

Detecting the economic cycle in Ecuador using time series techniques: a univariate and multivariate approach with empirical evidence applying the Hodrick-Prescott filter

Detección del ciclo económico en Ecuador con técnicas de series temporales: un enfoque univariado y multivariado con evidencia empírica aplicando el Filtro de Hodrick-Prescott.

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ABSTRACT

The purpose of this study is to identify and analyze economic cycles in Ecuador through the application of time series techniques, using both univariate and multivariate approaches. Official macroeconomic data such as Gross Domestic Product (GDP), deposits, unemployment, and other relevant variables are used to detect cyclical patterns that characterize the country's economic behavior in recent years. A rigorous empirical analysis is conducted using the Hodrick-Prescott Filter to identify the expansion and contraction phases of the Ecuadorian economy. This research aims to contribute to a better understanding of national economic dynamics by providing valuable insights for the design and implementation of more timely and effective public policies. Additionally, the study incorporates theoretical elements from classical and Keynesian schools of thought to contextualize the results within a solid conceptual framework. The findings will serve as a basis for future research on the country's macroeconomic stability and its vulnerability to external shocks.

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Keywords: Economic cycle, Time series, Hodrick-Prescott Filter, Univariate approach, Multivariate approach

RESUMEN

El propósito de este estudio tiene como objetivo identificar y analizar los ciclos económicos en Ecuador mediante la aplicación de técnicas de series temporales, utilizando enfoques univariado y multivariado. Se emplean datos macroeconómicos oficiales, tales como el Producto Interno Bruto (PIB), los depósitos, el desempleo y otras variables relevantes, con el fin de detectar patrones cíclicos que caractericen el comportamiento económico del país durante los últimos años. A través del filtro de Hodrick-Prescott, se realiza un análisis empírico riguroso que permite identificar las fases de expansión y contracción de la economía ecuatoriana. La investigación busca contribuir a una mejor comprensión de la dinámica económica nacional, ofreciendo insumos útiles para el diseño e implementación de políticas públicas más oportunas y efectivas. Asimismo, el estudio incorpora elementos teóricos de las escuelas clásicas y keynesianas, con el fin de contextualizar los resultados obtenidos dentro de un marco conceptual sólido. Los hallazgos permitirán establecer una base para futuras investigaciones sobre la estabilidad macroeconómica del país y su vulnerabilidad frente a choques externos

Palabras clave: Ciclo económico, Series temporales, Hodrick-Prescott, Enfoque univariado, Enfoque multivariado

INTRODUCTION

Identifying the economic cycle is an essential tool for macroeconomic analysis, as it allows us to recognize the phases of expansion and contraction of economic activity, thus facilitating the formulation of public policies, given that, as El camino al crecimiento (The Road to Growth) rightly points out, the road to growth is not a steady one; on the contrary, it suffers from cyclical fluctuations, with periods of boom and recession, which occur in most economies. In emerging economies such as

Ecuador's, characterized by high vulnerability to external shocks and fiscal constraints, knowing the current position of the economic cycle is particularly relevant to avoid pro-cyclical policies that could aggravate fluctuations

. The analysis of economic cycles has been the subject of study in macroeconomic literature from different schools of thought. Cycles represent recurring fluctuations in aggregate economic activity, reflected in variables such as gross domestic product (GDP), employment, investment, and prices. Various quantitative methodologies have been developed to detect them, among which time series decomposition approaches stand out, such as the Hodrick-Prescott filter and the Baxter-King filter.

These tools make it possible to separate the cyclical component from macroeconomic series, facilitating the identification of expansion and recession phases.

On the other hand, some technical reports and institutional documents from the Central Bank of Ecuador have addressed cycles in a descriptive manner, without applying robust econometric methodologies.

This review highlights a gap in academic research regarding the use of multivariate models and more comprehensive empirical analyses for the study of economic cycles in the country. In this regard, the present study seeks to contribute to the literature through the combined application of univariate and multivariate approaches, using time series techniques on official macroeconomic data, which will allow for a more complete understanding of the cyclical dynamics of the Ecuadorian economy.

MATERIALS AND METHODS

The research will be conducted using a quantitative approach, applying econometric time series techniques to detect the Ecuadorian economic cycle through a combined univariate and multivariate analysis.

In the univariate approach, the Hodrick-Prescott (HP) filter will be used to decompose the macroeconomic series Gross Domestic Product (GDP), deposits, and unemployment into their trend and cycle components. The smoothing parameter will be set at $\lambda = 1600$, which is appropriate for quarterly data, and unit root tests (ADF and KPSS) will be applied to confirm stationarity. This step will allow the expansion and contraction phases of each variable to be identified individually.

In the multivariate approach, a VAR (Vector Autoregressive) model will be constructed with the series in their stationary forms. The selection of the optimal number of lags will be made using information criteria (AIC, BIC). Once the model has been estimated, the Principal Components (PCA) of the series generated by the VAR will be obtained, with the aim of synthesizing the multivariate information into a single indicator representative of the economic cycle. The first principal component, which concentrates the greatest common variance, will be interpreted as the aggregate economic cycle.

This multivariate cycle will be analyzed in conjunction with the results of the univariate approach to verify consistency in the phases detected. Finally, the estimated VAR will be used to project the principal component, allowing us to anticipate the possible evolution of the economic cycle in the short term.

The data series will be obtained from the Central Bank of Ecuador and the National Institute of Statistics and Census (INEC), ensuring their official status and consistency. The study period will include all available quarters up to the most recent one.

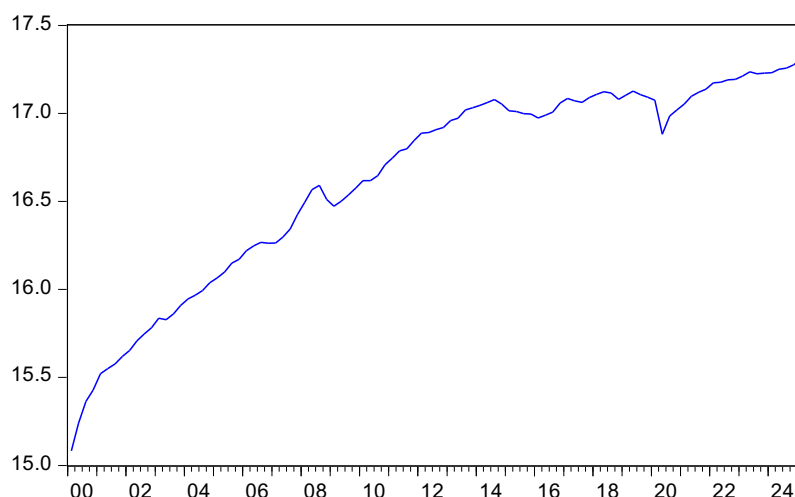
This integrated methodological design combines the descriptive clarity of the univariate approach with the synthetic and predictive capacity of the multivariate approach, generating a robust and anticipatory view of the national economic dynamics.

RESULTS

Figure 1 shows the evolution of seasonally adjusted GDP in Ecuador, represented by the LOGPIB_SA series between 2000Q1 and 2025Q1, showing an upward trajectory with slight fluctuations, suggesting sustained economic growth with moderate cycles. The use of logarithms allows changes to be interpreted as growth rates, facilitating the identification of proportional variations in the level of economic activity. Seasonality has been corrected, eliminating periodic distortions and allowing for a clearer view of underlying cyclical movements. Visually, phases of deceleration can be seen, especially around 2009 and 2020, coinciding with the global financial crisis and the pandemic, respectively. These temporary declines interrupt the general trend, justifying the use of a VAR model to capture the interdependencies between GDP and other macroeconomic variables. This approach will allow us to estimate the economic cycle and evaluate the response of GDP to structural shocks.

Figure 1 Evolution of Ecuador's real GDP, 2000-2025

LOGPIBAJUSTADO ESTACIONALMENTE



Source: Test results
 Prepared by: Galo Moya

As shown in Table I, the ADF unit root test applied to the LOGPIB_SA series indicates that seasonally adjusted GDP is stationary in levels. The t-statistic (-5.354) is significantly lower than the critical values at 1%, 5%, and 10%, and the p-value (0.0000) allows us to reject the null hypothesis of the presence of a unit root. This validates the use of LOGPIB_SA at levels within the VAR model, without the need for differentiation, which facilitates the analysis of dynamic relationships between macroeconomic variables.

Table I. Unit Root Test at LOGPIB SA Levels

Null Hypothesis: LOGPIB_SA has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=12)

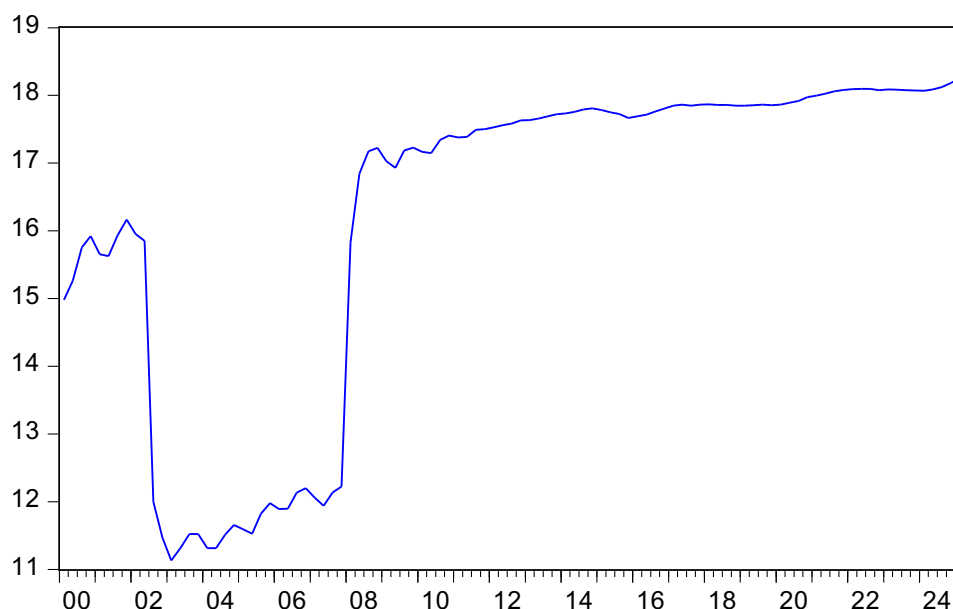
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.354099	0.0000
Test critical values:		
1% level	-3.497029	
5% level	-2.890623	
10% level	-2.582353	

*MacKinnon (1996) one-sided p-values.

Meanwhile, Figure 2 shows the seasonally adjusted LOGDEPOSITO series, which reflects the evolution of financial deposits in Ecuador between 2000 and 2025, eliminating periodic fluctuations to highlight structural trends. The graph shows a sharp

decline around 2008, coinciding with the global financial crisis, followed by a sustained recovery and stabilization in subsequent years. This behavior suggests the banking system's sensitivity to external shocks, as well as its ability to adapt in the medium term. The use of logarithms allows changes to be interpreted as growth rates, facilitating proportional comparisons between quarters. The seasonal adjustment applied improves the accuracy of the cyclical analysis by isolating transitory effects. This variable will be incorporated into the VAR model alongside GDP and unemployment, allowing for the evaluation of dynamic interactions between the financial system and economic activity. Its inclusion is key to identifying economic cycle transmission mechanisms and macroeconomic policy effects.

Figure 2 Evolution of Deposits, 2000-2025
LOGDEPOSITO AJUSTADO ESTACIONALMENTE



Fuente: Resultados del Test
Elaborado por: Galo Moya

En la tabla 2 el test ADF aplicado a LOGDEPOSITO_SA en niveles no permite rechazar la hipótesis nula de raíz unitaria ($t = -1.317$, $p = 0.6191$), indicando que la serie no es estacionaria. Los valores críticos superan el estadístico observado. Por

tanto, se requiere diferenciar la serie para su uso en modelos VAR, asegurando propiedades estadísticas adecuadas.

Table 2. Test Raíz Unitaria en Nivel LOGDEPOSITO_SA

Null Hypothesis: LOGDEPOSITO_SA has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.317424	0.6191
Test critical values:		
1% level	-3.497727	
5% level	-2.890926	
10% level	-2.582514	

*MacKinnon (1996) one-sided p-values.

In Table 3, the ADF test applied to the first difference of LOGDEPOSITO_SA confirms the stationarity of the series. The t-statistic (-7.774) is significantly lower than the critical values at all levels, and the p-value (0.0000) allows us to reject the null hypothesis of a unit root. This validates the use of the differentiated series in VAR models, ensuring statistical consistency and avoiding spurious regression problems in the dynamic analysis.

Table 3. Unit Root Test in $D(\text{LOGDEPOSITO_SA})$

Null Hypothesis: $D(\text{LOGDEPOSITO_SA})$ has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.774890	0.0000
Test critical values:	1% level	-3.497727	
	5% level	-2.890926	
	10% level	-2.582514	

*MacKinnon (1996) one-sided p-values.

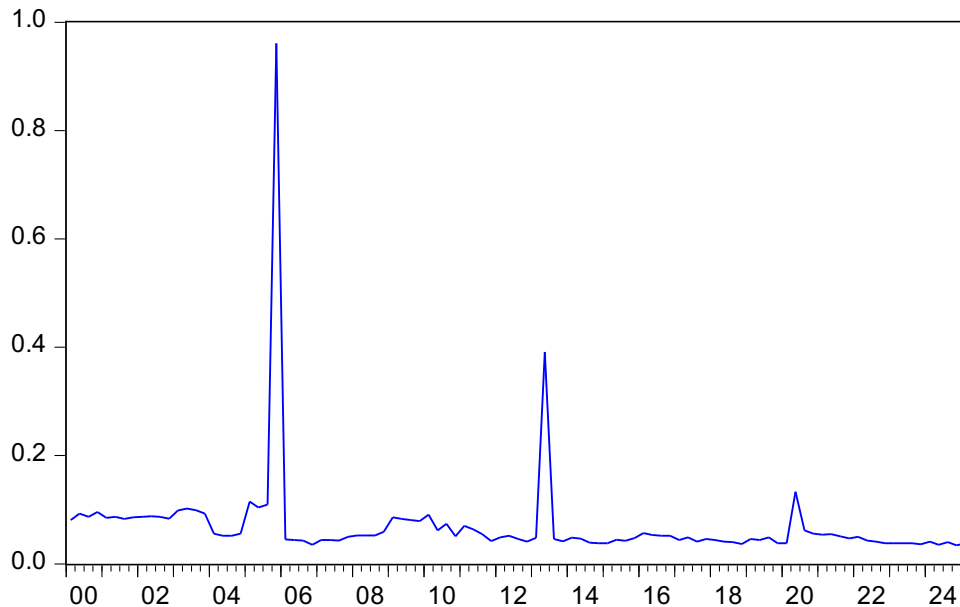
Source: Test results

Prepared by: Galo Moya

In Figure 3, the unemployment variable represents the proportion of the economically active population that is unsuccessfully seeking work, which is a key indicator of labor performance in Ecuador. Its evolution reflects structural and cyclical impacts, such as the 2008 financial crisis and the 2020 pandemic, which significantly increased the unemployment rate. In the period analyzed, the series shows moderate fluctuations, with values between 8% and 9.8%, suggesting some persistence in structural unemployment. This variable will be incorporated into the VAR model along with GDP and deposits, allowing for analysis of its dynamic interaction with the economic cycle. Its inclusion is essential for assessing the effects of macroeconomic shocks on the labor market and designing public policies aimed at employment recovery.

Figure 3 Unemployment Trends 2000-2025

Desempleo



Source: Test results

Prepared by: Galo Moya

In Table 4, the ADF unit root test applied to the unemployment variable indicates that the series is stationary at levels. The t-statistic (-9.442) is considerably lower than the critical values at 1%, 5%, and 10%, and the p-value (0.0000) allows us to reject the null hypothesis of the presence of a unit root with high confidence. This validates the use of the unemployment variable in its original form within the VAR model, without the need for differentiation. Its stationarity guarantees adequate statistical properties for the dynamic analysis of macroeconomic relationships.

Table 4. *Unit Root Test at Unemployment Level*

Null Hypothesis: DESEMPLEO has a unit root

Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=12)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-9.442310	0.0000
Test critical values:		
1% level	-3.497029	
5% level	-2.890623	
10% level	-2.582353	

*MacKinnon (1996) one-sided p-values.

Ecuador Economic Cycle (GDP) Univariate.

In Figure 4, Ecuador's economic cycle was estimated using the Hodrick-Prescott filter, a methodology developed by Robert J. Hodrick and Edward C. Prescott in 1980 to analyze GDP fluctuations. A smoothing parameter of $\lambda = 1600$ was used, as recommended for quarterly series, which allows the long-term trend to be separated from the cyclical component. In the graph, the cyclical component shows deviations from potential GDP, represented by the trend line. The black line at zero indicates the equilibrium point: positive values reflect economic expansion, while negative values indicate contraction.

Since dollarization in 2000, the Ecuadorian economy has faced several shocks: the global financial crisis in 2007–2008, the earthquake in 2016, and the pandemic in 2020, all reflected as significant declines in the cycle. In the recent period (2023–2025), the cycle remains close to zero, indicating an economy with no clear momentum for expansion. The fall in oil prices limits fiscal growth and reduces the scope for countercyclical policies. This analysis makes it possible to identify output gaps and guide economic policy decisions based on the country's cyclical position.

Ecuador Economic Cycle (GDP) Multivariate.

The decision not to perform the cointegration test is justified by the nature of the variables included in the model. In this case, LOGPIB_SA and DESEMPLEO are stationary at levels (I(0)), while LOGDEPOSITO_SA is stationary in first difference (I(1)). Given that Johansen's cointegration test requires all series to be integrated of the same order, typically I(1), its application would not be methodologically valid. Furthermore, the objective of the study is to analyze the short-term dynamic relationships between the variables, for which a VAR model with stationary series is sufficient and appropriate. Including variables with different integration orders in a cointegration test could generate inconsistent or uninterpretable results. Therefore, a mixed VAR approach is chosen, which guarantees statistical robustness without compromising the validity of the econometric analysis.

After running the VAR model, the model residuals are created and then, using principal component analysis, the multivariate economic cycle is calculated. Table 5 of the PCA is provided below.

Table 5 *Principal component analysis (PCA)*

Principal Components Analysis

Date: 09/15/25 Time: 23:43

Sample (adjusted): 2000Q3 2025Q1

Included observations: 99 after adjustments

Balanced sample (listwise missing value deletion)

Computed using: Ordinary correlations

Extracting 3 of 3 possible components

Eigenvalues: (Sum = 3, Average = 1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	1.157134	0.153263	0.3857	1.157134	0.3857
2	1.003871	0.164876	0.3346	2.161005	0.7203
3	0.838995	---	0.2797	3.000000	1.0000

Eigenvectors (loadings):

Variable	PC 1	PC 2	PC 3
RESID01	0.711371	-0.008229	0.702768
RESID02	0.574429	0.582946	-0.574635
RESID03	-0.404947	0.812469	0.419418

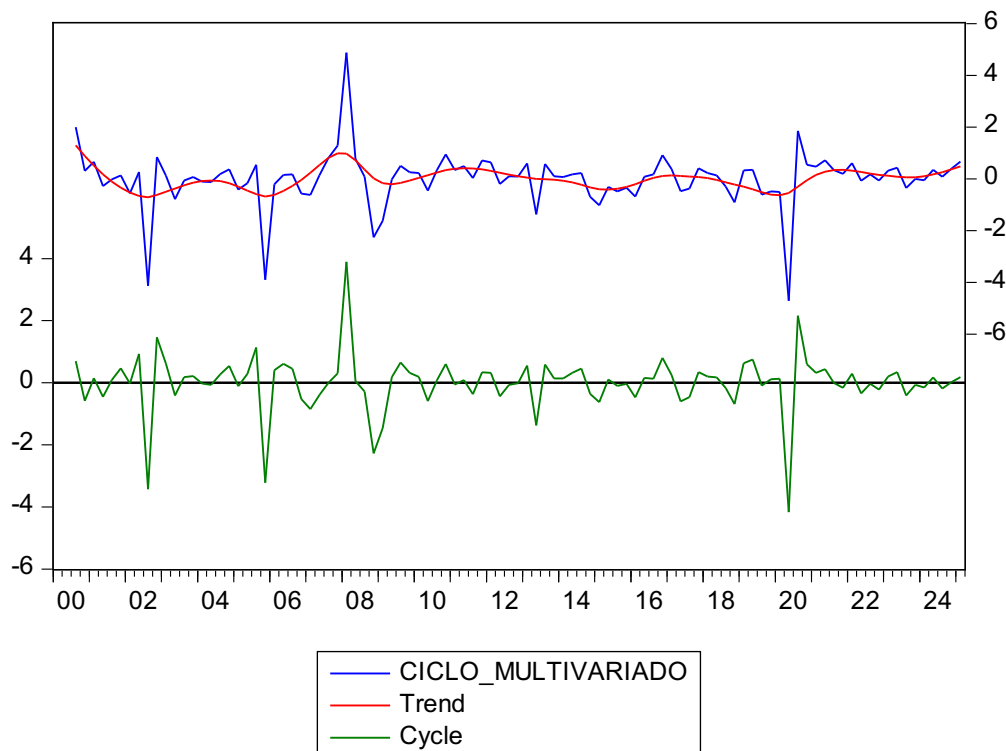
Ordinary correlations:

	RESID01	RESID02	RESID03
RESID01	1.000000		
RESID02	0.129211	1.000000	
RESID03	-0.092748	0.004086	1.000000

Figure 4 of the Multivariate Economic Cycle shows the joint evolution of GDP, demand deposits, and unemployment in Ecuador, broken down into their trend, cycle, and multivariate cycle components. This representation allows for the clear identification of phases of economic expansion and contraction, isolating temporary fluctuations from structural movements. The multivariate cycle synthesizes the interaction between real and financial variables, offering a more robust reading of the macroeconomic environment. The methodology applied in EViews is based on the estimation of a VAR model that incorporates GDP, demand deposits, and unemployment variables. From this model, residuals are obtained, which capture innovations not explained by the joint dynamics of the system. Subsequently, through a principal component analysis of these residuals, the multivariate economic cycle is extracted, allowing the identification

of common patterns of fluctuation between variables. This technique offers a more accurate and dynamic view of economic behavior, revealing phases of slowdown or recovery that would not be evident with univariate approaches.

Figure 4 Multivariate Economic Cycle
Ciclo Económico Multivariado



Source: Test results

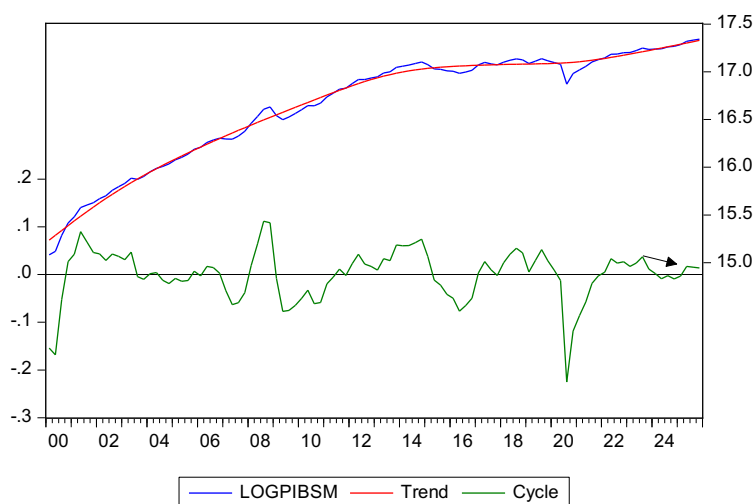
Prepared by: Galo Moya

At this stage, the univariate economic cycle will be projected using the exponential smoothing technique, applied directly to the cyclical component extracted from a single representative variable, such as GDP. This procedure allows for the generation of a smoothed trajectory that facilitates the identification of recent trends and possible turning points in economic activity. Once the projection has been obtained, the economic cycle will be extracted again using a univariate approach in order to observe how the cyclical component behaves under projected conditions.

As shown in Figure 5, the univariate economic cycle projection was made using the Hodrick-Prescott filter on the logarithmic series of Ecuador's quarterly GDP, with a lambda parameter of 1600. This technique made it possible to separate the long-term trend from the cyclical component, revealing fluctuations around potential growth. The

cycle projected through the fourth quarter of 2025 shows values close to zero, suggesting a phase of economic stabilization. However, this reading must be contextualized with recent events. As of September 2025, the Central Bank has not yet published updated data, which limits the empirical validation of the projection. In addition, the government has eliminated the diesel subsidy, raising its price from \$1.80 to \$2.80 per gallon. This decision, although aimed at reducing the fiscal deficit, could generate inflationary pressures and negatively affect consumption and production, especially in sensitive sectors such as transportation and agriculture. These factors could alter the projected trajectory of the cycle, introducing risks of a slowdown that are not yet reflected in the model. Therefore, it is recommended to complement the analysis with indicators of prices, employment, and domestic demand to anticipate possible deviations and adjust economic policy recommendations.

Figure 5 Projected Multivariate Economic Cycle
 Hodrick-Prescott Filter ($\lambda=1600$)



CONCLUSIONS

This research allowed for a comparison of three approaches to analyzing the economic cycle in Ecuador: the univariate cycle, the multivariate cycle, and the projection of the cycle using exponential smoothing. The univariate cycle, extracted from seasonally adjusted GDP using the Hodrick-Prescott filter, revealed clear patterns of expansion and contraction. For its part, the multivariate cycle, estimated using a VAR model and principal component analysis on the residuals of the GDP, deposits, and unemployment variables, offered a more integrated view of economic behavior. Both cycles showed a high similarity in their fluctuations, which validates the use of the univariate approach as a methodological alternative in contexts with data limitations.

The projection of the univariate cycle using exponential smoothing allowed us to anticipate a phase of economic stabilization towards the end of 2025. However, this reading should be interpreted with caution, as in September 2025 the Central Bank has not yet published updated data and the recent withdrawal of the diesel subsidy could generate inflationary pressures and affect productive activity. These factors could alter the projected trajectory and modify the behavior of the cycle in the short term. Overall, the results obtained offer useful tools for monitoring the economic situation and designing more timely and targeted countercyclical policies.

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