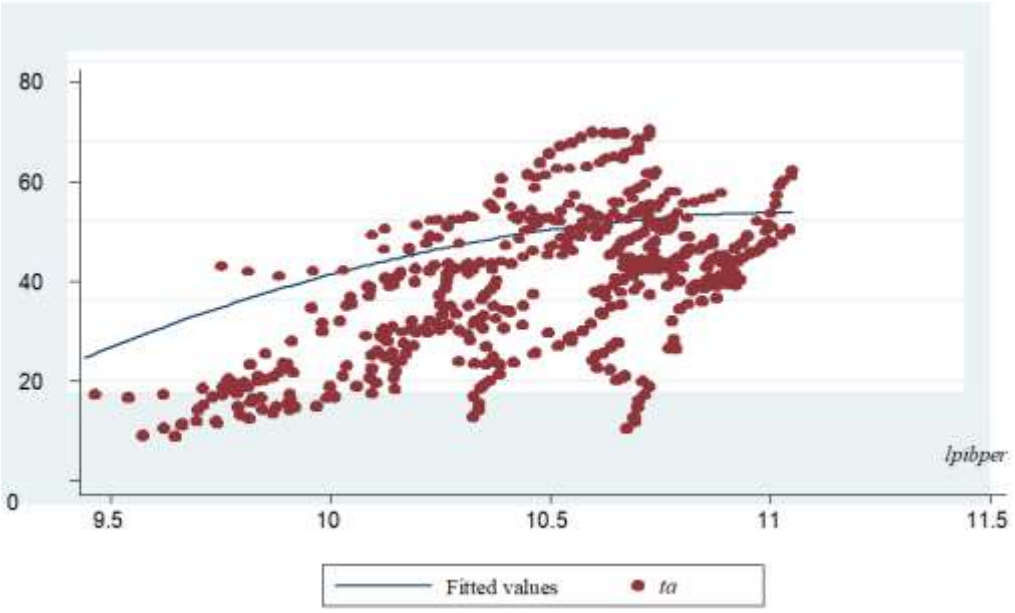

Fig. (1). Dynamics of GDP per capita and tertiary education adults between 55 and 64 years.
Source: Own elaboration with data from the OECD and the World Bank.

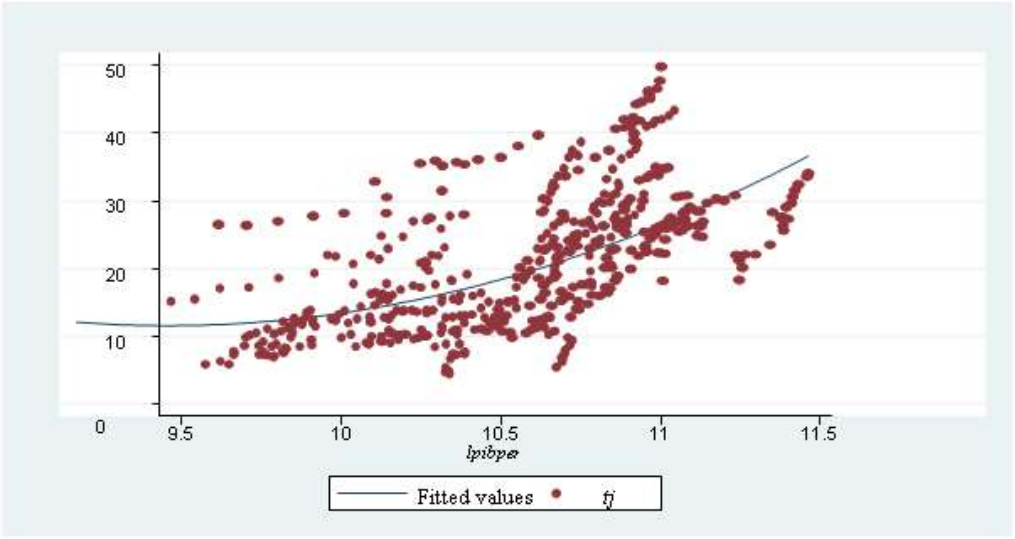

Fig. (2). Behavior of GDP per capita and tertiary education in young people between 25 and 34 years.
Source: Own elaboration with data from the OECD and the World Bank.

ing tertiary education for ages between 25 and 34 years, the average is 34.89604 of the total tertiary education in each country, and the standard deviation is 12.62797. The country with the lowest proportion of tertiary education of young people between 25 and 34 years of age compared to the total corresponds to Turkey (2000), while Korea (2016) had the highest proportion of young people between 25 and 34 years of age with tertiary education, around 69.9%.

Likewise, tertiary education for ages between 55 and 64 years, the average is 20.96417 of the total tertiary education in the 24 countries in the period 2000-2019, the standard deviation is 9.799792. The country with the lowest proportion corresponds to Portugal (2002), with 4.5% of total tertiary education, while the country with the highest proportion of tertiary education in this age segment corresponds to Canada (2019) with 49.8% of total tertiary education. Below are the results of the graphical analysis that relates the dependent variable, real GDP per capita, with the variables of tertiary education for young people between 25 and 34 years of age and tertiary education between 55 and 64 years of age in the 24 member economies from the OECD.

Fig. (**1**) presents the relationship between tertiary education of older adults between 55 and 64 years of age with real GDP per capita for the twenty-four OECD economies analyzed during the period 2000-2019. A positive but decreasing relationship is observed between tertiary education of older adults and real GDP per capita.

Fig. (**2**) shows the dynamics between the tertiary education of young people whose ages range between 25 and 34 years with the real GDP per capita in the twenty four OECD econ-

Table 2. Estimation of Panel Data Models.

Dependent Variable: lpibper	CS	FE	RE
ltj	0.4848776 (0.476)	0.4644221 (0.000)	0.4618245 (0.000)
lta	0.2203255 (0.644)	- 0.0854309 (0.044)	- 0.0785813 (0.061)
R^2	0.5668	0.6148	0.6148
Hausman Test			Prob>Chi2=0.3366
Number of countries	24	24	24
Number of observations	240	240	240

In brackets the corresponding standard error

Source: own elaboration with data from the OECD and the World Bank with estimates computed in Stata.

omies in the period 2000-2019. Fig. (**2**) also shows the dispersion of the observations and the ascending trend line indicating a positive relationship between the variables, it can be argued that countries with a higher proportion of tertiary education of individuals between the ages of 25 and 34 are in better conditions to raise its real GDP per capita. Furthermore, countries with higher real GDP per capita are more likely to have a higher share of tertiary education. In summary, Fig. (**2**) suggests that tertiary education boosts real gross domestic product per capita and, in turn, real gross domestic product per capita positively affects tertiary education.

4. ECONOMETRIC SPECIFICATION OF THE PANEL DATA MODELS

Panel data models are a very relevant tool for empirical analysis and their use is becoming more frequent, since they combine time series with a cross-sectional cut. Panel data models make it possible to analyze heterogeneity between the units under study. On the other hand, cross-sectional panel data observations are more appropriate for examining the dynamics of change of several units (countries). In addition to the above, panel data allow us to better detect and measure unobservable effects compared to time series and cross-sectional cuts. Another advantage of using panel data is that they allow us to better study complex phenomena with issues that are more complicated to study only with time series or only with cross section. Panel data allow the integration of a greater amount of information for several countries (units) over time, which makes it possible to reduce bias by adding more countries. The general panel data model can be represented in the following equation:

$$D_{pt} = \alpha_1 + \alpha_2 N_{pt} + u_{pt} \qquad (1)$$

where the variable D_{pt} is the dependent variable, that changes by country and over time, p denotes the country, t is related to changes in time, N_{pt} is the independent variable that changes by country and over time, α_1 is the constant, α_2 is the coefficient of the independent variable N_{pt}, and u_{pt} is the error term with the usual assumptions. The panel data models are estimated by different methods, by ordinary least squares (OLS) models, cross-sectional (CS) models, fixed effects (FE) models and random effects (RE) models (MEA). The use of panel data reflects several advantages since it presents a greater number of observations, incorporate more information, allows a greater number of variables and units (countries) and reduces multicollinearity between data of the independent variables, providing greater estimation efficiency and, finally, each observation unit (country) can be monitored. Likewise, data models allow limiting the problem of omitted variables, since those that do not move in time can be eliminated due to differences. In another sense, panel data have disadvantages, since the data is more complex and faces other types of problems, which are different from the common problems in time series data and cross-sectional data. The fixed effects model makes fewer assumptions about residual dynamics. In this case, the model is given by:

$$D_{pt} = \alpha_1 + \alpha_2 N_{pt} + \varepsilon_{pt} \qquad (2)$$

If it is assumed that the error ε_{pt} is divided into two components, a fixed part for each country v_p and random part v_{pt}, that is to say, $\varepsilon_{pt} = v_p + u_{pt}$, then the OLS requirements are met. If we replace this decomposition in equation (2), we obtain the following:

$$D_{pt} = \alpha_1 + \alpha_2 N_{pt} + v_p + u_{pt} \qquad (3)$$

This is equivalent to carrying out a general regression and assigning to each country a different ordinate. Also, the random effects model has the same specification as the fixed effects model, but v_p instead of being fixed for each country is a random variable with a mean value $E[v_p]$ and a variance $Var(v_p) \neq 0$. That is, the specification of the model is equal to (3) but with the randomness of v_p. The most relevant empirical results obtained with the application of the previous models are presented below.

5. ANALYSIS AND DISCUSSION OF RESULTS

The purpose of this section is to estimate a panel data model based on the information available in 2000-2019, provided by the World Bank and the OECD, which allows analyzing the relevance of tertiary education in economic growth in

some of the OECD member economies. The research focuses on a sample of twenty-four OECD countries: Australia, Belgium, Canada, Denmark, Estonia, France, Germany, Greece, Hungary, Italy, Latvia, Korea, Mexico, Netherlands, Poland, Spain, United States of America. Portugal, United Kingdom, Czech Republic, Slovak Republic, Sweden, Switzerland and Turkey. The balanced panel data model has 240 observations; It was estimated using the Stata econometric package, the main results are presented in the following table.

Table **2** presents the results of the estimations of the panel data models: cross-sectional (CS) model, fixed effects (FE) model and random effects (RE) model. The first column indicates that the dependent variable is the logarithm of the real GDP per capita, the explanatory variables are the logarithm of the tertiary education of young people between the ages of 25 and 34 (*ltj*), the logarithm of the tertiary education of older adults whose ages are between 55 and 64 years (*lta*). The coefficient of determination is R^2. Subsequently, there is the Hausman test, number of countries and number of observations in the sample. The second column of table 2 shows the results of the estimations of the CS Model, the coefficients of the variables: the logarithm of the tertiary education of young people between the ages of 25 and 34 (*ltj*) and the logarithm of tertiary education of older adults whose ages are between 55 and 64 years (*lta*) present expected positive signs. It is worth noticing that none of the coefficients is significant, the model presents a R^2=0.5668, the number of countries is 24 and there are 240 observations.

Likewise, the third column presents the FE Model, which indicates a positive and significant coefficient of the logarithm of tertiary education for young people between the ages of 25 and 34 *(ltj*), while the logarithm of tertiary education for older adults whose ages are between 55 and 64 years (*lta*) presents a negative and significant sign. The coefficient of determination is R^2=0.6148. On the other hand, the fourth column presents the RE Model, the estimates indicate a positive and significant coefficient for the logarithm of tertiary education of young people between the ages of 25 and 34 (*ltj*), in contrast to the logarithm of education tertiary education of older adults whose ages are between 55 and 64 years (*lta*) that shows a negative and significant coefficient. The coefficient of determination of the random effects model R^2=0.6148.

Subsequently, the Hausman test is presented with prob>chi2 = 0.3366 which indicates that the RE Model is preferable to the FE Model. Finally. In summary, estimates were carried out with different methods, to analyze the interrelation between tertiary education and real GDP per capita: panel data, FE Models and RE Models. The Hausman test is used to detect misspecification. This research indicates that the RE Model is the preferred model to explain the impact of tertiary education on economic growth in OECD countries during the period under analysis.

The estimates indicate that the RE Model is the model with the best fit among the estimated panel data models. It is also observed that a 1% increase in tertiary education for young people between the ages of 25 and 34 (*ltj*) leads to an increase of 0.4618245% in real GDP per capita. On the other hand, a 1% increase in tertiary education of older adults whose ages are between 55 and 64 (*lta*) leads to a decrease of 0.0785813% in real GDP per capita in the sample of economies of this study. In addition to the above, it is found that the real GDP per capita presents greater sensitivity to the tertiary education of young people between the ages of 25 and 34 (*ltj*) compared to the tertiary education of older adults whose ages are between 55 and 64 years (*lta*). On the other hand, the negative sign of the tertiary education coefficient of older adults whose ages are between 55 and 64 years (lta), could be linked to a depreciation of tertiary education after decades of use, which can be mitigated with education. Continuous and permanent training is recommended to update the knowledge of older adults with tertiary education in order to increase their productivity.

6. CONCLUSIONS

The objective of this research was to analyze the impact of tertiary education on economic growth in OECD countries and to validate with empirical evidence the hypothesis of this research work, that tertiary education plays an important role in economic growth, in agreement with most of the research in this field. However, when disaggregating tertiary education by age, important findings are found: individuals with tertiary education whose ages range between 25 and 34 years contribute positively to the increase in real GDP per capita, while individuals with tertiary education aged between 55 and 64 years have a negative impact on real GDP per capita of the economies analyzed in the period analyzed 2000-2019.

The present investigation also shows through descriptive analysis that tertiary education of young people between the ages of 25 and 34 has a positive relationship with growth, however tertiary education in older adults between the ages of 55 and 64 seems to fall into their productivity or contribution to production in the OECD. Estimates from panel data models highlight the importance of tertiary education for young people between the ages of 25 and 34 in contributing to the increase in real GDP per capita in OECD countries.

The models estimated in this research work, the CS model, the FE model and the RE model indicate a positive impact of tertiary education for young people between the ages of 25 and 34 for the economic growth of the economies that are analyzed. On the other hand, the empirical evidence obtained indicates that individuals with tertiary education whose ages range between 55 and 64 present a negative effect due to the obsolescence of the knowledge acquired, which in most cases was surpassed by the vigorous scientific and technological progress of the last decades

Derived from this research, it is recommended that decision makers in OECD countries seek the appropriate instruments and incentives to promote tertiary education for young people between 25 and 34 years of age, regardless of gender, in order to contribute more vigorously to the increase in real GDP per capita, as well as encourage continuous education through postgraduate studies and the training of older adults with tertiary education whose ages range between 35 and 54 years to promote updating and not fall into obsolescence. The measures can be taken by the public or private sector, aimed at updating the knowledge of older adults with tertiary education to increase their productivity and promote economic growth. Likewise, it is necessary to strengthen the coverage of tertiary education to add value to economic ac-

tivity in the OECD, thus achieving higher levels of well-being. The research is limited to analyzing the role of tertiary education in economic growth through two variables: the tertiary education of young people between 25 and 34 years of age; older adults with tertiary education whose ages range from 55 to 64 years. Although the results of the research are relevant, it is nevertheless recommended that future research explore from other perspectives the role played by other educational variables (postgraduate, gender, etc.) in economic growth, as well in other countries and in other periods of time.

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