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Original article

Effect of the variation in production on unemployment in Ecuador based on Okun's Law

Efecto de la variación de la producción en el desempleo del Ecuador basado en la Ley de Okun

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Abstract

Variation in production and unemployment are key macroeconomic indicators for the economic development of an economy and are inversely related. For this reason, the Ecuadorian state periodically evaluates these indicators in an effort to improve the economic and social conditions of the population. This study aims to analyze the effect of production variation on unemployment in Ecuador, as it is important to understand how productive and quality jobs can be created, improve people's well-being, and contribute to economic and social development. In this context, using annual time series data from the year 2000 to 2022, an econometric analysis is proposed through a simple linear regression model, applying Okun's Law. Additionally, a univariate regression model is employed to predict Ecuador's economic growth for the year 2025. The results obtained adhere to the literature and show an inverse relationship between the variables under study; that is, a one-percentage-point increase in production variation reduces the unemployment rate by approximately 0.16 percentage points. Similarly, the projection result indicates that, by 2025, the Ecuadorian economy will grow by an average of 3.6%. In conclusion, the findings suggest that using Okun's Law methodology provides relevant information to examine the dynamics and relationship between the labor market and economic growth.

Key words: Economic Growth, Unemployment, Okun's Law, ARMA Model, Ecuador.

Resumen

La variación de la producción y el desempleo son indicadores macroeconómicos clave para el desarrollo económico de una economía que están inversamente relacionados, por tal razón el Estado ecuatoriano evalúa periódicamente estos indicadores en un esfuerzo por mejorar las condiciones económicas y sociales de la población. En este sentido, este estudio tiene como objetivo analizar el efecto que genera la variación de la producción en el desempleo del Ecuador, debido a que, es importante para entender cómo se pueden crear empleos productivos y de calidad, mejorar el bienestar de las personas y contribuir al desarrollo económico y social. En este contexto, utilizando datos de series temporales con periodicidad anual comprendido desde el año 2000 al 2022; se propone un análisis econométrico, mediante un modelo de regresión lineal simple, aplicando la Ley de Okun, asimismo, se emplea un modelo de regresión univariante para realizar la predicción del crecimiento económico del Ecuador para el año 2025. Los resultados obtenidos se apegan a la literatura y muestran una relación inversa entre las variables en estudio; es decir, el incremento de un punto porcentual en la variación de la producción reduce la tasa de desempleo en 0,16 puntos porcentuales aproximadamente. Del mismo modo, el resultado obtenido acerca de la proyección fue que, para el año 2025 la economía ecuatoriana crecerá en promedio 3,6%. A modo de conclusión, los hallazgos implican que el uso de la metodología de la Ley de Okun proporciona información pertinente para examinar la dinámica y la relación entre el mercado laboral y el crecimiento económico.

Palabras clave: crecimiento económico, desempleo, Ley de Okun, modelo ARMA, Ecuador.

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INTRODUCTION

The labor market is intrinsically linked to the country's economic expansion, not only improving national productivity but also having important economic implications, especially in its interaction with the labor market. In the context of this research, Gross Domestic Product (GDP) will be used as the main variable to measure the variation in production. According to Miranda & Amaguaña (2022), real GDP, or GDP at constant prices, refers to the total value of all goods and services produced during a year, expressed in terms of the prices of a base period, thus providing a more stable and comparable estimate of economic growth.

In this context, Arthur Okun's theory, proposed in 1962, establishes a direct relationship between economic growth and unemployment, which marked a turning point in the study of economics, generating a deep interest in understanding the dynamics between these two variables. Fluctuations in GDP, whether growth or decline, pose significant economic and social dilemmas. A decline in labor market activity not only reflects the inability of an economy to generate adequate employment but also limits employment opportunities for a large part of the population, thus reducing their ability to purchase goods and services, which represents both a serious economic and social problem (Miranda & Amaguaña, 2022).

Unemployment, defined as the situation in which individuals of working age who are actively seeking employment are unable to find a suitable job, is a critical indicator of a country's economic well-being. It is measured through the unemployment rate, which represents a percentage of the economically active population (EAP) that includes all people willing and able to work. The study of the relationship between unemployment and economic growth has been extensive. It reveals that, globally, unemployment figures showed a notable reduction in 2022, reaching 205 million, down from 235 million in 2020, although still 13 million above 2019 levels. However, by 2023, a slight increase in global unemployment is anticipated, a reflection of diverse country-specific conditions despite an unfavorable global economic environment (International Labour Organization, 2023).

In Latin America and the Caribbean, the unemployment rate has shown a decreasing trend, from 8% in 2019 to 7% in 2022, with projections pointing to a reduction to 6.7% in 2023, according to data from the International Labor Organization (2023). This scenario suggests a direct correlation between employment and economic growth, where, as noted by Miranda Amaguaña (2022), an increase in GDP usually correlates with an increase in employment. This phenomenon has also been observed in Ecuador, where the variation of real GDP and the employment rate have shown trend similarities in both periods of increase and decrease.

In 2022, Ecuador experienced a GDP variation of 2.9% and an employment rate of 63.1%, showing a recovery from -7.8% of GDP and an employment rate of 52.8% in 2020. This analysis demonstrates the close relationship between economic growth and the capacity of an economy to generate employment, highlighting the importance of studying these dynamics not only to understand the labor market and its implications for public policies but also to address the social and economic cost of unemployment. Thus, the government and various institutions implement policies and programs focused on stimulating economic growth and combating unemployment, underscoring the relevance of this research in the formulation of effective strategies to improve both output and employment in the Ecuadorian context.

Economic theories on economic growth and unemployment

Okun's Law, one of the first methodologies to establish a relationship between economic growth and unemployment, has demonstrated in several countries an inverse connection between these two variables. According to Okun's original analysis (1962), a 1% change in the unemployment rate is associated with an approximate 3% change in economic growth.

Two main types of unemployment can be identified and classified according to their causes and characteristics:

- Open unemployment: Refers to persons who were not employed during the previous week, who looked for work, and who took specific actions in the four weeks prior to the interview to find work or start a business (National Institute of Statistics and Census, 2022).

- Closed unemployment: This includes those who were employed the previous week but did not look for work or take specific actions to find work or start a business in the previous four weeks. Reasons for this situation include part-time or casual work, waiting to start a job immediately, waiting for a response from an employer or own efforts to secure employment, waiting for a harvest or a specific work season, or discouragement after a period of unsuccessful job search (Instituto Nacional de Estadística y Censo, 2022).

Okun's Law, which describes the interaction between economic growth and the unemployment rate, pays tribute to the American economist Arthur Okun, who developed a model initially applied to the U.S. economy. This model aimed to predict how variations in Gross Domestic Product (GDP) affect unemployment rates, thus demonstrating the negative impact that the wastage of the labor factor has on total production, which translates into a loss of effective productive capacity (Mankiw, 2020).

This empirical link, known as Okun's Law, has been observed in numerous developed economies. However, the particularity is that the coefficients vary; that is, the specific impact differs from one country to another (Merchán & Freire, 2019). The basis of this Law is supported by three economic specifications that facilitate the estimation of the β coefficient, which quantifies the relationship between the unemployment rate and the rate of output growth (Merchán & Freire, 2019).

First differences method

It is a linear method that relates the absolute variable of the unemployment rate to the change in GDP.

$$\Delta U_t = \beta_1 + \beta_2 \hat{Y}_t + \varepsilon_t$$

Where:

ΔU_t = Absolute change in unemployment rate.

$\hat{Y}_t$ = GDP percentage change rate.

In this equation the parameter β_2 measures the increase in the unemployment rate with a decrease in GDP growth.

Gap test method

$$U_t = \beta_1 + \beta_2 \hat{Y}_t^B + \varepsilon_t$$

Where:

U_t = Unemployment rate

$\hat{Y}_t^B$ = Production gap

The gap is the relative difference between the trend value of GDP and the observed value of PIB. The estimated parameter β_2 shows the percentage of lost output caused by an increase in the unemployment rate. On the other hand, an estimate of the full employment unemployment rate is allowed by the parameter β_1 in the case of keeping all other variables constant.

$$\text{Gap} = \frac{\text{GDPtrending - GDP}}{\text{GDPtrending}}$$

Trend and elasticity adjustment method

This method directly derives Okun's coefficient by means of a constant elasticity between potential and actual output. In addition, the method proposes the existence of a constant growth in potential output.

$$\ln E_t = \beta_1 + \beta_2 \ln Y_t + \varepsilon_t$$

Where:

$E_t = (100\text{-}U_t)$

Y_t = Product observed

Keynes: aggregate demand theory

Keynes' references focus on the interaction between the total demand of the economy and its supply (production capacity). He stresses that when effective demand is lower than supply, unemployment is generated, which can trigger an economic depression. Keynes argues that, in an equilibrium state, the level of employment is determined by the overall supply function, the propensity to consume, and the volume of investment; these elements constitute the essence of his general theory of employment (Keynes, 1945). This approach stresses the importance of effective demand as the driving force of employment and production, integrating Keynesian theory as a fundamental pillar in the analysis of economic and labor dynamics.

$$DA = C + I + G + (X - M)$$

Where:

DA = Aggregate demand

C = consumption

I = investment

G = public spending

X = exports

M = imports

The Cobb-Douglas function and factorial participations

The Cobb-Douglas production function, with its neoclassical approach, provides a framework for evaluating a country's production function. This model then allows the expected economic growth of a nation to be projected. According to Briones *et al.* (2018), the Cobb-Douglas production function is an essential tool in economics to understand how different factors, such as labor and capital, contribute to the productive process and, therefore, to economic growth. This approach not only facilitates the estimation of the efficiency of these factors in production but also helps to design more effective economic policies to foster sustainable economic development.

$$Y = Ak^{a} L^{\beta}$$

Where:

Y = Production

A = Technological progress (exogenous), also called Total Factor Productivity (TFP)

K = Capital stock

L = Number of employees

α y β = parameters representing the weight of factors (K and L) in income.

The parameters vary between 0 and 1.

The Cobb-Douglas production function approaches economic growth from a perspective that emphasizes the importance of the positive relationship between capital and labor. This model uses the ordinary least squares method for empirical analysis, allowing a detailed understanding of how these factors interact to influence production. According to Biesuz (2014), the distinguishing feature of the Cobb-Douglas production function is its ability to show an elasticity of output in relation to capital and labor that remains more or less constant over time.

Within the framework of this research, the main objective was to analyze the impact of variations in production on unemployment in Ecuador during the period from 2000 to 2022, based on Okun's Law. This law is fundamental since, by understanding the consequences of unemployment, public authorities could exercise greater control and influence to measure and evaluate the future impact on the country's economic growth.

To this end, it is proposed as a general hypothesis that production exerts a statistically significant effect on unemployment, impacting it positively. At the same time, a specific hypothesis is proposed that predicts that Ecuador's Gross Domestic Product (GDP) will experience an average growth of 2.7% by the year 2025. The verification of these hypotheses would not only confirm the validity of Okun's Law in the Ecuadorian context but also provide valuable information for the formulation of more effective economic and labor policies.

METHODOLOGY

Approach, design and scope of the research

This research adopted a quantitative approach to evaluate, through statistical methods, the objectives arising from the identified problem. Hernández Mendoza (2018) defines the quantitative method as one that seeks to describe, explain, and predict the phenomena under investigation, identifying regularities and causal relationships between variables. In accordance with this approach, the study was designed under a non-experimental modality; that is, variables were not manipulated to observe their effects on others; rather, observations were collected and analyzed as they occurred in their natural context, as highlighted by Hernández & Mendoza (2018).

Given that the data collected corresponded to a time series, the design adopted was longitudinal. This implies, as Hernández & Mendoza (2018) point out, that longitudinal studies collect data at different times to infer the evolution of the problem or phenomenon under investigation, its causes, and effects. Therefore, this approach allowed a detailed analysis of the development of the study phenomenon over time.

The scope of this study was classified as descriptive and explanatory. It was descriptive in the sense that it detailed the trend and properties of the study variable, as well as its association with other variables. Likewise, it was explanatory in that it delved into the causes of the phenomenon in question, which implied an evaluation and quantification of the effect of the selected independent variables on the dependent variable. This underlines the objective of deeply understanding the dynamics governing unemployment and its relationship with the variation of production in Ecuador, in accordance with the methodological and theoretical guidelines pointed out by Hernández & Mendoza (2018).

Population

For this research, the study population focused on Ecuador, analyzing annual data related to both the unemployment rate and Gross Domestic Product (GDP). This approach allowed us to evaluate the variations and trends of these crucial variables for the Ecuadorian economy over time, providing a solid basis for understanding the dynamics between economic growth and employment in the specific context of the country.

Data collection technique

The data used in this study come from secondary sources, specifically collected from the websites of the National Institute of Statistics and Census (INEC) and the World Bank. The period of analysis spans from 2000 to 2022, with annual periodicity data, which characterizes these data as a time series. This collection methodology allowed for an exhaustive documentary analysis, facilitating the accumulation of prior knowledge relevant to the study. This approach ensures a reliable and representative database to examine the trends and effects of unemployment and GDP in Ecuador during the specified period.

Econometric methodology

The simple linear regression model is presented as an essential starting point in the field of applied econometrics, as Wooldridge (2010) explains. This analysis is based on the relationship between two variables, identified as y and x, representing some population. The interest lies in "explaining y in terms of x" or in "studying how and when x changes." Simplicity in both its algebraic structure and interpretations makes simple linear regression a valuable tool occasionally, functioning as an introductory starting point. However, its application in applied econometrics is limited since economic phenomena often require a more complex analysis involving multiple variables for a proper understanding of the relationships and dynamics under study.

Model specification

This study focused on examining the relationship between the unemployment rate and economic growth in Ecuador, using econometric estimation based on Okun's Law. In order to achieve this objective, the first different method was applied.

$$\Delta U_t = \beta_1 + \beta_2 Y^t + \varepsilon_t$$

Where:

ΔU_t = Absolute change in unemployment rate.

Y^t = PIB percentage change rate.

Specification of the econometric model

In order to evaluate the impact of the independent variable on the dependent variable, a simple linear regression model was estimated. This approach is based on the selection of coefficients 1b1 and 2b2 as the best estimators of 1B1 and 2B2, respectively, so that the residuals resulting from the model are the smallest possible. As Gujarati Porter (2010) points out, the optimal criterion for estimating the Population Regression Function (PRF) involves minimizing the sum of squared residuals (SRC). This method ensures that the regression model fits the observed data as accurately as possible, allowing a reliable interpretation of how variation in the independent variable affects the dependent variable.

To determine the simple linear regression model, this paper proceeds by specifying the regression equation of the econometric model:

$$Y = \beta_0 + \beta_1 X_1 + \mu$$

Where:

Y : independent or explained variable.

X_1 : independent or explanatory variable.

β_1 : parameter that quantifies the relationship between the explained variable and the explanatory variable.

μ : disturbance or error term.

The model is as follows:

$$tunemployment = \beta_0 + \beta_1(PIB) + \mu$$

Where:

tunemployment: unemployment rate.

GDP: economic growth.

μ: disturbance or error term.

Table 1
Description of the variables in the multiple linear regression model

Type of variable	Variable name	Description	Unit of measure	Source	Expected sign
Dependent	Unemployment rate (tdesemple)	The proportion of the Economically Active Population (EAP) that is not employed..	Percentage	National Institute of Statistics and Census and the World Bank	
Independent	Economic growth (GDP)	Shows the value of gross domestic product at constant prices.	Percentage	World Bank	Positive

Likewise, the table below shows the data on which the corresponding econometric model was developed. Twenty-two observations are specified for each variable included in the model, covering a study period of the last thirty-two years.

Table 2
Data on unemployment and economic growth

Period	Total unemployment	GDP growth	Period	Total unemployment	GDP growth
2000	4,8	1,09	2012	3,23	5,64
2001	4,25	4,02	2013	3,08	4,95
2002	4,9	4,1	2014	3,48	3,79
2003	5,66	2,72	2015	3,62	0,1
2004	5	8,21	2016	4,6	-1,23
2005	3,78	5,29	2017	3,84	2,37
2006	3,55	4,4	2018	3,53	1,29
2007	3,14	2,19	2019	3,81	0,01
2008	3,92	6,36	2020	6,11	-7,79

2009	4,61	0,57	2021	4,5	4,24
2010	4,09	3,53	2022	4,4	2,9
2011	3,46	7,87			

Fuente: (INEC; Banco Mundial)

Estimation of the econometric model

For the estimation of the model in this study, the ordinary least squares (OLS) method was used through the statistical program Stata since this method focuses on minimizing the sum of the squares of the residuals, where the residual is defined as the difference between the observed data and the values estimated by the model (Hanke & Wichern, 2010). This approach allows for the accurate and reliable estimation of the model parameters.

Gujarati Porter (2010) highlights several important statistical properties of OLS estimators: 1) The estimators are based exclusively on the observable quantities of X and Y, which facilitates their calculation and interpretation. 2) Each estimator produces a single value for the population parameter, behaving as a point estimator. 3) The sample regression line is derived directly from the OLS estimators, guaranteeing an objective and well-founded approximation of the relationship between the variables.

To analyze the data and validate the assumptions underlying the model, such as specification bias, non-multicollinearity, homoscedasticity, normality, and non-autocorrelation, the Eviews and Stata software packages were used. Zidong Ciminelli (2021) stresses the importance of these programs in modern econometrics for their ability to facilitate the estimation, interpretation, and assumption checking of econometric models, thus ensuring the validity and reliability of the results obtained.

Model validation

All model assumptions were validated by applying the following techniques: Overall significance was validated through the F-test, and individual significance through the p-value and the t-student statistic, considering a significance level of 5%. Likewise, the same level of statistical significance was used to validate the model assumptions (Porras & Román, 2023).

The stationarity of the variables was evaluated using the Augmented Dickey-Fuller test. Then, in Stata, the regression was run, and the model was checked for correct specifications using the Ramsey RESET test. Subsequently, to validate the assumption of non-multicollinearity, the Variance Inflation Factor (VIF) test was used.

Homoscedasticity was verified using the Breusch-Pagan, White, Park, and Glejser tests. To evaluate the normality of the residuals, the Kernel density plot and the frequency histogram were used, complemented with formal tests such as skewness and kurtosis, Shapiro-Wilk, and Shapiro-French. Autocorrelation was examined using the Breusch-Godfrey test, the Durbin test, the Jarque-Bera test, and the Durbin-Watson test. In addition, the AR(1) model was validated for economic growth projections for the year 2025 (Porras & Román, 2023).

For growth projections in future years, the Box and Jenkins methodology was used and applied to the analysis and prediction of univariate time series. Fournies & Villalobos (2013) argue that starting from a time series Xt, the Autoregressive model represents a valuable tool for understanding and forecasting the future values of the series.

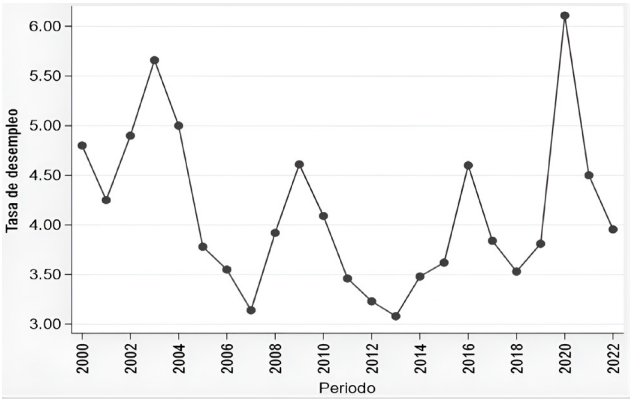
Eyassu (2022) describes the ARMA model as a structure composed of two key elements: an autoregressive (AR) part and a moving average (MA) part. This model is denoted as ARMA(p,q), where p is the order of the autoregressive part and q is the order of the moving average part. Thus, the ARMA model is presented as a more versatile and powerful tool compared to previous methodologies, as it integrates both methods for time series forecasting. This hybrid approach sometimes allows for adjusting time series predictions more accurately. It is applicable to a wider range of series by combining AR(p) and MA(q) forecasting techniques (Fournies & Villalobos, 2013).

The Box-Jenkins methodology, on the other hand, is articulated in four fundamental phases: identification, estimation, validation, and forecasting. The identification phase is carried out by observing the chronology of the series and the correlograms, which made it possible to determine the AR(1) process in this study. Model estimation was performed using the ordinary least squares (OLS) method. For validation, the significance of the model and the correlogram of the process were examined, and the presence of white noise was evaluated. The Inverse Roots were used to discern whether the estimated process can be considered an adequate model. These steps facilitated the elaboration of the final forecast.

RESULTS AND DISCUSSION

Based on the literature review and the data collected, the results obtained in the research are presented, aimed at fulfilling the first specific objective: to identify the behavior of the variation in production and unemployment throughout the study period. This analysis allows us to know the most relevant events that have occurred during that period, shedding light on how these economic phenomena have been interrelated and have affected the economy in general. Pehlivanoglu Tanga (2016) emphasizes the importance of this approach to understanding the underlying economic dynamics and their implications in the field of employment and national production.

Figure 1.
Unemployment rate of Ecuador during the period 2000 – 2022



Source: (National Institute of Statistics and Census, 2022).

Figure 1 presents the behavior of unemployment in Ecuador between 2000 and 2022, showing a trajectory marked by instabilities, with pronounced peaks and valleys and a slight downward trend throughout the period. The post-dollarization stage evidenced remarkable volatility: unemployment, which in 2000 was 4.8%, increased to 5.6% in two subsequent periods. Arellano Estrada (2019) attributes the increase in unemployment in 2003, in part, to the repercussions of the 1999 banking crisis and the adoption of dollarization in 2000.

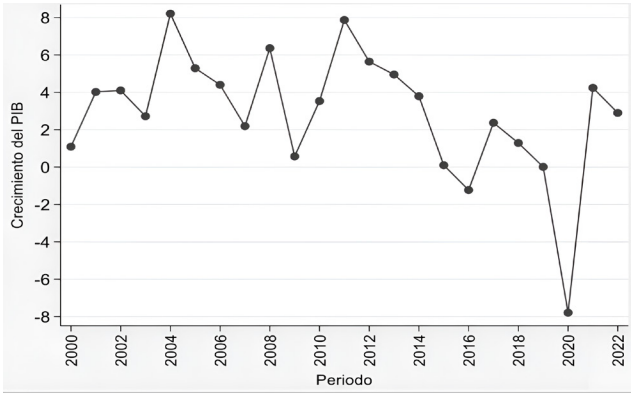
Under Rafael Correa's presidency in 2007, the unemployment rate dropped to 3.1%, driven by policies such as the elimination of hourly contracting and labor intermediation (outsourcing), according to Troya Bastidas (2020). This decrease is the result of an interaction of economic and political factors, reinforced in 2008 with Constitutional Mandate No. 8, which outlawed flexible hiring practices.

2013 also recorded an unemployment rate of 3.1%, reflecting the positive impact of economic growth and political and social stability. However, in 2016, unemployment rose to 4.50% in the face of the financial challenges faced by the government stemming from falling oil prices. Responses to this situation included austerity measures that could have contributed to the rise in unemployment.

By 2018, a decrease in unemployment to 3.5% was observed, attributable to economic restructuring, fiscal adjustment, and the strengthening of the private sector as a generator of employment. Ramirez Campuzano (2021) notes that job creation programs, such as construction projects and hydroelectric innovation, played a crucial role in this decline.

Unemployment experienced an increase to 6.1% in 2020, exacerbated by the COVID-19 pandemic and the enactment of the "Humanitarian Support Law" by President Lenin Moreno, which contributed to job losses. Campoverde (2022) criticizes the Humanitarian Assistance Law for allowing precarious working conditions contrary to the principles of the Constitution, highlighting the importance of equitable and non-discriminatory labor relations.

Figure 2.
Ecuador's economic growth during the period 2000 -2022



(Central Bank of Ecuador)

The evolution of economic growth in Ecuador over the last 22 years is illustrated in Figure 2, showing a generally positive trend. At the beginning of this period, in 2000, coinciding with the implementation of dollarization, GDP growth was 2.3%. This change in economic policy marked a significant contrast with the negative growth of -4% experienced in 1999. The adoption of the U.S. dollar as the official currency not only symbolized the end of an era but also the beginning of a new one, under which initial economic growth was 1.1%. According to the Central Bank of Ecuador (2010), since that time, the country's economy has gained stability, benefiting from favorable external factors such as high oil prices, remittances, and important projects such as the construction of the Heavy Crude Oil Pipeline.

In 2004, the economy experienced significant growth of 8.2%, driven mainly by oil activity and higher oil prices. The Central Bank of Ecuador (2004) highlights that this growth was possible thanks to the increase in oil production by private companies.

The year 2016 was marked by an economic downturn attributed to the April earthquake and the fall in oil prices. The Telegraph (2017) notes that the combination of these factors, along with the strengthening of the dollar and certain legal issues, negatively affected economic activity.

During 2020, the economy suffered a 7.8% contraction in the wake of the COVID-19 pandemic, according to World Bank reports (2021). This decline marked the end of a year of zero growth in 2019, underscoring the challenges for economic recovery in the second half of the year.

To address the second specific objective of this research, which seeks to determine the effect of output variation on unemployment and verify the application of Okun's Law in Ecuador, a simple linear regression was performed using the ordinary least squares (OLS) method. After stationing the variables and validating the assumptions of specification bias, non-multicollinearity, homoscedasticity, normality, and non-autocorrelation, the econometric model was estimated. This estimation allowed us to evaluate the statistical significance and the magnitude of the impact of the independent variable on the dependent variable, providing crucial evidence for understanding how variation in production affects employment underscoring the importance of generating quality jobs to improve social welfare and contribute to economic development.

Table 3
Results of the econometric model estimation

Variables	D.tunemployment
GDP	-0.164***
	(0.0420)
Constant	0.451**
	(0.188)
Remarks	22
R-squared	0.433

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The econometric model revealed a predictive capacity of 43.30%, indicating that the independent variable explains 43.30% of the variation in the dependent variable. In comparison, the remaining 56.70% is attributed to factors exogenous to the model. At the individual significance level, both variables proved to be statistically significant at 5%.

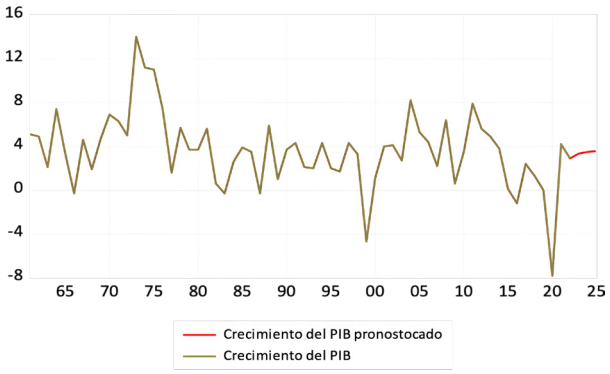
The results of the ordinary least squares (OLS) estimator corroborate an inverse relationship between economic growth and unemployment, suggesting that a one percentage point increase in economic growth is associated with a 0.16 percentage point reduction in the unemployment rate, on average. This finding contrasts with other studies, such as Maldonado et al. (2021),

which indicate a reduction in unemployment of 0.18 percentage points for each percentage point increase in real GDP. Similarly, Merchán Illescas (2019) found that a 1% increase in the variation of real GDP reduces the unemployment rate by 0.31% on average, and Miranda & Amaguaña (2022) reported a 0.18% decrease in unemployment for each percentage point increase in GDP, analyzing the period 2003-2019.

These differences in the magnitudes of impact may be due to the fact that each study considers different periods of analysis. However, they all agree that Okun's Law is verified in Ecuador, evidencing a direct relationship between GDP and unemployment, although they vary in the precision of the variation.

To address the third specific objective, regarding the projection of economic growth for the year 2025 and thus anticipate whether GDP will increase or decrease in that period, an Autoregressive model of order 1 (AR[1]) was estimated. Before proceeding with the projection, the assumptions of the model were validated by verifying the stationarity of the GDP growth variable, using data from 1961 to 2022. The application of the AR(1) model allowed an estimation based on the significance of the model at 5%. The stability of the model was confirmed by the AR/MA inverse roots criterion, ensuring that all points were within the unit circle, and the correlogram analysis indicated that all values were greater than 0.05, confirming that the residuals constitute white noise.

Figure 3.
Economic growth forecast for the year 2025.



(World Bank)

The economic growth projection for the year 2025, reflected in the graph, indicates an expected increase of approximately 3.6%. In contrast, the Central Bank of Ecuador's projections suggest that the long-term growth rate will average 1.7% during the five years from 2021 to 2025. This discrepancy is based on the different scenarios of public and private capital and investment projected to boost the economy in various sectors, as reported by the Central Bank of Ecuador in 2021. It is worth noting that these differences between the projections can be attributed to the variation in the study periods. At the same time, this research covers 22 years, and the Central Bank's estimates focus on five years.

Additionally, a subsequent ECB report (2022) notes that, for the three years 2023-2025, economic growth is anticipated to average 2.9% annually, driven largely by expectations of growth in the oil sector. Beyond this range, GDP growth rates of 2.8% and 3.0% are forecast for the years 2024 and 2025, respectively. These projections suggest a sustained economic recovery and underscore the importance of the oil sector as an engine of growth for Ecuador in the medium term.

Contribution to knowledge

This study highlights the effective application of Okun's Law in the local context, highlighting a significant inverse relationship between these variables. It reveals how economic growth can catalyze improvements in the labor market, reflecting the interdependence between unemployment and the economy. External factors such as dollarization, natural disasters, and health crises have diverted the economy from its expected course, highlighting the need for flexible and resilient economic policies. These findings broaden the understanding of the economic forces at play, providing a solid basis for the formulation of strategies aimed at fostering inclusive growth and reducing unemployment.

Limitations

The study faced limitations inherent to econometric analysis, such as the availability and scope of historical data, which could influence the accuracy of future projections. The variability in exogenous events and their not fully quantifiable impact on the economy introduces uncertainties in the model. In addition, the analysis focused

on a specific time frame, which, although broad, does not encompass potential future structural changes in the Ecuadorian economy or the global environment. These limitations suggest the need for caution when interpreting the results and underscore the importance of continuous updating of the data and analysis.

CONCLUSIONS

The validation of Okun's Law in the Ecuadorian context, derived from this research, confirms a significant inverse relationship between output variation and the unemployment rate. This dynamic underscores how economic growth directly affects the improvement of labor market conditions and, reciprocally, how unemployment affects the overall economy. On the other hand, exogenous factors such as dollarization, the 2016 earthquake, and the COVID-19 pandemic have marked turning points, altering Ecuador's economic trajectory and evidencing the country's vulnerability to external shocks. The relevance of developing mitigation and adaptability strategies in the face of future challenges becomes apparent, underscoring the importance of economic resilience for long-term stability and growth.

In addition, the projection of an average economic growth of 3.6% by 2025 reveals a trend toward recovery and robust growth potential based on the premise of strategic investments in key sectors and economic policies that promote public and private investment. It also highlights the need to adopt proactive and resilient economic policies that not only boost economic growth but also strengthen the country's capacity to overcome and recover from economic adversities. Such policies should encourage economic diversification, improve infrastructure, foster innovation and entrepreneurship, and promote social and labor inclusion.

Finally, this study identifies areas for future research, especially in the evaluation of specific policies and their effectiveness in fostering sustainable economic growth and reducing unemployment. It emphasizes the importance of continuing to monitor the interaction between output and unemployment through the application of Okun's Law, adjusting economic strategies to changing global realities. In conclusion, this analysis not only enriches the body of economic literature by confirming Okun's Law in Ecuador but also provides practical insights for policy formulation. By highlighting the interrelationship between economic growth and unemployment, it underscores the imperative of promoting inclusive and sustainable growth that benefits all of Ecuadorian society, thus setting the stage for a more prosperous and resilient future.

Recommendations

Given these findings and limitations, continued evaluation of economic and labor policy in Ecuador is recommended, with a focus on economic diversification and investment in human and physical capital to strengthen resilience to external shocks. Future research should explore the relationship between economic growth and unemployment with a focus on different economic sectors and demographics to develop more tailored and effective strategies. Also, the adoption of emerging technologies and innovative practices in economic management is encouraged to improve prediction and response to labor market trends.

Authors' contributions

Roger Tomás Yela Burgos: Conceptualization, Formal analysis, Research, Methodology, Project management, Supervision, Validation, Writing - original draft, Writing: review and editing.

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

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