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Effects of Public Spending on Economic Growth: An empirical approach in Latin American countries. Period 2006 – 2019

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Abstract

The objective of this research is to empirically examine the influence of gross capital formation (GFK), public spending on education, spending on research and development (R&D), the number of companies and tax collection, in economic growth, evaluating these variables in the economy of twelve Latin American countries in the periods 2006 to 2019. For this, static panel models (fixed effects and random effects) and dynamic panel (Generalized Method of Analysis) were used as econometric methodology. Moments – GMM), in order to establish the best model that presents the estimators, where the two-step GMM system is more consistent and significant. The results found that gross capital formation, spending on education and taxes significantly influence economic growth, while spending on R&D and the number of companies negatively influence economic growth. Coming to the conclusion that spending on education generates growth in the economies of Latin American countries, this is due to lagging economic growth and tax collection, but there is a lack of information on why spending on R&D, taxes, company numbers, generates a negative impact, which is why studies that evaluate factors that influence these variables are recommended.

Keywords: *Expenditure on Education, Research + Development (R&D), Gross Capital Formation (GFK), Tax Collection, Business Numbers, Economic Growth, Latin America, Panel Data, Panel Models.*

INTRODUCTION

In developed countries, economic progress leads to the creation of new jobs with adequate remuneration, generating significant changes in society, while, specifically in Latin American countries, economic growth occurs in reducing the poverty gap, reducing the rate of unemployment, create infrastructure, and implement social programs. But there are events that hinder economic progress in these countries, such as political and economic instability, the high rate of corruption and the poor development of economic sectors.

With respect to this problem, there are many theories that explain economic growth from different points, especially models that justify government intervention to achieve growth, theories such as Rebelo (1991), explores investment in R&D that can lead to the creation of new products, processes and technologies, promoting economic well-being. Furthermore, Rebelo suggests that investment in R&D can be more effective than investment in fixed capital in terms of development, while Lucas (1988) states that expenditures on human capital and on research and development and on R&D are fundamental to promoting economic development, and human capital is essential for the creation and generation of innovation and growth.

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On the other hand, Romero (1986) details that such growth is possible in the long term if factors such as investment, technology, education, infrastructure and the development of competitive markets are included. Finally, Barro (1990) argues that state investment could drastically affect economic development by increasing or decreasing it, as an effect of allocating resources and applying it rationally, and that economic balance is a key factor to promote development.

Given these premises, the economies of Latin American countries have a serious problem in terms of their economic growth, which is why they must present investment policies in government spending, to stimulate development, since through investment in infrastructure roads, bridges, airports and commercial ports are created that facilitate connectivity and reduce costs for companies and consumers, on the other hand it generates employment, a factor to highlight is that the improvement that it can bring to society is to create social programs that reduce the social gap and the important point is that spending on health and education improves the well-being of society. Continuing along the same lines, spending on research and development is vital for development, because R&D leads to technological innovation, generating new products, processes and services, making companies more efficient and productive.

The purpose of this study is to determine and analyze the effect of public expenditures or investments of certain variables or factors such as expenditures on gross capital formation (FBK), expenditures on education and research plus development, also expenditures in numbers of companies and in tax collection.

These expenses or investments made by the governments of certain Latin American countries, in a context of endogenous economic growth and to fulfill this objective, the background and theories of current literature are being considered as a basis, which leads to conceptualizing the model with some variations, thus we have the Barro (1990) model, which considers that spending is composed of spending on education and R&D spending. In this sense, variables will be added, such as: gross capital formation, number of companies and tax collection. Furthermore, the implementation of instrumental variables that solve the endogeneity problem. With the purpose that these variables provide information to the proposed model.

The article is prepared taking into account the following structure: The first section deals with the statement and description of the problem. The second section contains the review of the literature, covering the theoretical framework and empirical literature, which will be a key piece to deepen the study and the evolution of the variable. The third section focuses on the data that were obtained for the analysis and the econometric methodology. The fourth section contains the analysis of the descriptive and econometric results. In the fifth section the contrast with other research is presented, then the discussion of the results is presented and finally, the conclusion and recommendation of the research.

LITERATURE REVIEW

In this section, the review of theoretical and empirical literature related to the variables of this research was addressed, such as educational expenses, spending on research and development (R&D) and how they influence the rate of the Gross Domestic Product (GDP) in order to have greater consistency in the theoretical framework.

Theoretical Framework: Barro's Endogenous Growth Model (1990)

In the endogenous growth model, Barro expresses that the public spending carried out by economies is intended to provide social programs and work for the benefit of the community. This model is an extension of the Cobb Douglas production function, described by Barro and Sla–i- Martin (1995), which is represented by the following function:

$$Y = AK^{\alpha}L^{1-\alpha}G^{1-\alpha} \quad (1)$$

Where: Y is the product, K is private capital, L is work, A is the constant component and G is the spending made by the government, whether in infrastructure, such as providing public services, health, education and security for the benefit of society. Factoring equation (1), the production function is expressed as follows:

$$Y = AK^{\alpha}(LG)^{1-\alpha} \quad (2)$$

In this model Barro assumes that work is a constant and that government spending does not change, and as in the Cobb-Douglas model, the production function has diminishing returns on capital, but Barro affirms that if the government increases spending or investment to the same proportion of capital, the production function will have constant returns on spending and capital, this causes the economy to have endogenous growth. Barro adds that the spending carried out by the government is planned by a budgetary policy and this is influenced by a production tax rate, that is:

$$G = rY \quad (3)$$

Where: r is the tax rate, where it is inferred that said tax rate is constant over time, and is also the ratio between government spending and income. Additionally, government capital and spending is subject to the tax rate. The expense relationship will be represented by the following function.

$$G = rY = AK^{\alpha}G^{1-\alpha} \quad (4)$$

Empirical Literature Review

In this section, empirical literature regarding the variables is evidenced with the objective of deepening its study and having as a theoretical and methodological guide. With respect to the education variable, it has been found that Maneejuk and Yamaka (2021) in their research addressed how education, especially higher education, influences the economic growth of the member countries of the Association of Southeast Asian Nations, with a period analysis 2000-2018, for this purpose a non-linear regression model was carried out, the spending made by ASEAN-5 governments on higher education has a greater impact than those on secondary education, in that same sense, the enrollment rate, university level or higher has a stronger influence on the growth rate than the enrollment rate in secondary education. On the other hand; unemployment in young people with higher education has unfavorable effects on economic well-being.

That is why Agasisti and Bertoletti (2020) in their scientific article aimed to examine the consequence of university education on economic well-being in 284 European regions, having the period of analysis from 2000 to 2017, for which they applied the GMM econometric methodology. where they found the significance of human resources in the economic growth of European regions, since the increase in the number of universities and the research quality of students causes a significant influence on GDP per capita.

While Márquez and Mourelle (2019) in their research seek to clarify, through a non-linear model, the degree of relationship that the type of secondary and tertiary education has on spanish economic well-being at the regional level, for this they had the period of analysis from 1971 to 2013, in the results they found that spending on education generates effects on economic well-being, in detail spending on higher education is greater than secondary education at the regional level. On the other hand, it was found that the labor force had a non-linear behavior in growth at the national level, but not at the regional level.

And with respect to educational spending and its influence on economic well-being, it is evident that, in recent years, empirical literature has been addressed about the relationship between spending by both the government

and companies on R&D and growth economic, both regional and international. In this sense, Haseeb, et al. (2019) tried to examine how economic growth is related to energy consumption, environmental pollution, and government spending on health and R&D in member countries of the Association of Southeast Asian Nations. , having the analysis period from 2009 to 2018, for this purpose the autoregressive distributed delay (ARDL) model was applied. In which they found that environmental pollution positively and significantly impacts health spending in the long term, while energy consumption had a positive and significant effect on health and R&D spending in the long term.

While Ketabforoush, et al. (2019) in their article, addressed how R&D spending influences economic well-being in 15 OECD member countries, with the research period from 2012 to 2018, using the GMM method as an econometric methodology. In its results, it was found that R&D spending drives the development of new technology, which allows companies to increase their production, generating a decrease in costs, increasing aggregate demand and generating economic growth. On the other hand, the Lagged GDP in a period, exchange rate and tax burden have significant influence on economic well-being.

Continuing with the line of research, Nair, et al. (2020), aimed to examine the relationship of R&D, and also the relationship of the development of Information and Communications Technology (ICT) infrastructure and economic growth in OECD countries, in a period of analysis from 1961 to 2018. As they are endogenous variables, they applied the Granger causality test and the panel autoregressive vector model. Reaching the conclusion that in the long term the variable R&D and ICT infrastructure significantly influence economic growth. On the other hand, there is a bidirectional causality between economic growth and R&D spending, and a unidirectional relationship between R&D spending and ICT infrastructure.

In the same country, Boeing, et al. (2022) aims to examine how R&D spending by the Chinese state has an effect on private investments and how this in turn affects the development of technology and economic growth, for this they applied an autoregressive vector model. Structural studies with panel data in the provinces of China during the period 2000-2010. In their results, they found that the spending carried out by the Chinese government on R&D reduces the spending carried out by private companies on R&D, but increases the R&D in the personnel employed, in addition, said spending carried out by the government generates positive externalities, such as a technological improvement, increases business efficiency and therefore economic well-being.

On the other hand, it is important to investigate developing countries in order to have a broader and deeper knowledge of the study variables, which is why Ahuja and Pandit (2020) tried to explore how public spending impacts economic growth. of 59 developing economies, taking the years 1990 to 2019 as the analysis period, using the Granger causality test and a panel regression, in which the results showed that there is a unidirectional relationship between public spending and well-being economic, in addition, in the regression model it was found that public spending has a positive and significant effect on economic growth, on the other hand, the control variables, such as population, have a negative effect on economic growth, added to this the openness trade have a positive impact on economic well-being.

Likewise, Sun, et al. (2018), in their article, aimed to examine whether the Chinese government's spending on education through the exploitation of natural resources is an influential factor in capital and technological progress. To do so, they analyzed 31 Chinese provinces, which cover as the period of analysis from 1999 to 2015, which divided them into two sectors, eastern China and central-western China. Through a fixed effects model, we conclude that the eastern region of China depends heavily on these resources for budget allocation. But in general there is a positive and significant impact of natural resources with the spending that the Chinese government assigns to education and that said spending contributes to the development of the country, through labor productivity, generating a reduction in wage inequality in the regions. In turn, the eastern region of China depends heavily on these resources for budget allocation.

Regarding the number of companies and its relationship with economic growth Jian, et al. (2019) in their research article aimed to examine the effect of business creation and innovation on Chinese economic growth, analyzing 31 Chinese provinces in the period from 1978 to 2017. To do so, they used a dynamic panel

econometric model, specifically the GMM method, reaching the conclusion that the creation of companies has a positive and significant effect on economic growth, that is, the regions that have the greatest number of companies are prosperous regional economies, on the other hand, innovations have a positive and significant but delayed effect on economic growth.

METHODOLOGY AND MODEL

This section presents the collection of secondary data information, the econometric methodology applied for the estimation and causal relationship between spending on higher education, spending on research and development and economic well-being.

Database

For the econometric analysis, panel data from 12 Latin American countries (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Mexico, Panama, Paraguay, Peru, Uruguay) were used from 2006 to 2019, not the other Latin American countries were taken into account due to the scarce information on the variables that we intend to take into account for this study. The data were obtained from the World Bank database (World Bank, 2023), from the Science and Technology Indicators Network (RICYT, 2023), and from economic and sociodemographic information (Datosmacro, 2023). See Table 1, which describes the list of variables, description and sources of all variables used for the model. The variables that they intend to use to meet the objectives of the research are described in the manner already mentioned, in order to reduce the variance of the data and to facilitate the interpretation of the results, natural logarithm was applied.

Table 1. List of variables and data source

Variable	Legend	Fountain
Dependent variable:		
Gross Domestic Product in natural logarithm (US$ at constant 2010 prices)	GPD	World Bank. World Development Indicators (WDI) Database. Available at: <https://datos.bancomundial.org/>
Independent variable:		
Gross Capital Formation in natural logarithm (% of GDP)	FBK	World Bank. World Development Indicators (WDI) Database. Available at: <https://datos.bancomundial.org/>
Government spending on education in natural logarithm (% of GDP)	EDU	World Bank. World Development Indicators (WDI) Database. Available at: <https://datos.bancomundial.org/>
Government spending on Research and Development in natural logarithm (% of GDP)	R&D	Network of Science and Technology Indicators (RICYT). Science and Technology Indicators of Latin America and the Caribbean. Available at: <http://www.ricyt.org/category/indicadores/>
Number of companies in natural logarithm	N_EMPRE	World Bank. World Development Indicators (WDI) Database. Available at: <https://datos.bancomundial.org/>
Tax collection in natural logarithm (%GDP)	TRIBU	World Bank. World Development Indicators (WDI) Database. Available at: <https://datos.bancomundial.org/>

Note: Data used for estimation of static panel and dynamic panel models

Econometric Model

This study aims to analyze the degree of relationship and influence between government spending on education, R&D and economic growth. That is why the endogenous growth model of Barro (1990) was used, since it highlights the importance of human capital and R&D as important pieces for long-term economic growth, since it generates constant returns to scale and externality positive, this can be represented empirically using a panel data econometric model.

$$y_{it} = \beta_1^J X_{it}^1 + e_{it} \quad (1)$$

Where the subscript stands out, i is represented by each country, while t is the time period (with t = 1,2, …, T) and the GDP in real terms in logarithms of the country, y_{it} of the country i during the period. Furthermore,

the variable $X_{it}^{1} = \left[ln_{fbk_{it}}, ln_{edu_{it}}, ln_{ryd_{it}}, N_{empresa_{it}}, Impuestos_{it}\right]$ is the vector of J covariates of the spending components carried out by central governments expressed in real terms, as they are endogenous variables, that is, they are strongly correlated with the error term e_{it}.

Mankiw et, al. (1992) discovered empirically that 17 developed countries have different technological developments, which would not depend directly on economic growth, but on factors that would be in the error term. To avoid this information bias, the error term was modeled based on those factors not taken into consideration, i.e $e_{it} = f(V)$. Where V is expressed as $V = \beta_1 y_{it-1}^{1} + e_{it}^{*}$. In this equation the growth lag is taken into account, as proposed by Bleaney et al. (2001). Is obtained:

$$y_{it} = \beta_1 y_{it-1}^{1} + \beta_2^{J} X_{it}^{1} + u_{it} \quad (2)$$

Where the error term u_{it}, is the association of e_{it} and e_{it}^{*}. In addition to this, a series of instrumental variables and time dummies were added, presenting an extended model:

$$y_{it} = \beta_1 y_{it-1}^{1} + \beta_2^{J} X_{it}^{1} + \beta_3^{V} X_{it}^{2} + u_{it} \quad (3)$$

Where: X_{it}^{2} = [GDP per capita, foreign direct investment, health spending, unemployment rate, inflation, trade, population rate, corruption index, number of scientific articles published, investment coefficient, exports of high-tech products] and time dummies with the purpose of the vector of J covariates that can be potentially influential factors in economic growth.

These instrumental variables have been taken prior to a preliminary analysis, in order to control the endogeneity of the variables analyzed, which is why a set of social, political, economic and demographic variables compiled from the World Bank database. RICYT and Datamacro are detailed. As can be seen in Table 2, firstly, variables that are strongly correlated with gross capital formation and the number of companies were taken into consideration, such as: the interest rate, unemployment rate. While, for spending on research and development in an economic growth model, the number of patents (residents and non-residents), spending on information and communication technologies (ICT) and spending on foreign direct investment were taken. On the other hand, the expenditure provided on education was counted as instrumental variables: population rate, health expenditure, literacy rate and per capita income. Finally, globally, the corruption index was taken into account, since having a high corruption index can negatively affect the investments and political stability of a country, since according to Cuevas and Jaimes, (2021), At low levels of corruption, it positively supports economic growth. While Jumbo, et al. (2021), that government integrity positively impacts economic development.

In that sense, Equation (3) is a dynamic panel data model, since the dependent variable is GDP growth and the explanatory variables are the lagged dependent variable and endogenous variables, as explained previously. This brings with it endogeneity problems and autocorrelation problems. That is why to solve the endogeneity bias, the generalized method of moments (GMM) is taken as an econometric methodology. This methodology has been rooted by researchers when using dynamic panel data with macroeconomic variables, specifically the empirical literature related to economic growth, it is that of the generalized method of moments (GMM), developed by economists Hansen and Blundell (1980) and improved by Arellano and Bond (1991), since it solves endogeneity problems in dynamic panel data models, using instrumental variables and requiring that the data be complete, that is, balanced panel data. On the other hand, Arellano and Bover (1995) use moment errors at the model level; this type of method allows the data to be missing, that is, unbalanced panel data.

To estimate the GMM, Stata statistical software was used, specifically the command developed by Roodman (2006), which takes certain points into consideration, such as the one-step application that is used to estimate

a homoscedastic weighting matrix. and two-step for an estimation of a heteroskedastic weighting matrix. According to Labra and Torrecillas (2014), this last mechanism specifies that the estimators are more efficient. Another point to clarify is that when performing this type of GMM estimation, the validity test of the econometric model is carried out, that is, whether the model is adequately overidentified, since instrumental variables necessary to identify the model variables were included. According to Roodman (2009), two tests should be applied for over-identification, the first is the Hansen test for one-step estimates and the second is the Sargan test for two-step estimates.

Table 2. List of instrumental variables and data source.

Instrumental variables:		
Interest rate	TI	World Bank. World Development Indicators (WDI) Database. Available at: <https://datos.bancomundial.org/>
Unemployment rate (% growth of the EAP)	TASA_DESEM	World Bank. World Development Indicators (WDI) Database. Available at: <https://datos.bancomundial.org/>
Number of patents (residents and non-residents)	PAT	Network of Science and Technology Indicators (RICYT). Science and Technology Indicators of Latin America and the Caribbean. Available at: <http://www.ricyt.org/category/indicadores/>
ICT spending	TIC	World Bank. World Development Indicators (WDI) Database. Available at: <https://datos.bancomundial.org/>
Foreign direct investment, net capital inflow (% of GDP)	IED	World Bank. World Development Indicators (WDI) Database. Available at: <https://datos.bancomundial.org/>
Population rate (growth % of total population)	TASA_POB	World Bank. World Development Indicators (WDI) Database. Available at: <https://datosmacro.expansion.com/>
Current Health Expenditure (% of GDP)	SALUD	World Bank. World Development Indicators (WDI) Database. Available at: <https://datos.bancomundial.org/>
Literacy rate, total adults (% of people ages 15 and older)	TASA_ALF	World Bank. World Development Indicators (WDI) Database. Available at: <https://datos.bancomundial.org/>
Gross Domestic Product per capita (US$ at constant 2010 prices)	PBI_PC	World Bank. World Development Indicators (WDI) Database. Available at: <https://datos.bancomundial.org/>
Corruption index	IND_CORR	Macro data. World Economic Indicators. Available at: <https://datosmacro.expansion.com/>
Trade (% of GDP)	TARDE	World Bank. World Development Indicators (WDI) Database. Available at: <https://datos.bancomundial.org/>

Note: Data used for dynamic panel mode estimation – GMM

RESULTS

Descriptive analysis

This section detailed the description of the central statistics, the correlation of the variables, the evolution of the data over time and the estimation of the variables, using the static panel method and dynamic panel including instrumental variables with the purpose to be able to contrast each estimation method and be able to choose the most significant one for the research objectives.

Central Statistics

Table 3 shows the main central statistics, which describe the variables selected for modeling. In the average value of GDP in constant terms in logarithms is $25,639.21, with a standard deviation of 1,444, which indicates heterogeneity among the data set; The maximum registered value is $28,592.74, and the lowest minimum registered value is $23,320.71. On the other hand, the gross capital formation in logarithm at constant prices, the average value is $24,132.60 with a standard deviation of 1,428, which indicates that there is heterogeneity between the variable data; The maximum value recorded is $27,07069 and the minimum value is $21,629.04. Similarly, the spending allocated by the government on education is $22,654.89, having a heterogeneity of 1,536 among the data set, with a maximum value of $25,734.58 and a minimum value of $20,008.24. Along the same lines, the expenditure made by each Latin American economy on R&D has a standard deviation of 2.092,where does it indicatea high variability in the data set, having a maximum value of $24,163.17 and a minimum value of $15,789.69. Regarding the number of new companies created per economy, the deviation is 1,602, with a maximum value of 12,780.79 companies created and a minimum value of 6,9255.95 companies created per year and finally, tax collection, where the average value received per year is $23,699.25, and the maximum and minimum value received in the analysis period is $26.68566 and $20.83787, respectively.

Table 3. Descriptive statistics of the selected variables.

Variables	Observations	mean	Standard deviation	Minimum	Maximum
Log (GDP)	168	25.63921	1.444968	23.32071	28.59274
Log (FBK)	168	24.1326	1.428338	21.62904	27.07069
Log (Education Expenditure)	168	22.65489	1.536606	20.00824	25.73458
Log (R&D)	168	19.87503	2.092726	15.78969	24.16317
Number of companies	110	9.924444	1.602049	6.925595	12.78079
Log (Tax collection)	168	23.69925	1.458338	20.83787	26.68566

Note: The variables used in this analysis were collected from the period 2006-2019. Authors' elaboration using Stata 17.

Correlation Table

Continuing with the descriptive analysis, Table 4 shows the correlation matrix between the study variables. Where he found that GAS_EDU, GAS_RYD and EMPRESAS correlate positively and significantly at a 5% level with GDP. In addition, the FBK has a negative and significant correlation at 5% with the GAS_EDU, GAS_RYD and IMPU. On the other hand, spending on education has a significant positive correlation with the GAS_RYD and a non-significant negative correlation with IMPU at the 5% level in both. Similarly, R&D spending is positively and significantly correlated at 5% with the number of companies created per year, but in a non-significant negative way with tax collection. Finally, the number of companies is negatively and non-significantly correlated with tax collection.

Table 4. Pairwise correlation matrix.

	GDP	FBK	Education spending	R&D spending	Number of companies	Tax collection
GDP	1	-	-	-	-	-
FBK	-0.1773*	1	-	-	-	-
Education spending	0.4106*	-0.4269*	1	-	-	-
R&D spending	0.6749*	-0.3366*	0.6688*	1	-	-
Number of companies	0.6441*	-0.0318	0.3496*	0.7444*	1	-
Tax collection	-0.1274	-0.1957*	-0.0766	-0.0344	-0.036	1

Note: Authors' elaboration using Stata 17. Values with ***, **, * indicate the significance level of 0.1%, 1% and 5%, respectively.

Figures

Analyzing the evolution of the study variables by country, Figure 1 shows the evolution of GDP from 2006 to 2019, where the analysis period is represented by years on the X axis, while on the Y axis it is represented by the GDP in logarithms of each country. It is evident that Brazil is the strongest economy in Latin America, since over time it has had a GDP above the region, followed by Mexico, Argentina, Colombia and Chile, which border on a GDP in logarithms of28 to 26 million dollars, continuing with the graphic analysis, economies such as Costa Rica, Ecuador, Panama, Paraguay, Peru and Uruguay fluctuate a GDP in logarithms of 26 to 24 million dollars throughout the analysis period. Finally, the economy of El Salvador has aGDPwell below 24 million, with the country having the lowest GDP of the 12 countries studied.

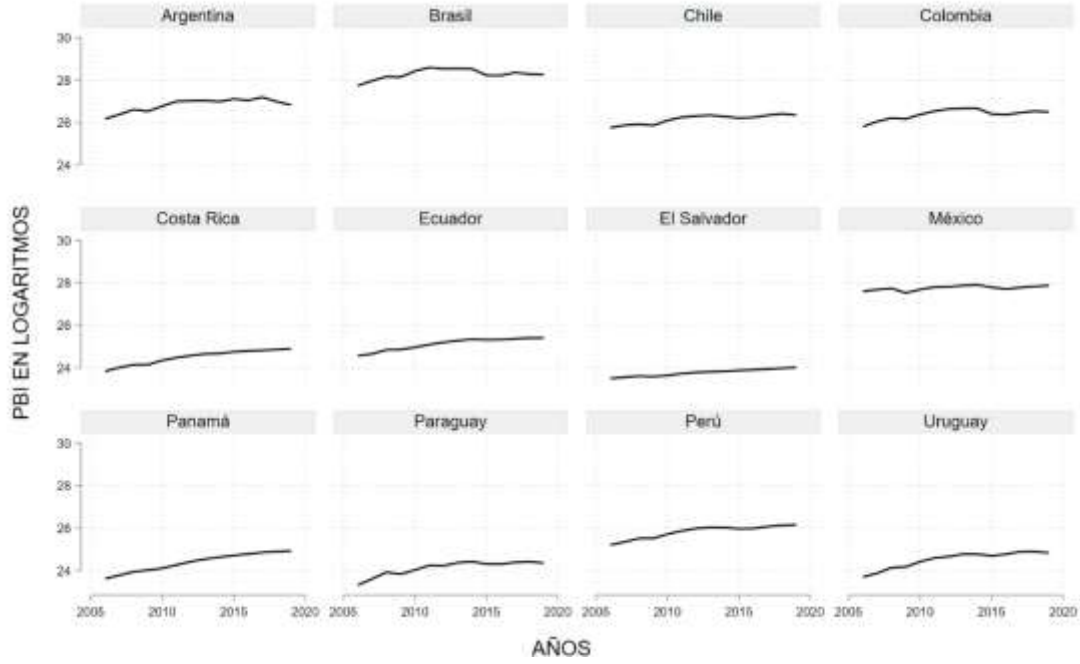

Figure 1. Evolution of theGDPin logarithms.

Source: World Bank (2023). Own elaboration

Continuing with the graphic analysis, Figure 2 shows the evolution of spending by central governments on education, which includes everything from primary education to higher education that spans from 2006 to 2019. On the X axis, the years of study and On the Y axis is the education spending (% of GDP) of each country. The figure indicates that the Brazilian and Mexican economies have educational spending above the region, while countries like Argentina, Chile, Colombia and Peru have a high average spending in Latin American countries, but countries like Costa Rica, Ecuador, Panama, Paraguay, Uruguay have average spending and El Salvador has low spending in the region. This is strongly related to the GDP perceived by each country.

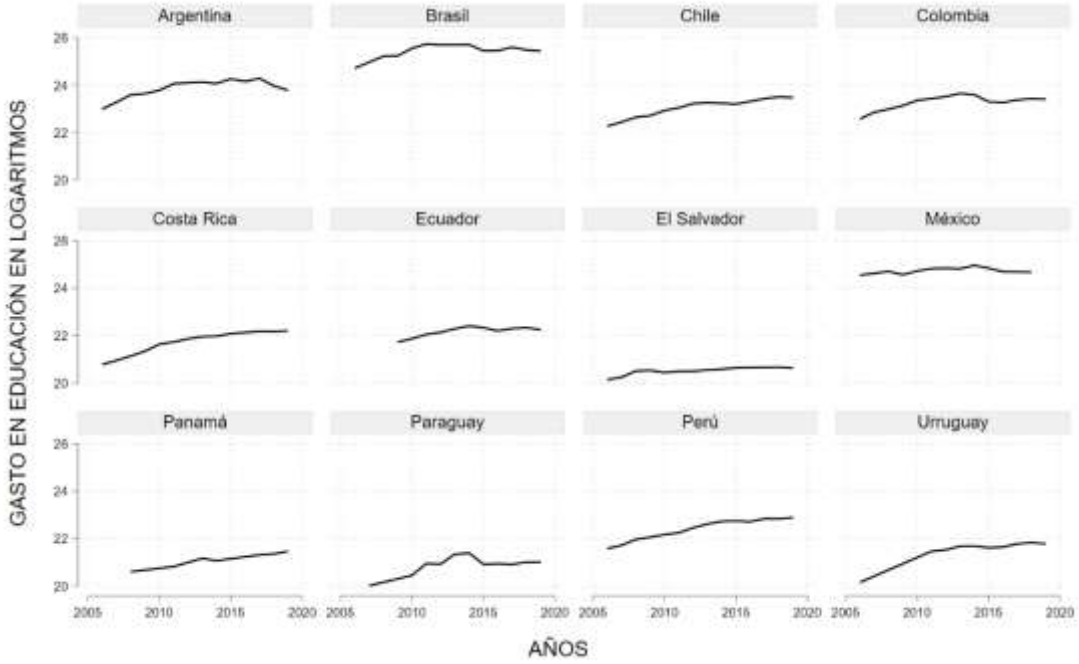

Figure 2. Evolution of spending on education in logarithms.

Source: World Bank (2023). Own elaboration.

Finally, Figure 3 shows the evolution of government spending on research and development (R&D). On the figure shows that the Brazilian economy is well above the other Latin American countries, followed by the Mexican and Argentine economies. However, the economies of Chile and Colombia have a high average expenditure in the region, while the economies of Costa Rica, Ecuador, Panama, Peru and Uruguay have a low average expenditure and finally El Salvado, Paraguay have a low expenditure on R&D. This percentage of allocation to research and development is due to how much money it captures in the GDP and this distributes it.

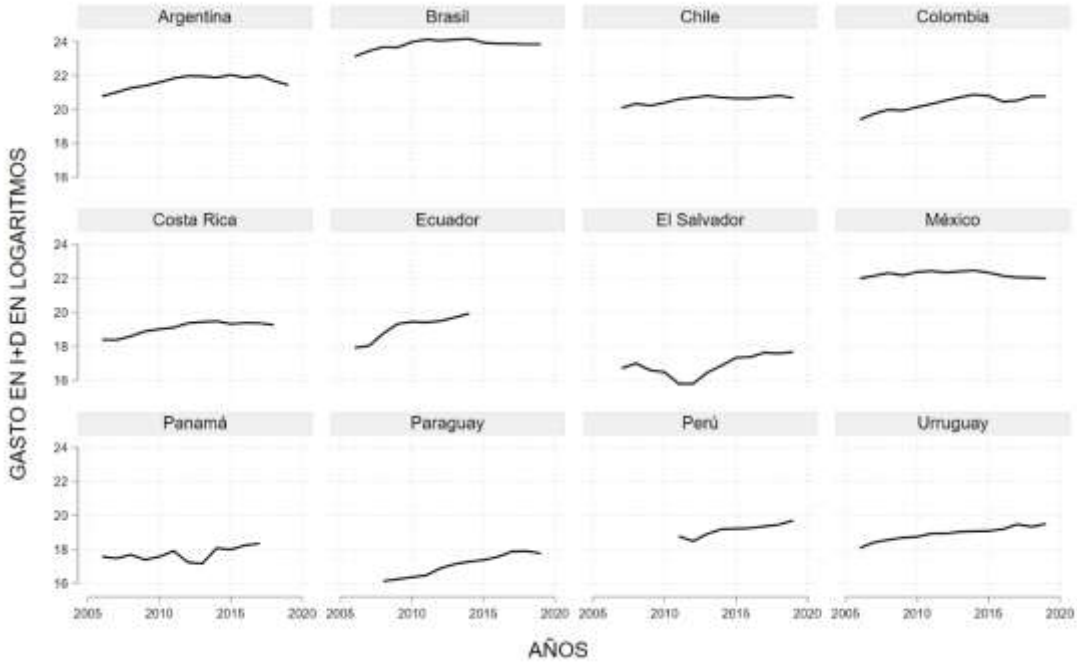

Figure 3. Evolution of R&D spending in logarithms.

Source: World Bank (2023). Own elaboration

Econometric Analysis

Based on the previous data, the pooled Least Squares model was tested (examined), which indicates that the explanatory variables are statistically significant in the model, where gross capital formation, spending on education and tax collection influence positively to GDP growth, while R&D spending and the number of companies negatively influence economic growth. This estimate is not reliable, since it has a very high R^2. On the other hand, the Between regression only considers that gross capital formation, spending on education and tax collection are statistically significant and positively impact GDP growth, while spending on R&D and number of companies do not positively impact GDP growth in Latin America, but only in the number of companies is it statistically significant.

Continuing with the interpretation of the results in Table 5, applying static panel models, the estimation was carried out by fixed effects and random effects, to choose the best model that explains the relationship between the study variables, The Hausman test was performed. As seen in Table 5, a p-value = 0.0000 stands out, which indicates the rejection of the null hypothesis; according to the econometric literature, there is a correlation between the dependent variable and the independent variables. Therefore, the appropriate model is that of fixed effects. Going deeper with the fixed effects model, the spending allocated by the government to education and tax collection are statistically significant, while the variables gross capital formation, spending by governments on R&D and the number of companies created per year are not statistically significant. This is because, as explained by Arellano and Bond (1991), they are endogenous variables and have autocorrelation problems, which is why GMM was applied including instrumental variables to the robustness of the model.

Table 5. Descriptive statistics and correlation of the selected variables

	Dependent variable: GDP growth (yiT)					
	Pooled OLS(1)	**BetweenGroups(2)**	**Fixed Effects(3)**	**Random Effects (4)**	**Difference (ef-ea)**	**Err.Std**
FBK in logarithms	0.3930***(17.86)	0.4220*** (7.01)	0.0551(1.16)	0.2010***(4.85)	-0.1462	0.0227
Education spending in logarithms	0.3470***(10.43)	0.4280**(3.12)	0.3590***(7.56)	0.3810***(7.11)	-0.0221	0.0000
R&D expenditure in logarithms	-0.0509*** (--3.69)	-0.0908 (--1.48)	0.0100 (0.43)	- 0.0033(-0.13)	0.0133	0.0000
Number of companies	-0.0449***(-6.42)	-0.0644** (-3.21)	-0.0411 (-1.77)	-0.0314(-1.91)	0.1114	0.0164
Tax collection	0.3550***(11.40)	0.3080*** (3.31)	0.5200***(7.04)	0.4090***(5.63)	-0.0096	0.0136
Constant	1.4040*** (6.39)	0.9600 (1.35)	4.1190*** (7.75)	2.9100***(6.48)	-	-
Specific tests						
Hausman test			45.15			
(p-value)			(0.0000)			
F test for all u = 0	1050.25(0.0000)		14.80(0.0000)			
Wald test (p-value)		5506.18 (0.0000)	4.1907 (0.0000)	5824.01(0.0000)		
R2	0.9982	0.998	0.9956	0.997		
Observations/countries	106/12	86/12	86/12	86/12		

Note: Authors' elaboration using Stata 17. Statistical values in parentheses () represent the robust standard error, rather than the p value. ***, **, * indicate the significance level of 0.1%, 1% and 5%, respectively.

Continuing with the same line of analysis of the results, analyzing the estimate by GMM, as seen in Table 6. The estimates express that there is a positive relationship between the economic growth of GDP and its lag, in addition to gross capital formation, Education spending allocated by the government and tax collection has a significant impact on GDP growth. While spending on R&D and the number of companies has a negative impact. According to the results shown, R&D spending and the number of companies do not influence economic growth in Latin American countries. On the other hand, gross capital formation, spending on education, tax collection and lagged GDP in a period contribute to GDP growth.

Once the GMM model was applied, as seen in Table 6, statistical tests were carried out to check the reliability of the results presented, the Hansen test and the Arellano-Bond test. The results show that Hansen's J statistic has a p-value = 0.1090 greater than the 5% significance level, which rejects the hypothesis, that is, the model's over-identification restrictions are valid for the model. On the other hand, the Arellano-Bond serial correlation test tells us that there is no first-order autocorrelation since the p-value is greater than 5% of the significance level, the same happens in the second, the p-value is greater at 5%, which shows that in both the first and second order there are no autocorrelation problems. In conclusion, the statistical tests carried out indicate an adequate estimation of the GMM model.

Table 6. Dynamic panel data estimation method with time fixed effects. Estimation method: Generalized Moment Method (GMM).

	Dependent variable: GDP growth (yiT)			
	Coefficient	**Std. Err.**	**z**	**P > | z |**
FBK to logarithms (ln_ffk)	0.2842	0.0975	2.92	0.0040
Education expenditure in logarithms (ln_edu)	0.2696	0.1323	2.04	0.0420
R&D expenditure in logarithms (ln_ryd)	-0.0967	0.0403	-2.40	0.0160
Number of companies (num_companies)	-0.0406	0.0135	-3.02	0.0030
Tax collection (ln_tributo)	0.2662	0.0677	3.93	0.0000
Lagging GDP growth (yi,T-1)	0.3400	0.0894	3.80	0.0000
Instrumental variables		Yeah		
Temporary effects included		Yeah		
Constant		No		
Specific tests (p-value)				
Sargan test		132.65 (0.000)		
Hansen test		68.13 (0.109)		
Residual AR(1) test		-0.110 (0.915)		
Residual AR(2) test		-0.460 (0.643)		
Observations/countries		68/12		

Note: Elaboration by the authors using Stata 17,forGMM estimation using xtabond2 command

DISCUSSIONS AND CONCLUSIONS

In this research, we tried to examine how spending on education and R&D influences economic growth. In addition, it was examined how gross capital formation, the number of companies and tax collection influences economic growth in Latin American countries, with the analysis period from 2006 to 2019. For this, static panel and dynamic panel models were implemented with the purpose of choosing the best estimate that explains the results obtained. In the static panel model, thanks to the Hausman test, the fixed effects model explains the estimators better, but only spending on education and revenue have a positive and significant influence on GDP growth, but spending on I +D, FBK and the number of companies are not statistically significant. Regarding the dynamic panel model, the GMM model with instrumental variables, it was shown that GDP growth is positively and significantly influenced by its lag.

Regarding tax collection, the results obtained are contrasted with the research of (Badri, et al., 2019; Arvin, et al., 2021; Ramírez and Brito, 2021; Cacay, et al., 2021) which affirm that tax collection positively influences economic well-being. Along the same lines, Gnangnon and Brun (2019) express that underdeveloped countries depend a lot on tax revenues, since they allocate a large part to primary expenses, such as the construction of infrastructure, in education, health, security, in research and development, this effect would not be possible if trade openness is not taken into consideration, which is why this study took trade openness into account as an instrumental variable.

While R&D spending and the number of companies negatively and significantly impact GDP growth, these two premises refute the empirical applications of (Ketabforoush, et al., 2019; Haseeb, et al., 2019; Nair , et al., 2020; Boeing, et al., 2022), which conclude that R&D spending influences economic well-being, but studies such as Inekwe (2014) concluded that countries With average income, spending on R&D has a positive effect on economic well-being or growth. On the other hand, Gumus and Celikay (2015) explain that developing economies should invest more in R&D, in order to increase innovation and growth. While López, and Martínez (2017), economies with high levels of income and with little use in R&D do not significantly influence economic well-being. Other factors that are not taken into consideration with respect to R&D spending by Latin American economies are that they do not have a good application policy or the institutions in charge do not have investment policies. It should be noted that Mendoza and López (2020) highlight the importance of public institutions free of dishonest behavior for economic growth. In this regard, Fernand and Pastás (2022) express that in Latin American countries, corruption significantly harms economic well-being.

Another aspect to highlight is that the creation of companies does not guarantee economic growth, since there may be many factors that can prevent companies from generating a positive impact. According to Lederman, et al. (2014) the business creation rate is very low, due to certain factors such as little investment in R&D, low educational level, which leads to a limited business culture and the lack of both public and private strategies that influence in economic well-being.

This research has several limitations. Firstly, Latin American countries have limited and incomplete data on some variables, which causes an imbalance in the application of the GMM model of Arrellano and Bond (1991), since the primary requirement of this methodology is that the data must be completely balanced for the analysis, another limiting factor is the period of analysis, periods prior to 2006 were no longer taken, not from 2019 due to the lack of data information, from some Latin American countries, which is why they are not taken into account in this empirical study.

That is why it is recommended for future research to analyze what research and development factors can influence economic well-being in Latin America with the aim of having a more detailed perspective of the impact of R&D, in turn analyzing spending on education by levels and examine which level is most influential in economic well-being, either through a dynamic panel model or a panel autoregressive vector model. In conclusion, the lagged GDP in a period has a positive impact on well-being, on the other hand, the spending made by Latin American governments on education drives economic growth, while spending on research and development does not generate such well-being, since Investment is not sufficiently proportional to GDP income, which has a negative impact by not having policies that promote research, which is why it is recommended that the region's economies significantly increase spending on research and development.

accompanied by policies that promote research, in turn making the private sector invest in research, so that companies generate greater productivity, with the aim that in the long term research drives economic growth.

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