Revista de la Facultad de Ciencias Económicas
ISSN: 1390-7492 e-ISSN: 2806-5980
Volumen 7 | Número 9 | 2025

LA LEY DE OKUN DURANTE LA PANDEMIA DEL COVID-19 EN EL ECUADOR: UN MODELO VAR DINÁMICO

International the Okun's law during the Covid-19 pandemic in Ecuador: a dynamic var model

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Resumen

Esta investigación tiene como objetivo evaluar la relación entre desempleo y crecimiento económico durante la crisis del COVID-19 en Ecuador de 2010 a 2022. Se puso a prueba la hipótesis de una relación inversa entre la varianza de la tasa de desempleo urbano y el crecimiento económico real (Ley de Okun) utilizando un Modelo dinámico de vectores autorregresivos (VAR). Los resultados muestran una causalidad de Granger bidireccional entre el desempleo y el crecimiento económico real, y una respuesta negativa del desempleo urbano a los shocks en el crecimiento económico durante el primer y segundo período. En resumen, los hallazgos de este estudio confirman la existencia de la Ley de Okun en Ecuador en el corto tiempo, sin ninguna ecuación de cointegración, que podría ser resultado del efecto negativo por la pandemia de COVID-19.

Palabras clave: Desempleo, Crecimiento Económico, Modelo de Vectores Autorregresivos.

Clasificación JEL: E24, 047, C01.

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Abstract

This research aims to assess the relationship between unemployment and economic growth during the COVID-19 crisis in Ecuador from 2010 to 2022. We test the hypotheses of an inverse relationship between the variance of urban unemployment rate and real economic growth (Okun's Law) using a Vector Autoregressive (VAR) dynamic model. The results show a bidirectional Granger causality between unemployment and real economic growth, and a negative response of urban unemployment from shocks in economic growth during the first and second periods. In summary, the findings of this study confirm the existence of Okun's Law in Ecuador in the short time, without any cointegration equation, that could be a result of the negative effect of the COVID-19 pandemic.

Keywords: Unemployment, Economic Growth, Vector Autoregressive Model.

JEL Classification: E24, 047, C01.

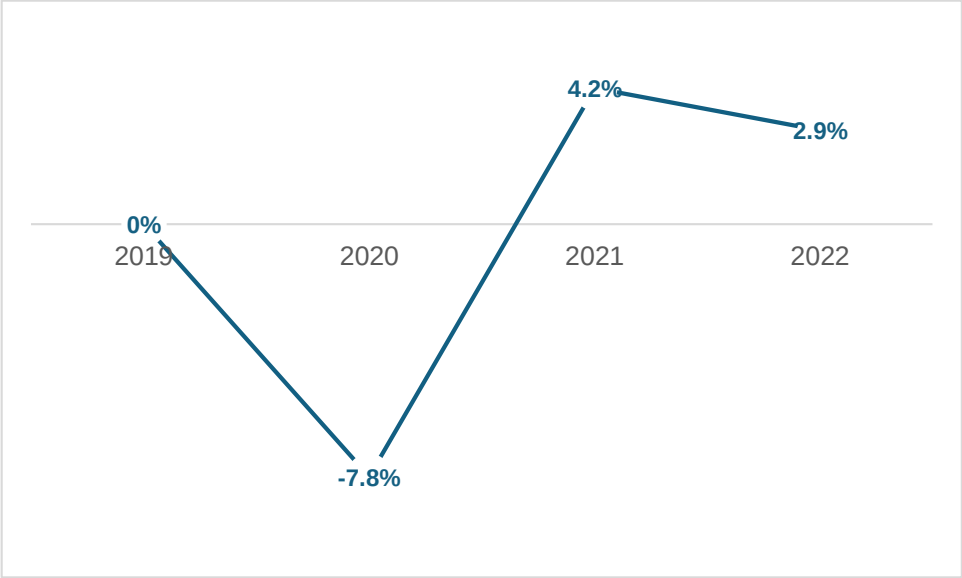
Fecha de recepción: enero 4, 2025.
Fecha de aceptación: junio 12 , 2025.

1. Introduction

Unemployment has become a key variable for the design of public policies in all countries since it is one of the variables on which the reputation and efficiency of government policies rest (Brown and Sessions, 1997; Garro and Rodríguez, 2002). The consequences of the COVID-19 pandemic showed the relevance of understanding the macroeconomic determinants of unemployment, mainly in Latin American countries.

Since 2019, Ecuador's real economic growth rate has been 0%. In 2020, the government implemented a strict lockdown to reduce the number of deaths and infections caused by COVID-19 during March and May, which severely impacted Ecuadorian economic growth (-7.8% of GDP). Since then, the GDP has recovered slowly, with an annual real rate from 2021 and 2022 of 4.2% and 2.9%, respectively (Figure 1).

Figure 1. Real Rate of Economic Growth in Ecuador, 2019-2022.



Note: Central Bank of Ecuador (BCE).

To evaluate the relationship between the unemployment rate and real GDP growth, it's recommended to use a Vector Autoregressive (VAR) model, which combines simultaneous equation models with time series. The variables are endogenous because the explanatory variables are the lags of the dependent variables. According to

Cuevas-Ahumada (2010), when there are no cointegration relationships, the starting point is the VAR model proposed by Sims (1980).

It is important to point out that this paper is distinguished from the current literature in the following aspects: 1) it is updated using the period 2010Q1-2022Q4; 2) it estimates a dynamic VAR model; 3) it tests Okun's Law from Ecuador.

This research is organized as follows: Section 2 provides a brief review of the specialized literature; Section 3 presents the data and its descriptive statistics; Section 4 details the methodology that this study uses; Section 5 discusses the empirical results; and, finally, Section 6 gives conclusions and a set of recommendations regarding public policies on underemployment and unemployment.

2. Brief literature review

Last century, the English economist William Phillips formulated and demonstrated that there is an inverse and non-linear relationship between unemployment and nominal wages; therefore, reducing unemployment leads to high inflation and vice versa (Phillips, 1958). A decade after Phillips presented his model, economist Arthur Okun (1962) established that effective Gross Domestic Product (GDP) decreases when the unemployment rate increases. In this sense, Okun explains that the effects of variations in unemployment tend to be proportionally smaller than variations in GDP (Garabiza et al., 2019).

The idea behind Okun's formulation is that as the stock of human resources employed increases, the production level increases, and the unemployment rate decreases, although not by the same amount as the employment rate increases, due to exchanges in the labor market between the unemployed and employed.

Arellano and Ayaviri (2021) studied the macroeconomic determinants of unemployment through a time series analysis from 2003 to 2018 with a vector error correction (VEC) model with which they calculated Granger causality relationships, impulse-response functions, and variance decomposition. According to their results, unemployment is determined by the following factors: the share of the manufacturing sector in GDP, the terms of trade index, capital accumulation, and economic growth.

The authors confirm a long-term equilibrium relationship between the determinants of unemployment and unemployment in Ecuador.

Mutascu and Sokic (2021) use wavelets to explain the movement of the cyclical components of unemployment and output in the United States. The authors find that GDP negatively drives unemployment when the US economy faces a domestic socioeconomic shock. On the contrary, when it is external, unemployment negatively influences production, even when compared with the first differences of the cyclical components of these variables (Aguiar-Conraria et al., 2020).

To contribute to the explanation of the relationship formulated by Okun for the United States, Karlsson and Österholm (2020) estimate a hybrid model of a bivariate Bayesian Vector Autoregressive. This analysis shows that the impulse response function is in line with the results expected: when a shock influences GDP growth, it causes an adverse change in the unemployment rate. Furthermore, they corroborate that this relationship is unstable over time due to the quantity and size of the shocks in the US economy between 1948 and 2019.

Some studies estimate the relationship at the country level and separate the regions of the United States. To do this, Guisinger et al. (2018) use unobserved components to rewrite the variables' cyclic components as autoregressive vectors. They confirm that, although there is a divergence between each state, in 47 of them, the theory maintains the relationship of Okun's Law.

From the study of the countries in the European zone, the cointegration coefficient is analyzed to know if Okun's Law is valid. Although it is quantified that, since the 2000s, the level of unemployment in this region is high compared to other developed countries, the panel data study by Altuñoz (2019) reveals that the Okun coefficient is lower than in the continent. In America, in the long term, for each increase in the unemployment rate, a real decrease in the production of 0.71% is expected, representing a percentage less than the 3% stipulated in Okun's Law.

Baah-Boateng's (2014) investigation into the macroeconomic and microeconomic determinants of unemployment in Ghana has significant implications. The study confirms an inverse relationship between unemployment and economic growth.

However, it also reveals that the decrease in unemployment is not inversely proportional to the increase in production because economic growth is driven by sectors that generate little employment (oil and mining). In contrast, the sectors that generate more employment (agriculture and manufacturing) experience low growth. These implications are crucial for policymakers and economists alike.

There is a long-term relationship between unemployment and growth for 23 countries of the Organization for Economic Cooperation and Development (Kargi, 2016). Even though there are differences in population and economic structure between countries, it is concluded that increasing economic growth is necessary to maintain (or even reduce) the unemployment rate. Other authors also confirm the validity of Okun's law using a different set of countries (Huang et al., 2020; Rahman and Mustafa, 2017).

Building on the previous studies, the research conducted by Garabiza et al. (2019) for the Ecuadorian economy provides valuable insights. Their study, which takes the period 1997-2016 as a reference, concludes that the model proposed by Okun best represents the reality of unemployment in Ecuador. The researchers estimate that unemployment is a function that relates to economic growth and inflation. The main result indicates that unemployment responds more to variations caused by a change in economic growth than to fluctuations in inflation. These findings open the door for further research in this area.

3. Nature of data and descriptive statistics

The data was collected from the Central Bank of Ecuador (BCE, by its acronym in Spanish) and the National Institute for Statistics and Census (INEC, by its acronym in Spanish). Table 1 presents the summary statistics of urban unemployment rate variation and real economic growth in Ecuador from 2010Q1 to 2022Q4. The mean of urban unemployment variation and economic growth were -0.04% and 0.45%, respectively, and the median were 1.15% and 0.75%.

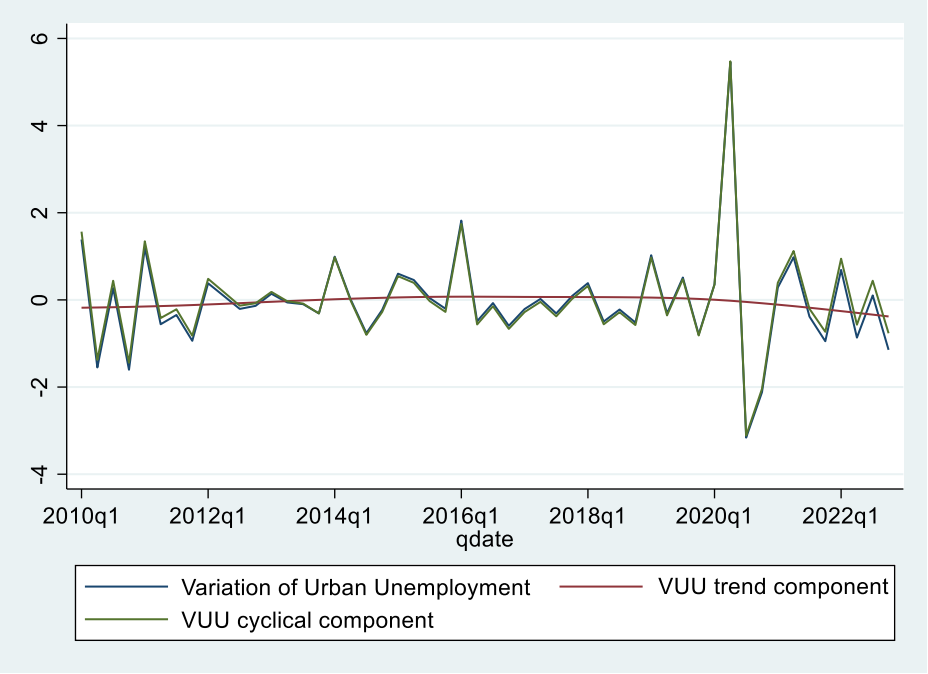
Table 1. Descriptive Statistics, from 2010 to 2022.

	Variation of Urban Unemployment	Real Economic Growth
Mean	-0.0447584	0.4559158
Std. dev.	1.154759	2.399227
Median	-0.1163931	0.7503667
Minimum	-3.16028	-12.1396
Maximum	5.457764	6.123177
Obs.	52	52

Note: Authors elaboration with Central Bank of Ecuador data.

During the second quarter of 2020 (2020Q2), the variation of the urban unemployment rate in Ecuador increased by 5.46%, and the real economic growth rate reached a minimum of 12.13%. Those results highlight the negative impact of the COVID-19 pandemic breakout in Ecuador, with strict lockdown policies. Figure 2 shows the cyclical and trend components of urban unemployment variation calculated with the Hodrick-Prescott (HP) filter, and it is possible to confirm no trend and non-constant.

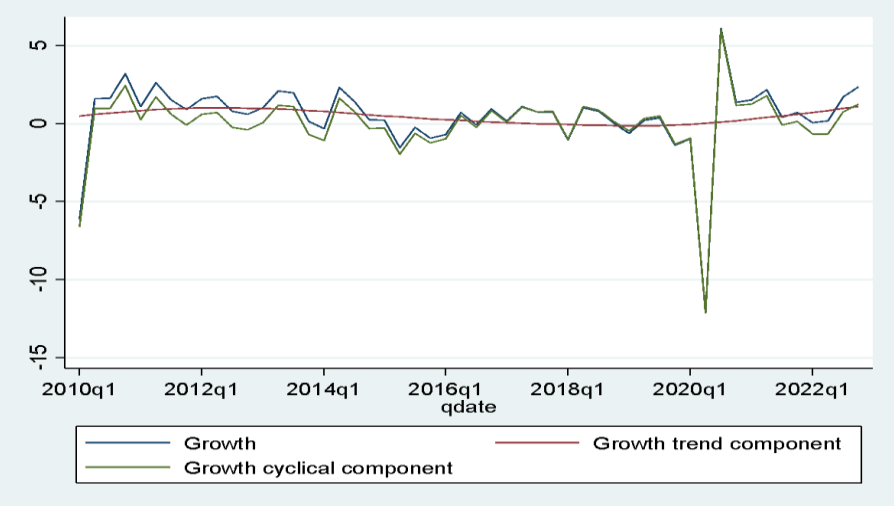
Figure 2. Urban unemployment rate in Ecuador, from 2010 to 2022.



Note: Authors elaboration using Stata 18 with INEC data.

Figure 3 describes the cycle and trend component of economic growth from Ecuador using the HP filter. In this variable, the gap is very small and even disappears during the COVID-19 pandemic crisis in 2020. This also confirms no trend and is non-constant for the data.

Figure 3. Economic Growth in Ecuador, from 2010Q1 to 2022Q4.



Note: Authors elaboration using Stata 18 with BCE data.

4. Econometric Methodology

4.1 VAR model

According to Blanchard (2017), Okun's law can be written as the change in unemployment that is approximately equal to the negative of the growth rate of output (g_Y), as follows:

$$u - u_{-1} \approx - g_Y$$

We estimate a VAR model to identify the relationship between urban unemployment and the real growth rate in Ecuador from 2010 to 2022. Using the specification of Cuevas-Ahumada (2010), the specification of the model is:

$$Y_t = A_0 + \sum_{t=1}^{p} A_t y_{t=i} + \varepsilon_t$$

Donde: Y_t, is a vector with $nx1$ variables in the period t; A_0, is a vector with $nx1$ constant terms

A_t, is a matrix of nx coefficients associated with lag i of variables Y; p, is the maximum number of lags; ε_t, is a vector of $nx1$ shocks of white noise; n, is the number of variables in vector Y. And, finally, the VAR model considers the Variation of urban unemployment (VUU) rate and the real rate of economic growth ($Growth$), and a dummy for the COVID-19 pandemic as follows:

$$Y = (VUU, Growth, Covid19)$$

Table 2 presents the results to the unit root, and both variables reject the null hypothesis in levels. We use the Augmented Dickey-Fuller (ADF, 1979) and the Phillip Perron (PP, 1998) to test the unit root hypothesis. The Hamilton procedure was used to choose the constant and trend, according to the nature of the data (1998).

Table 2. Unit Root Tests.

Augmented Dickey–Fuller (ADF)				
	t	**1%**	**5%**	**10%**
Var Unemployment	-9.378*	-3.579	-2.929	-2.600
Growth	-8.330*	-3.579	-2.929	-2.600
Phillip Perron (PP)				
	t	**1%**	**5%**	**10%**
Var Unemployment	-10.852*	-3.579	-2.929	-2.600
Growth	-8.245*	-3.579	-2.929	-2.600

Note: Authors elaboration. *The null hypothesis is rejected at 1% of statistical significance

Table 3 confirms that this model's optimal number of lags is p=4. Then, we consider the first, second, third and fourth lags of VUU and Growth as dependent variables of the model.

Table 3. Number of lags.

Lag	**LL**	**LR**	**df**	**p**	**FPE**	**AIC**	**HQIC**	**SBIC**
0	-156.178				0.175504	6.77352	6.81796	6.89161
1	-133.987	44.382	9	0.000	0.100239	6.2122	6.38996	6.68458
2	-101.034	65.905	9	0.000	0.03637	5.19293	5.50401	6.01959
3	-80.3729	41.322	9	0.000	0.022436	4.69672	5.14112	5.87766

4	-62.8382	35.069*	9	0.000	.015991*	4.33354*	4.91126*	5.86877*
5	-60.701	4.2744	9	0.892	0.0223	4.62558	5.33661	6.51509

Note: Authors elaboration with STATA 18.

5. Estimation and discussion of the empirical results

This section presents the results of the Vector Autoregressive (VAR) model estimated from Ecuadorian data from 2010Q1 to 2022Q2. Table 4 demonstrates a statistically significant relationship between urban unemployment and growth.

Table 4. Estimated Vector Autoregressive Model

	Coefficient	**Std. Err.**	**Z**	**P>|Z|**
Variation of Unemployment				
Var Unemp				
L1	-0.4869582	0.17	-2.940	0.003***
L2	-0.3937742	0.1762056	-2.23	0.025**
L3	-0.1426864	0.1595504	-0.89	0.371
L4	0.264135	0.1442951	1.83	0.067*
Growth				
L1 †	-0.1836435	0.0777726	-2.36	0.018**
L2	-0.0016941	0.0821523	-0.02	0.984
L3	0.1203143	0.0674223	1.78	0.074*
L4 †	-0.1552781	0.0582487	-2.67	0.008***
Covid19				
L1	4.664593	0.5423201	8.6	0.000***
L2	-6.887866	0.856053	-8.05	0.000***
L3	2.178681	0.895439	2.43	0.015**
L4	0.1475674	0.5763871	0.26	0.798
_cons	0.044857	0.1159287	0.39	0.699
Growth				
Var Unemp				
L1	0.1462648	0.3423439	0.43	0.669
L2	0.2172263	0.3648015	0.6	0.552
L3	-0.4829014	0.33032	-1.46	0.144
L4 †	-0.5773671	0.2987366	-1.93	0.053*
Growth				
L1	0.2080273	0.1610139	1.29	0.196
L2	0.2471336	0.1700813	1.45	0.146

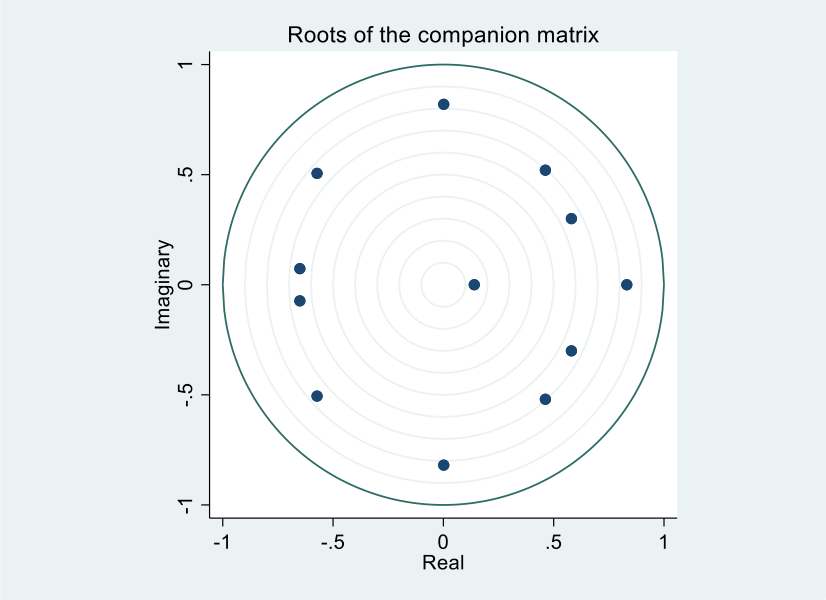
L3	-0.2743954	0.1395855	-1.97	0.049**
L4	0.3096249	0.1205932	2.57	0.01**
Covid19				
L1	-10.16782	1.122775	-9.06	0.000***
L2	16.41551	1.772301	9.26	0.000***
L3	-4.549619	1.853843	-2.45	0.014***
L4	-1.653396	1.193304	-1.39	0.166
_cons	0.2531476	0.2400092	1.05	0.292
Covid19				
Var_unemp				
L1	-0.0491024	0.0433185	-1.13	0.257
L2	0.0428159	0.0461602	0.93	0.354
L3	-0.0064318	0.0417971	-0.15	0.878
L4	-0.002168	0.0378007	-0.06	0.954
Growth				
L1	-0.0622948	0.0203739	-3.06	0.002***
L2	-0.0099598	0.0215212	-0.46	0.644
L3	0.0352491	0.0176625	2	0.046**
L4	-0.0135684	0.0152593	-0.89	0.374
Covid19				
L1	0.8920454	0.1420704	6.28	0.000***
L2	-0.4050674	0.2242583	-1.81	0.071*
L3	0.3033428	0.2345761	1.29	0.196
L4	-0.1506517	0.1509948	-1	0.318
_cons	0.0526411	0.0303696	1.73	0.083

Note: Authors elaboration with Stata 18.
*The hypothesis null is rejected at: *10% of statistical significance, **5% of statistical significance, *** 1% of statistical significance.
† These coefficients demonstrate a negative relationship between urban unemployment and growth.

5.1 Diagnostic tests

We test the normality of the estimated error term, the no autocorrelation at lag order, the eigenvalue stability conditional, and the Granger causality. First, we confirm the normality of the estimated error term using the Shapiro–Wilk test for normal distribution, with the null hypothesis of normality. Then, we use the Lagrange-multiplier test to dismiss the null hypothesis of no autocorrelation at lag order and test the stability condition (Figure 4). We also test the Granger Causality and confirm a bidirectional statistical relationship between the urban unemployment rate and economic growth in Ecuador from 2010-2022.

Figure 4. The Eigenvalue Stability Condition.



Note: Authors elaboration using Stata 18.

Table 5. Granger Causality Test

Equation	Excluded	chi2	df	Prob > chi2
Var unemployment	growth	13.756	4	0.0080
Var unemployment	Covid19	98.094	4	0.0000
Var unemployment	ALL	126.06	8	0.0000
Growth	Var unemployment	12.389	4	0.0150
Growth	Covid19	122.46	4	0.0000
Growth	ALL	163.07	8	0.0000
Covid19	Var unemployment	5.6217	4	0.2290
Covid19	Growth	12.382	4	0.0150
Covid19	ALL	38.493	8	0.0000

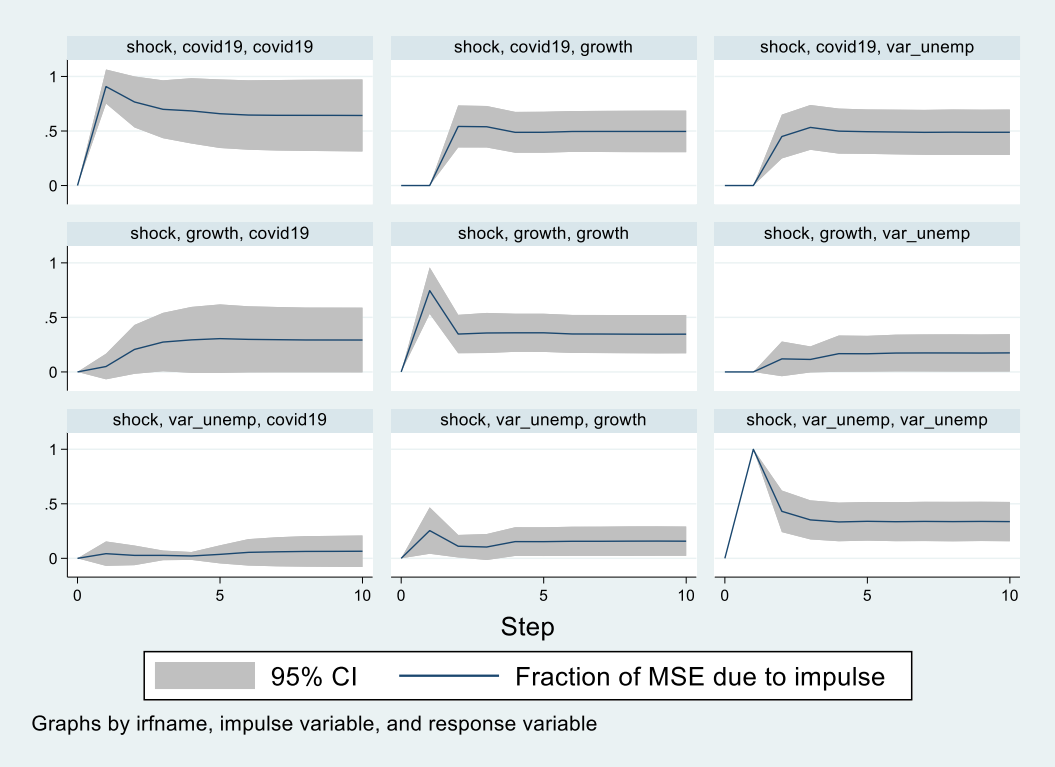
Note: Authors elaboration using Stata 18.

5.2 Variance Decomposition

The variance decomposition allows studying the behavior of the variables when they are subjected to disturbances (shocks) and shows the weight that the residuals of each variable have on the final prediction error of the model. The variance decomposition of growth and the variation of urban unemployment indicates that the final prediction

error was explained by 50% by the COVID-19 pandemic crisis until the tenth period. The variance decomposition of Growth and Urban Unemployment is also influenced by 40% by themselves. Only 10% of the final prediction error of the model has been described by the relationship between the variance of unemployment and economic growth.

Figure 5. Variance Decomposition.



Note: Authors elaboration using Stata 18.

We used Johansen's cointegration test to find a long-term relationship between the variables. However, the null hypothesis was rejected, and this research contributes a short-term analysis of Okun's Law.

5.3 Impulse Response

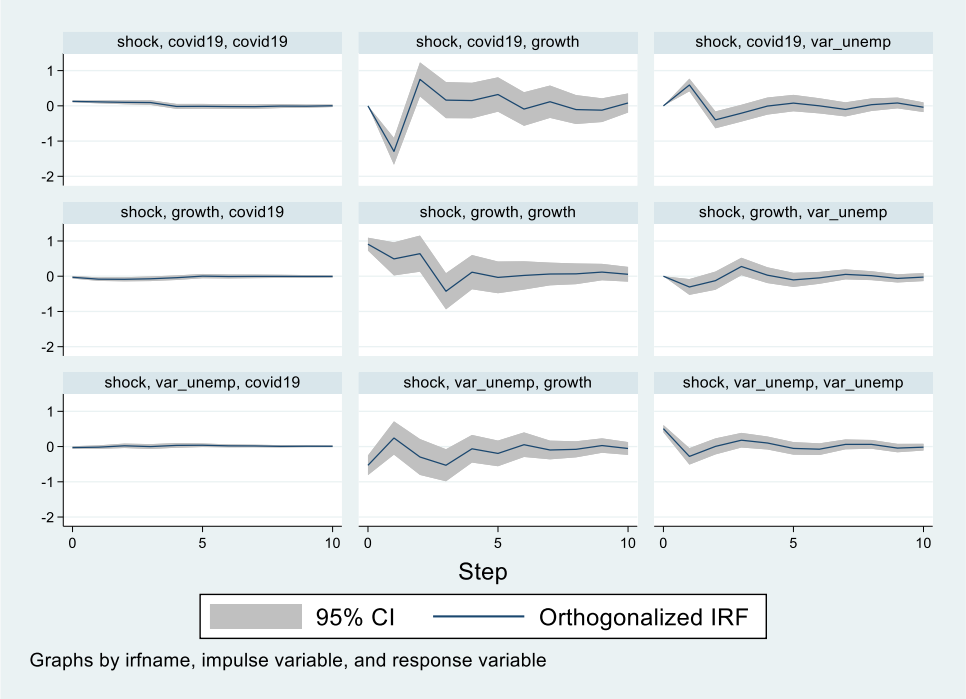
According to Pesaran and Shin (1998), an Impulse-Response Function (IRF) can be interpreted as the difference between the expected value of a variable in the period $t + n$, because of a disturbance that occurred in period t, and its expected value in period $t + n$ in the absence of that disturbance. This last expected value is derived from the known history of economics until $t - 1$. For example, if we start from the

assumption that a disturbance of magnitude δ affects the equation jth of the vector Y_t, the vector of generalized functions impulse-response is given by:

$$IRF_Y(n, \delta, \Omega_{t-1}) = E(Y_{t+n}|\varepsilon_{jt} = \delta, \Omega_{t-1}) - E(Y_{t+n}|\Omega_{t-1})$$

Cuevas (2010) also explains that each innovation (shock) represents an unexpected and temporal increase of one standard deviation in the variable only during one period. Figure 4 presents the dynamic response of urban unemployment, growth and the dummy of COVID-19 from stochastic shocks. Using the impulse-response analysis, we confirm the negative response of economic growth due to an urban unemployment innovation in the second and third periods and prove the negative response of urban unemployment from shocks in economic growth during the first and second periods.

Figure 6. Impulse and Response Variable.



Note: Authors elaboration using Stata 18.

Finally, the response of economic growth due to innovations in COVID-19 is negative in the first period, positive in the second period, and then disappears in the fifth period. The response of urban unemployment to shocks in COVID-19 is

positive in the first period, negative in the second and third periods, and then disappears.

6. Conclusions

The central objective of this research was to test the negative relationship between the real economic growth rate and the variation of urban unemployment in Ecuador, from 2010 to 2022. Using a Vector Autoregressive (VAR) model with quarterly data from the BCE and the INEC, we find a bidirectional Granger causality between unemployment and economic growth and a bidirectional Granger relationship between the COVID-19 pandemic and growth.

The variance decomposition describes a final prediction error that was explained 50% by the COVID-19 pandemic crisis until the 10th period, implying that this event persisted in the Ecuadorian economy.

The impulse response function confirms a negative response of urban unemployment variation from shocks in economic growth during the first period and describes a negative response of growth due to urban unemployment innovation in the second and third periods.

In summary, the findings of this study confirm the existence of Okun's Law in Ecuador in a short time without any cointegration relationship, which could be a result of the negative effect of the COVID-19 pandemic.

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