Contemporary Readings in Law and Social Justice
ISSN: 1948-9137, e-ISSN: 2162-2752
Vol 16 (1), 2024
pp. 1367 - 1375

Agdp and Life Expectancy in Huila - Colombia: A Correlational Study

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Abstract: This study investigates the relationship between economic growth and health development in the department of Huila, Colombia. Using time series data from the National Administrative Department of Statistics (DANE) spanning 2006 to 2023, we examine the correlation between Gross Domestic Product (GDP) at constant prices and life expectancy as a proxy for health development. A vector autoregressive (VAR) model is employed to analyze the dynamic interplay between these variables. Our findings indicate a unidirectional causal relationship between GDP to life expectancy, as revealed by Granger causality testing. Furthermore, impulse response functions demonstrate the presence of both short- and medium-term impacts of economic growth on life expectancy in Huila.

Keywords: *Economic growth, life expectancy, life expectancy, VAR, Huila, regional analysis*

Received:13 March 2024 **Revised:** 19 May 2024 **Accepted**:16 June 2024

Introduction

The economic growth of a country can have a positive impact on the health of the population by increasing the capacity of the government and its health services to improve living conditions. It is estimated that with a higher Gross Domestic Product (GDP), governments thus allocate more resources to health infrastructure, prevention programs, and advanced medical treatments that can prolong the life expectancy of their population and reduce preventable diseases such as those suffered (World Bank, 2020).

The link between economic growth and the health of the population has been studied for decades. In Colombia, the relationship between these two aspects is of interest, since the country has experienced sustained economic growth in recent decades, accompanied by advances in the health system and an increase in life expectancy. According to World Bank data, Colombia's GDP grew by 10.7% in 2021, driven by the economic recovery after the COVID-19 pandemic (World Bank, 2022). Accordingly, life expectancy at birth in Colombia reached 77 years in 2021, showing a positive trend in the last decade (DANE, 2022).

This study aims to analyze the correlation between economic growth and health, measured through life expectancy, in Colombia. By understanding this relationship, it seeks to promote economic growth that is not only reflected in GDP but also contributes to the integral well-being of the population.

Economic Growth And Health

Economic growth and life expectancy are two aspects that can be closely related to a country's development. There is a body of research that explores the intricate connections between these two variables. Firstly, it is important to recognize that the term "economic growth" was addressed and proposed by classical economists and later schools of thought; for this reason, its description is diverse and encompasses different notions. Yagual et al. (2019), as mentioned in Ortiz et al. (2020), state that the term growth refers to the changes or variations that can occur from one economic period to another. Fermoso (1997) points out that economic growth is understood as the quantitative and qualitative increase in the real income of a territory over a specific time interval.

Subsequently, Colom (2000) argues that the term growth implies physical expansion, capital accumulation, and greater economic availability. In other words, economic growth suggests a process of increasing the economy over time. Finally, Papadópolos (2016) indicates that it can be defined as the increase in the production of goods and services of an economy, measured and compared to the previous period and that the variable that best expresses these movements is the Gross Domestic Product (GDP).

Now, concerning the term life expectancy, it can be explained in its strict sense as the average number of years that a person will live from birth, assuming that the mortality trend does not change significantly (Sánchez & Tuñón, 2004).

Various studies have shown that economic growth is a crucial determinant in improving population health and increasing life expectancy. As a country's per capita income rises, people have greater access to nutrition, sanitation, housing, and medical care—all of which contribute to better health and increased longevity. Conversely, higher life expectancy can also drive economic growth by boosting labor productivity and incentivizing greater investments in human capital (Peterson, 2017). Healthier individuals are more capable of contributing to the economy through increased workforce participation, higher wages, and better cognitive abilities (Timothy, 2018). This positive feedback loop between economic growth and life expectancy has been observed in both high-income and low-income countries.

However, the relationship between these two variables is not always linear or direct. In some developing countries, rapid population growth can exert significant pressure on limited resources, which can slow economic development and limit improvements in life expectancy.

Literature Review

Yi Chen et al. (2019) conducted an analysis of the existing relationships between the economic growth of the United States and health progress or development, measured through life expectancy at birth as a proxy variable. To make their estimates, the authors rely on a mixed frequency vector autoregressive model (MF-VAR) that allows for the evaluation of variables presented in different periods, offering greater explanatory power of the phenomenon. The authors consider quarterly GDP data and the annual variation in life expectancy from 1948 to 2016.

The research results affirm a bidirectional causality between health progress and economic growth through Granger causality tests. Additionally, the impulse response analyses of the mixed-frequency VAR model showed that despite the impacts of economic growth on health advancement usually being procyclical, there exists a changing correlation between the variables of analysis during the four quarters of each year in the analyzed period. These results align with previous time-series analyses between these two variables.

The study by Yildirim et al. (2019) examined the role that health plays in economic growth in OECD countries using cluster analysis and econometric estimations. Twelve countries were analyzed, and divided into two clusters according to the health level of each country, measured through essential health indicators. Other variables used included export rates, population data, fixed capital investments, inflation, and foreign direct investments, with life expectancy and GDP growth rates as control variables. These data were sourced from the World Bank, WHO, and OECD for the period between 1999 and 2016. Subsequently,

the panel data methodology was used to explore the significant relationships between variables, focusing on the impacts of health and economic growth.

The authors conclude that improvements in health (life expectancy) have positive repercussions on economic growth, especially for countries with low health levels, and that policies focused on health improvements or advancements can enable countries to achieve sustainable economic growth.

Bayarbat & Li (2020) inspect through empirical analysis the relationship between per capita health expenditure and economic growth in Mongolia. The study uses a vector autoregressive model (VAR) to describe the dynamic correlation between these variables over 25 years (1993–2018), analyzing the variance decomposition as well as the impulse response functions present. The results of Bayarbat & Li's work suggest that a correlation is perceived between both variables, in only one direction according to the Granger causality test.

Furthermore, the authors argue that economic growth has a positive impact on per capita spending in Mongolia in the short term (1–3 years), reaching contributions of up to 18.1%; after this time, the effects become less significant. Finally, the authors suggest to policymakers not only to increase the per capita expenditure budget but also to boost spending on public health and improve the private health system.

Khalid & Qayyum (2021) investigate the existing link between health indicators and economic growth in Pakistan over a 30-year interval (1990 to 2020) using an ARDL (Autoregressive Distributed Lag) model, considering variables such as GDP, fertility rate, foreign direct investment, life expectancy, and infant mortality rate. The study focuses on the effect of these variables on the country's economic growth using descriptive statistics, cointegration techniques, and unit root tests like the Dickey-Fuller test.

The conclusions of the study indicate that in the short term, correlations are evident between GDP, foreign direct investment, fertility rate, and life expectancy, which would have effects on the country's economic growth. The mortality rate was found to harm economic growth in the short term.

Jayadevan (2021) reveals that health and economic growth are related. He examined the relationship between the healthy conditions of human capital and economic growth using structural equation models and panel data analysis of 181 countries over 17 years (2001–2017). He found that good health of human capital is an investment from which territories benefit, in the sense that it will increase per capita income, and productivity, and reduce poverty. The research also demonstrates that life expectancy, health investment, and education are actionable variables for determining economic growth, especially for less developed countries.

The study The Effect of Health on Economic Growth: A Meta-regression Analysis by Ridhwan et al. (2022) investigates the relationship between health and economic growth through a meta-regression analysis of 719 estimates from 64 studies. The authors argue that, although a publication bias towards a positive estimation of the phenomenon can be perceived, they managed to demonstrate that health has a positive effect on the economic growth of territories due to the economic demographic transition. However, Ridhwan and others mention that the effects presented between these two variables will depend on the data arrangement, estimation procedure, model specification, and characteristics of the country, region, department, city, or other area of analysis.

Joaqui & Orozco (2023) investigate the nonlinear relationship between GDP per capita and the mortality rate in the United Kingdom, using data from the Human Mortality Database and FRED. Multivariate analysis, specifically principal component analysis, is employed to reduce the dimensionality of the information and find correlation structures between the variables. Additionally, econometric techniques such as the cross-quantilogram are used to identify nonlinear relationships between GDP per capita and the mortality rate. This technique allowed for examining the directionality of the variables and determining the quantiles of the distributions for which the relationship was significant. The importance of economic growth in reducing mortality rates is highlighted, as demonstrated in previous studies. Moreover, it is mentioned that improvements in economic conditions have been a relevant factor in the decrease of

mortality rates throughout history. The results obtained suggest that economic growth is inversely related to mortality rates in the medium and long term.

Methodology

According to Sims (1980, 1982) and Christiano et al. (1999), VAR models have been frequently used as a tool for macroeconomic analysis over the past decades. Similarly, Lopreite & Zhu (2020) argue that vector autoregressive models not only are easy to formulate but also have explanatory power in capturing dynamic relationships between variables.

On the other hand, Ogungbenle et al. (2013) state that the VAR technique is commonly used to analyze the dynamic impact of random disturbances (shocks) in the system of variables. Moreover, given that there are few restrictions on how the system's variables interact, this method is very suitable for examining the channels through which a variable operates. This is why the strength of the VAR model lies in its ability to incorporate the residual of the past observation into the regression model of the current observation. Pesaran et al. (2001) affirm that this technique allows for a mix of variables that are regressors, meaning the order of integration of the relevant variables may not necessarily be the same.

Bayarbat (2021) uses a VAR model to analyze the relationship between per capita health expenditure and economic growth in Mongolia. The VAR model is a multivariate time series model that captures the dynamic interactions among multiple variables over time. In this case, the VAR model is applied to the variables of per capita Gross Domestic Product (GDPpc) and per capita health expenditure (PCHE) in Mongolia from 1993 to 2018.

The VAR model allows for examining the impact of economic growth on health expenditure over time. In turn, variance decomposition and impulse response functions are used within the VAR framework to analyze the dynamic relationship between the variables and evaluate the effects of disturbances or changes in GDPpc on PCHE.

That said, this article will address the implementation of Vector Autoregressive (VAR) Models by including the relationship between GDP and life expectancy (an a priori variable of health) for the case of the department of Huila in the period from 2006 to 2023. The data to be used are based on official statistics from the National Administrative Department of Statistics. This study is developed using a quantitative approach with a descriptive scope.

VAR models are applied based on the simultaneous relationship between variables and consist of establishing multiple models with the implementation of lags to evaluate the relationships between variables.

The Vector Autoregressive (VAR) Model can be mathematically expressed as follows:

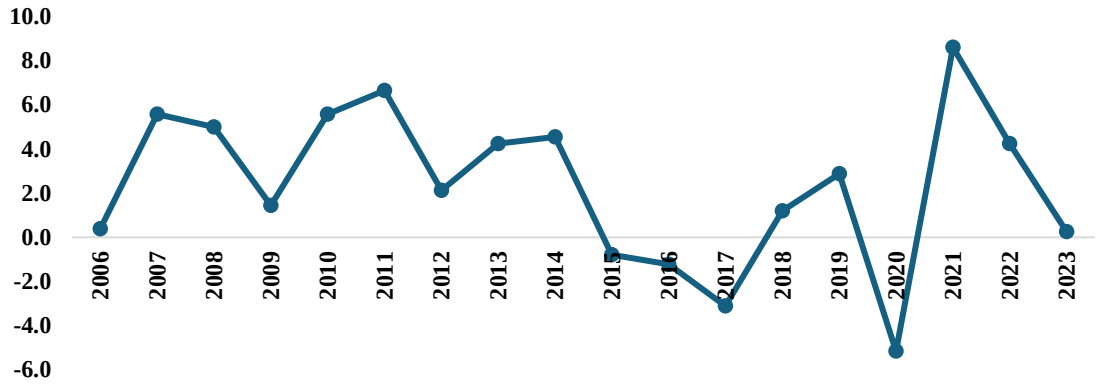
$VA(Y)$: $Yt = A_1Y_{t-1} + A_2Y_{t-2} + \cdots + ApY_{t-p} + et$

Where q is the maximum number of lags, c represents the constant variables of the model, Yt is a vector of the endogenous variables (N), A is the regression coefficients in matrix form (N×N), and it is the white noise error term with a covariance matrix E(utu't) = ψ Lopreite & Zhu (2020).

Data And Results

As mentioned earlier, for the estimations of the vector autoregressive (VAR) model, data from the National Administrative Department of Statistics (DANE) are used. This includes annual data on GDP variation for the department of Huila and the total life expectancy for the same territory during the period from 2006 to 2023. Regarding the Gross Domestic Product of the department, fluctuations are observed throughout the series, with the highest points in the years 2011 and 2021, showing growth above 6 percentage points. The lowest growth rates were recorded in the years 2017 and 2020; it is also important to mention that the years 2015 and 2016 also presented negative results.

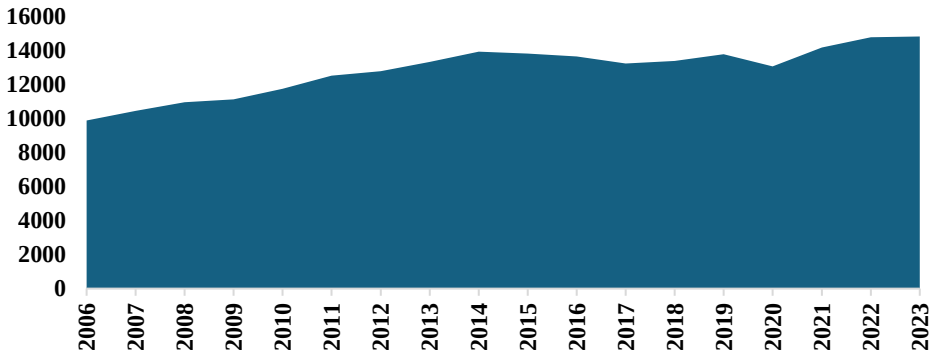
Figure 1 Evolution of GDP for the Department of Huila



Source: Own elaboration based on DANE

Next, Figure 2 illustrates the evolution of the departmental Gross Domestic Product in billions of pesos, where it is possible to observe that the series shows an upward trend.

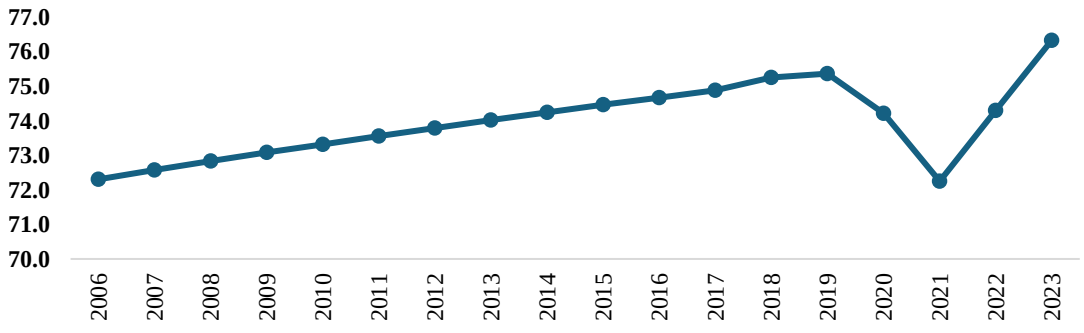
Figure 2 Evolution of GDP for the department of Huila in billions



Source: Own elaboration based on DANE

Subsequently, regarding life expectancy, it is evident that for the department of Huila, there were gradual increases from the base year 2006 to 2019, with declines in the years 2020 and 2021—declines explained by the COVID-19 pandemic that affected the world. By 2023, life expectancy surpassed pre-pandemic levels and became the highest value in the series.

Figure 3 Life expectancy for the department of Huila



Source: Own elaboration based on DANE

VAR MODEL RESULTS

For the estimation of the vector autoregressive (VAR) model, the steps suggested by the literature are followed. Initially, it is analyzed whether the variables are stationary or exhibit trends. For this purpose, autocorrelogram and partial autocorrelogram tests are used, as well as the Dickey-Fuller tests presented below. In the case of GDP, it is observed that the series presents a p-value of 0.40, which suggests the presence of a trend. To correct this, the variable is smoothed through the process of taking the logarithm and differencing the logarithm of the variable to achieve stationarity.

Table 1. Dickey-Fuller test for GDP

		Dickey-Fuller		
	Test	critical value		
	statistic	1%	5%	10%
Z(t)	-1.756	-3.750	-3.000	-2.634
MacKinnon's approximate p-value for Z(t) = 0.4024.				

Source: Own elaboration

Secondly, for the life expectancy variable, the same statistical tests described in the previous paragraph and used for the Gross Domestic Product variable are performed. This is because, when conducting the Dickey-Fuller test, a p-value of 0.53 is observed, which suggests that the series exhibits a trend.

Table 2. Dickey-Fuller test for Life Expectancy

		Dickey-Fuller		
	Test	critical value		
	statistic	1%	5%	10%
Z(t)	-1.492	-3.750	-3.000	-2.634
MacKinnon's approximate p-value for Z(t) = 0.5372.				

Source: Own elaboration

Once the stationarity of the variables to be used in the model has been adjusted, we proceed to specify the optimal number of lags to use. For this purpose, the HQIC and SBIC selection criteria are employed. However, although these criteria indicated a certain number of lags, these had to be adjusted due to the stability of the model even with stationarity in the variables.

Subsequently, a Granger causality test is conducted. As described by Vera & Kristjanpoller (2021), this is a statistical test used to determine whether one time series can predict or explain another. In a stricter sense, it can be understood as whether past values of a variable called X contain information that helps predict the values of another variable called Y. In this context, the Granger test supports a unidirectional causality where past values of GDP would explain future values of life expectancy, within a 95% confidence interval, as described in Table 3.

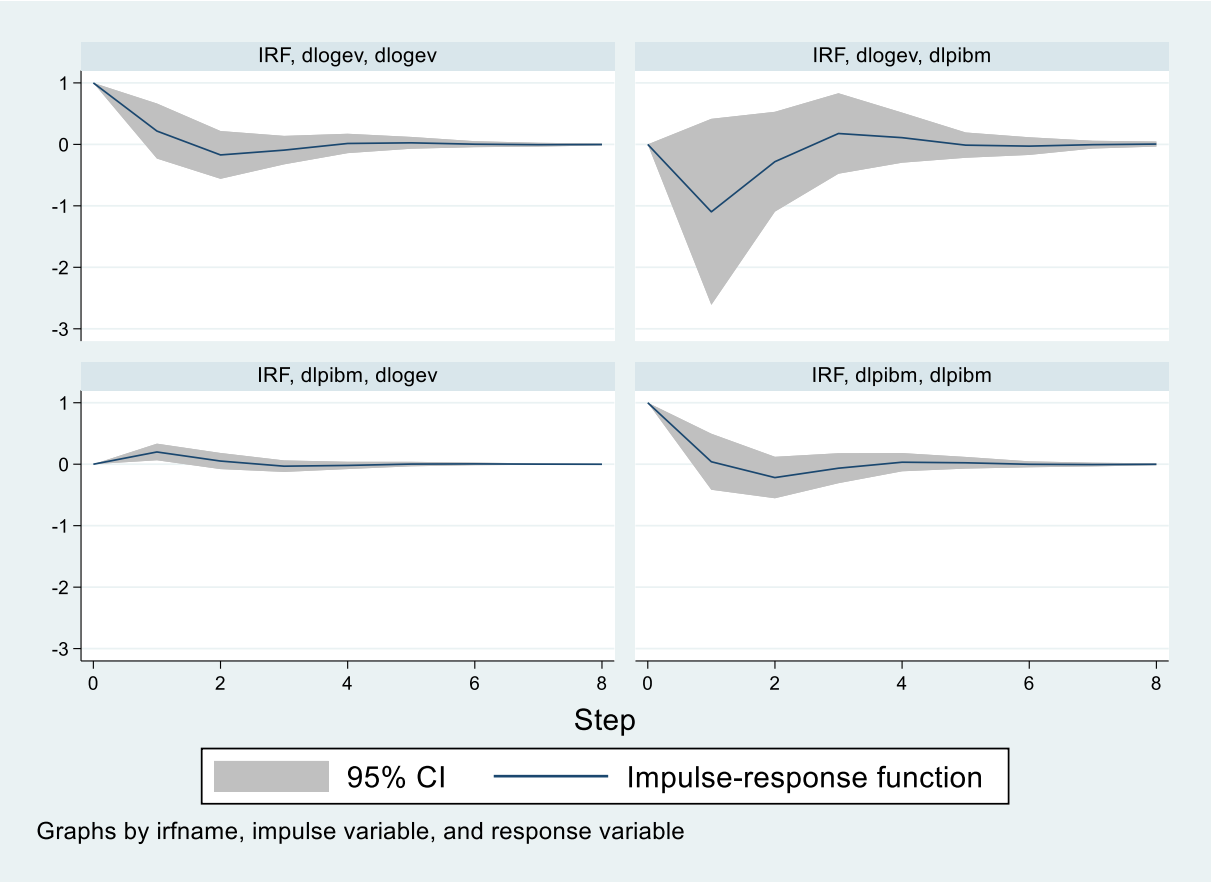
Table 3. Granger causality test

Equation	Excluded	chi2	df	Prob > chi2
Dlpibm	dlogev	.36393	1	0.546
Dlpibm	ALL	.36393	1	0.546
Dlogev	dlpibm	84.629	1	0.004
Dlogev	ALL	84.629	1	0.004

Source: Own elaboration

Finally, graph or illustration 4 shows the impulse response functions of the variables over eight periods. In these, it can be observed that the shock to the life expectancy variable is negative in the first period, positive in period 3, and proceeds to normalize in the following periods, which presupposes a medium-term impact. In turn, the shock of GDP on life expectancy in the department is positive in the first period and decreases until it normalizes by the fourth period; this indicates that its impact generally occurs in the short term.

Figure 4 Impulse response functions



Source: Own elaboration

Conclusions

Hence, this study found a close link between Gross Domestic Product and life expectancy in the department of Huila. Through the adoption of the VAR model, it could be shown that, in the short run and the medium term, positive impacts of economic growth were reflected in life expectancy, and that improvements in health could increase Gross Domestic Product. This finding supports studies observed in other parts of the world, such as Mongolia and Pakistan, where the relationship between these variables seems not to be exclusive to Huila, but rather to be responding to a global pattern.

Following this, one can say that public policies specifically focused on health investments would not only improve the quality of life of the people but also be a means of boosting economic growth. Thus, the extra effort has to extend to key areas, like ensuring everyone has equal access to health services, especially in disadvantaged communities, which probably just act as a multiplier of regional socio-economic welfare.

Not only that but the observed effects in both the short and medium terms could be prolonged if investment in health and education is sustained. The latter would increase productivity in a more sustained manner and enhance the quality of human capital, which would translate to more solid and sustainable economic growth.

The study not only reinforces the results of international research but also offers an opportunity for comparisons and possibly the adaptation of policies that have been effective in different regions. From this perspective, it follows that Huila can greatly benefit from international experiences that have already proven to be efficient in the concomitant improvement of public health and economic growth. This, therefore, opened future studies into how other factors, including education and access to technology, could influence the relationship.

Lastly, there should be an emphasis put in place that this analysis should be taken as a first step for more comprehensive studies in the region. The relation between GDP and health is rather intricate; therefore, it requires constant monitoring to zoom in on new variables that may have some influence on this dynamic and, therefore, design more comprehensive and effective public policies in the future.

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