Economic Growth Model of Ecuador with Upper Middle Income to Explain and Predict Productivity during the Period 2000-2022

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Abstract: Economic growth is one of the most widely used measures of a country's macroeconomic performance, although it is not without its critics. There are strong arguments that per capita gross domestic product growth can reflect an important part of the success or failure of policies implemented in an economy. The objective, to analyse Ecuador's economic growth model with high average income to explain and predict productivity over the period 2000-2022. The materials and methods, this line of research addresses a hypothetical-deductive and descriptive level of inquiry, by developing aspects from the global perspective concerning economic theory and implicit models of classical growth: such as the model that describes the Cobb-Douglas production function, to explain and predict the temporal behaviour of Ecuador's economic development. The above, in order to establish a correlational analysis of the contributions of the macroeconomic determinants of productivity. The response variable to be measured has been the gross domestic product per capita (GDPpc ) with respect to the independent variables: Domestic Savings (S), Gross Fixed Capital Formation (FBKF), Government Final Consumption Expenditure (G), Exports (E) and as a control variable represented by Labor Force (L). A systematic documentary search was carried out through databases: Scielo, Scopus, Google Scholar and Science Direct, to support the present research with contributions with articles of temporal relevance within the last 5 years. In addition, it was based on annual secondary data extractions from official sources such as the Central Bank of Ecuador (BCE) and the World Bank (WB), according to the temporal coverage from 2000 to 2022. Results, 23 temporal observations were analysed to build an econometric model under the adaptation of a Cobb Douglas production function to explain and predict the behavior of elasticity in Ecuador's economic growth, which establishes that 99.81% of the total variability present in the data is explained by the model that includes variations in savings, gross fixed capital formation, labour force, government final consumption expenditure and exports in the analysed period. Conclusions, the imports variable is eliminated as it is not statistically significant, the resulting model complies with the basic assumptions and the corresponding economic validation in terms of the signs of the estimates for the determinants of economic growth in Ecuador.

Keywords: Economic growth, gross domestic product, income, productivity, Cobb Douglas production function.

1. INTRODUCTION

One of the most popular metrics for measuring a nation's macroeconomic performance is economic growth, although it is not without its detractors. There are compelling reasons in favor of the proposition that output growth can reveal a significant part of the success or failure of economic policies. The search for the highest level of well-being, greater competitiveness and economic growth has been the focus of some research based in both the political and scientific fields. Economic growth is an important factor in achieving economic and social development, being one of the primary goals of any country. It is therefore crucial for all nations to analyse economic growth and the factors that influence it. In these times of global economic crisis, where efficiency is closely scrutinized as a driver of growth and the productivity of internal activities such as job creation and innovation is crucial, attention to this issue is of utmost importance. These are the pillars to achieve competitive advantages that allow the nation to expand in any industry and consolidate in the markets.

Knowledge of the variables that affect the growth of Gross Domestic Product per capita GDPpc, such as exports, imports, gross fixed capital formation, labor force, level of savings and government final consumption expenditure, is crucial for understanding the economic reality of a country and formulating strategies for the economic future.

Exports are crucial for a nation's economic growth, as they improve jobs, foreign exchange earnings, production levels and business competitiveness ¹. Economic theory has focused on analyzing the importance of international trade, particularly its export component. A country or area can raise its relative level of production and income
through trade, as established by authors of the stature of Smith, Ricardo, Kalecki, Kaldor and Thirwall, among others (Rodríguez et al., 2018). In addition, the importance of international trade, including imports and exports, is highlighted as a strategy to boost economic growth.

In this order of ideas, Aguilar et al. consider that international trade together with the Gross Fixed Capital Formation (FBKF), are of great significance, which allow knowing the level of income capture from exports, or on the contrary the capital outflows that contract imports; in addition, they allow evaluating the competitive situation in which the national trade is at the international level. FBFK is a macroeconomic indicator that measures the value of fixed assets purchased or produced in the public or private sector, including companies, families and institutions that make up the State. It is also defined as the ratio between the increase and decrease of durable goods in a country during a specific period of time.

The FBFK is defined by the Central Bank of Ecuador (BCE) as the variation of non-financial fixed assets, both public and private, during a certain period of time (total purchases minus sales of fixed assets). The FBFK makes it possible to identify the industries and different assets that have increased their productive capacity and generated more sources of employment, thus favoring the development of both public and private institutions. It also demonstrates the extent of a nation’s investment in new products, the reinvestment and transfer of its existing commodities and the consumption of those goods.

In addition, a skilled workforce provides people with the tools they need to escape poverty, which in turn helps national social and economic stability and ultimately promotes global economic progress. To escape this low-growth trap, strategies that raise the quality of the labor force and the productivity of the productive apparatus are essential.

In 1956, American economists Trevor Swan and Robert Solow formulated their economic growth hypothesis, in which they emphasize the importance of savings and investment as the engine of growth, and the need not to exaggerate consumption. Savings serve as the first engine of development, according to Solow and Swan’s theory. Reinvesting such savings results in the creation of new capital. Higher income is produced through capital accumulation. The higher income once again goes into savings and spending, and the cycle repeats itself. Thus, a positive feedback loop is established and eventually capital accumulation reaches a point where it is impossible for it to continue to expand. This is the stationary condition, according to Lastras.

Another component of interest is the link between public spending and economic growth, one of the most discussed topics in dissertations on economic growth and development. Keynesian theory states that public spending increases GDP and has a positive impact on aggregate demand. It also argues that public spending can be used as a countercyclical instrument to close the real output gap. In conclusion, according to this methodology, public spending positively and significantly affects GDP growth, which in turn affects economic growth. According to traditional economic theory, public spending can only contribute to long-term economic growth if it increases factor productivity. On the other hand, according to the heterodox view, the maintenance and long-term dynamism of economic dynamics depends on the demand stimulus provided by public spending.

The present study on the Economic Growth of Ecuador, a country that according to the World Bank’s World Development Indicators, classifies the economies of countries for analytical purposes using the Atlas method in the category according to their level of upper middle income development (GDP per capita between US$4,466 and US$13,845). This Atlas method is used to smooth exchange rate fluctuations and thus allows for an empirical view of per capita gross domestic product through econometric analysis of the relationships between this product and its main determinants based on a foundation of economic theory.

According to Alvarez, emphasizes the importance of investigating the relationship between public spending and economic growth. He highlights the need for developing economies to focus public spending on the development of strategic industries and the improvement of their institutional framework to support their growth; therefore, the State recognizes the importance of incurring in public spending for the development of strategic industries and the improvement of their institutional framework.
According to the Economic Commission for Latin America, it is crucial to analyse and recommend appropriate fiscal policies that complement private investment and gross fixed capital formation in order to advance economic development. This ideal point will allow to better concentrate public spending and compose it avoiding the creation of significant social costs that would harm the lowest quintiles of the Ecuadorian population.  

Given that public spending is an endogenous growth factor that positively affects job creation, gross fixed capital formation and some types of public spending, it is interesting to determine the optimal size of public spending and understand how it affects Ecuador's gross domestic product growth rate between 2000 and 2022. In terms of understanding, it is considered in the cost structure, infrastructure spending that has the potential to increase private investment and have a beneficial impact on economic growth.

In this regard, Izquierdo et al., points out that while public spending has increased in developing countries, such as Ecuador, where public spending for 2018 represented 37% of GDP and a public debt that for these years exceeded 50% of GDP, the world average now stands at around 40% of GDP. This postulate can be contrasted with a study of Latin America, where ECLAC, (2020), examines eight countries where public spending grew at a high rate. The countries with the largest increases in spending were the central governments of Argentina, Ecuador, Brazil and Uruguay.

There are different ways in which the term economic growth is conceived and how these can change over time due to market dynamics and the production strategies of nations. Both traditional and modern notions are described, specifically:

According to Barriga et al., ever-expanding production changes the economy quantitatively, affecting a nation's employment, competitiveness and income. Accordingly, Parkin, points to the growth of production options brought about by capital accumulation and technical advances. Expanding with Marquez et al., GDP is used as an indicator of production and the increase in goods and services depends on demand. Growth refers to the increase in production from one year to the next.

From the previous ideas, one can create one's own definition of economic growth, which includes the increase in the level of production and investment, leading to a greater accumulation of capital in a specific geographic area.

Several indices, including the referred Gross Domestic Product (GDP), Gross National Product (GNP) and, finally, Gross Domestic Product per capita (GDP per capita), are used to measure the size of an economy. There are three ways to measure a country's economic development: through its expenditures, its production and its income. These three strategies produce the same value in the market, but different measures are used to understand the contributions of each component to production Although all are adequately substantiated, the growth models discussed below do not always show the same identification structures, as each model uses a dominant variable to elaborate its analysis. As a result, although they are all based on different theories and approaches to how growth occurs, they do not all show the same structures.

Hence the importance of capturing the incidence of the components that contribute in Ecuador to economic growth during the annual coverage from 2000 to 2022; consequently, the analysis of the effect of the underlying variables in the Ecuadorian economic behavior from the perspective of the econometric model that expresses the Cobb-Douglas production function, to establish the explanatory and predictive power in the dynamics of Ecuadorian economic growth and the elasticities of its components. Therefore, this article is developed in different sections that include theoretical-methodological aspects, findings, discussion of the results of the model with the stylized facts. Finally, conclusions are presented.

2. STUDY PROBLEM AND QUESTIONS

Ecuador's economic growth model is an intriguing subject of study, particularly due to its high average income, which sets it apart from many other countries in the region. While there has been considerable attention given to the general economic conditions in Ecuador, a comprehensive analysis of the specific factors contributing to its high
average income and their implications for productivity has been lacking. This research project aims to bridge this gap by investigating the unique economic growth model of Ecuador during the years 2000-2022.

The primary motivation behind this study is to shed light on the factors that have led to Ecuador's remarkable economic performance, especially in terms of income levels. Understanding the drivers of high average income can provide valuable insights for policymakers, economists, and scholars interested in economic development. Moreover, it can serve as a foundation for predicting future productivity trends in Ecuador, helping decision-makers make informed choices. For this purpose the main objective of this paper is to analyse Ecuador's economic growth model with high average income to explain and predict productivity during the period 2000-2022.

3. METHOD AND PROCEDURES

This line of research addresses a hypothetical-deductive and descriptive level of inquiry, by developing aspects from the global perspective concerning economic theory and the implicit models of classical growth, such as the model describing the Cobb-Douglas production function \(^{3,17}\) considering a log-log econometric model, which reduces the misspecification of the functional form of the model \(^{18}\) to explain and predict the temporal behavior of Ecuador's economic development. The above, in relation to establishing a correlational analysis of the contributions of macroeconomic determinants of productivity. The response variable to be measured has been the gross domestic product per capita (GDPpc) with respect to the independent variables: Domestic Savings (S), Gross Fixed Capital Formation (FBKF), Government Final Consumption Expenditure (G), Exports (E) and as a control variable represented by Labor Force (FL). A systematic documentary search was carried out through the following databases: Scielo, Scopus, Google Scholar and Science Direct, to support the present research with contributions with articles of temporal relevance within the last 5 years. In addition, it was based on annual secondary data extractions from official sources such as the Central Bank of Ecuador (BCE) and the World Bank (WB), according to the temporal coverage from 2000 to 2022.

The model is posed in terms to the variables under study to explain and predict the behavior of the economic growth of Ecuador, it obeys the following mathematical structure:\(^{19}\)

\[
\log PIB_t = \beta_1 + \beta_2 \log S_t + \beta_3 \log FBFK_t + \beta_4 \log G_t + \beta_5 \log E_t + \beta_6 \log I_t + \beta_7 \log FL_t + \epsilon_t
\]

\( PIB_t \): Gross Domestic Product per capita, this variable is expressed in current dollars. Gross Domestic Product per capita represents the Gross Domestic Product (final production of goods and services of a given country or region during a certain period)

divided by the total population.

\( S_t \): Savings, this variable is expressed in current dollars.

\( FBFK \): Gross Fixed Capital Formation in thousands of dollars, this variable is expressed in current dollars. Increases or losses in a territory's durable assets over time, including land improvements, the purchase of machinery, equipment and facilities, as well as the construction of roads, railroads and other infrastructure.

\( G_t \): Government final consumption expenditure, this variable is expressed in current dollars.

\( E_t \): Exports from Ecuador in thousands of dollars FOB.

\( I_t \): Imports from Ecuador in thousands of dollars.

\( FL \): Labor Force of Ecuador in thousands of people or economically active population (EAP). It refers to the group of people who have a job or occupational role.

\( \epsilon_t \): Random disturbance, chance component associated with specification errors in the model structure.
In terms to the substantiation of the econometric literature cited previously, in order to understand the relative effect of the factors considered, it is important to underline that the production function shows the returns to scale of an economy by extracting and summing the coefficients of the logarithmic model, which can be interpreted as follows (Feraudi and Ayaviri, 2018):

- Less than 1 refers to diminishing returns of diminishing scales.
- Equal to 1 would correspond to constant scale yields
- And greater than 1, should be understood as returns of increasing scales.

Therefore, for statistical validity of the model, it is important to consider the use of different significant tests. These tests include the Jarque-Bera multivariate normality test, to evaluate compliance with the basic assumptions of the estimated econometric model. Such tests are evaluated in EViews 12 software.

4. STUDY RESULTS AND DISCUSSION

4.1. Description and Identification of the Underlying Structure of Macroeconomic Variables

When building an econometric model, one starts with the specification, estimation, validation with the formulation of a set of hypotheses. There are different tests in EViews for specification and diagnostics concerning the specification of the symmetric part of the model and the properties that the random perturbation must fulfill.

Table 1: Descriptive analysis of macroeconomic variables for Ecuador, period 2000-2022

<table>
<thead>
<tr>
<th>Variable</th>
<th>PIB</th>
<th>S</th>
<th>FBRF</th>
<th>G</th>
<th>E</th>
<th>I</th>
<th>FL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4512.019</td>
<td>1.7E+10</td>
<td>1.74E+10</td>
<td>9.99E+09</td>
<td>1.99E+10</td>
<td>1.94E+10</td>
<td>65.19826</td>
</tr>
<tr>
<td>Median</td>
<td>5202.656</td>
<td>2.05E+10</td>
<td>2.05E+10</td>
<td>1.01E+10</td>
<td>2.11E+10</td>
<td>2.09E+10</td>
<td>65.78000</td>
</tr>
<tr>
<td>Maximum</td>
<td>6391.282</td>
<td>2.80E+10</td>
<td>2.77E+10</td>
<td>1.70E+10</td>
<td>3.36E+10</td>
<td>3.28E+10</td>
<td>69.34000</td>
</tr>
<tr>
<td>Minimum</td>
<td>1451.531</td>
<td>4.42E+09</td>
<td>4.38E+8</td>
<td>5.68E+9</td>
<td>6.81E+9</td>
<td>7.90E+9</td>
<td>50.09000</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>1695.265</td>
<td>8.70E+09</td>
<td>8.99E+9</td>
<td>5.38E+9</td>
<td>8.10E+9</td>
<td>8.36E+9</td>
<td>24.05452</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.494398</td>
<td>-0.399941</td>
<td>-0.271325</td>
<td>-0.169152</td>
<td>-0.263605</td>
<td>-0.26767</td>
<td>-0.32510</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>1.740638</td>
<td>1.530065</td>
<td>1.478368</td>
<td>1.447307</td>
<td>2.007430</td>
<td>1.865885</td>
<td>0.30860</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>2.441518</td>
<td>2.544039</td>
<td>2.501091</td>
<td>2.420083</td>
<td>1.210318</td>
<td>1.506347</td>
<td>1.292268</td>
</tr>
<tr>
<td>Probability</td>
<td>0.294991</td>
<td>0.280205</td>
<td>0.283348</td>
<td>0.298185</td>
<td>0.545986</td>
<td>0.470870</td>
<td>0.520460</td>
</tr>
<tr>
<td>Sum</td>
<td>106076.4</td>
<td>4.09E+11</td>
<td>4.00E+11</td>
<td>2.99E+11</td>
<td>4.34E+11</td>
<td>4.47E+11</td>
<td>1499.590</td>
</tr>
<tr>
<td>Sum Sq. Dev.</td>
<td>62492572</td>
<td>1.67E+12</td>
<td>1.67E+12</td>
<td>1.47E+12</td>
<td>1.55E+12</td>
<td>1.47E+12</td>
<td>1337259</td>
</tr>
<tr>
<td>Observations</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
</tr>
</tbody>
</table>

One of the most frequent problems when working with variables is to know if they have Normal distribution. Statistical inferences cannot be applied if the sample is not normal, in which case non-parametric tests would be used. Therefore, the Jarque-Bera test allows us to evaluate the null hypothesis that the variables under study have a normal distribution. Its conclusion is validated by not being able to reject the null hypothesis through the use of the probabilistic value (P-value> 0.05); that is, there is normality in the data for the variables of interest in the study, with a confidence of 95% (See Table 1).

Corresponding to the descriptive analysis, the COVID-19 pandemic effect exerts a decreasing behavior in the main macroeconomic variables for the year 2020, with the exception of the level of final consumption expenditures by the government, which has maintained the upward trend of previous behavior without evident changes (See Figure 1).

The behavior of per capita income for Ecuador during the period 200 to 2022 shows an increasing trend, therefore, growth has been fluctuating for some macroeconomic variables of interest in this study; In other words, it is possible to observe oscillations around the general trend, implying that there have been many temporary periods in which there has been significant growth in general, but in other cases there has been behavior below the trend.
line, ending in slow growth crises as a consequence of both external and internal factors, such as the world crisis, the collapse in the price of oil, economic policies, among others. However, even when the economy has managed to grow at much higher rates, the problem lies in how to achieve a trend towards a sustained growth process at a general level.

Figure 1: Graphical representation of the variables: GDP, S, FBKF, G, E, I and FL

The data considered to explain the behavior of Ecuador's economic growth must be adjusted using the EViews statistical package, the most appropriate for our case study being the logarithm transformations of the following variables: Log(GDPpc), Log(S), Log(FBK), Log (G), Log (E), Log (I) and Log (FL). This transformation is considered advantageous because it reduces the range of the variables, the values are better appreciated in terms of graphical realization and therefore, in general terms, it limits the risk in the appearance of heteroscedasticity.

4.2.- Estimation of the Ecuadorian Economic Growth Model

The coefficients estimated by the Ordinary Least Squares (OLS) method are shown in terms of the incidence of exogenous variables on the economic growth of Ecuador, a country characterized by high average income during the period 2000-2021 (See Figure 2).

According to the results obtained, a preliminary estimate is presented in terms of the variables that have been identified as essential to explain the behavior of Ecuador's economic growth during the period 2000-2022. The first model to consider is:

\[
\text{Log}(\text{PIB}_t) = -0.285801. \text{Log}(\text{St}) + 0.555396. \text{Log} (\text{FBKF}_t) + 0.234447. \text{Log}(\text{G}_t) \\
+ 0.325803. \text{Log}(\text{Et}) - 0.121906. \text{Log}(\text{It}) + 0.491442. \text{Log}(\text{FL}_t) + \epsilon_t
\]

However, the above model shows no statistical significance for the contribution of the imports variable in explaining economic growth for Ecuador during the time period from 2000 to 2022. In this scenario, formal tests are required to check the implicit correlation and redundancy effect of including or excluding this variable in the study.
To evaluate whether there is redundancy in the information provided by the variable imports (I), the null hypothesis that Log (I) is redundant for the economic growth model of Ecuador, such a conclusion of eliminating the variable imports was similar in the study. At this point, since the probability of the F statistic is 0.4020 greater than 5%, the null hypothesis cannot be rejected. This allows us to conclude that the imports variable does not represent statistical significance for this econometric model that refers to Ecuador's economic growth (See Figure 3).

The coefficients estimated by the Ordinary Least Squares (OLS) method exhibit an interpretation that depends on the nature of the model's variable; correspondingly, since series in logarithm are used in the estimation, the coefficients represent the elasticity of growth for the gross domestic product per capita (See Figure 4). In short, the model has to explain a variability (Coefficient of Multiple Determination = 99.81%), this indicates that if savings (S) decreases by 0.188% Ecuador's economic growth decreases by 0.188%, if the Gross Fixed Capital Formation in thousands of dollars (FBKF) increases by one percentage point, Ecuador's economic growth increases by 0.451%. Furthermore, if government final consumption expenditure (G) increases by 1%, Ecuador's economic growth increases by 0.249%; coupled with the fact that exports (E) increase by 1%, Ecuador's economic growth increases by 0.197%. Finally, if Ecuador's Labor Force in thousands of people or what refers to the PAE increases by 1%, Ecuador's economic growth increases by 0.484% and in relation to the constant term, it is interpreted that for null values of S, FBFK, G, E and FL, the reality that Ecuador's economic growth increases is negative (-10.129%).
These findings are consistent with those embodied in various studies. As for exports, this represents a variable of higher incidence that contribute to the gross domestic product, respectively to its growth and development (Aguilar et al., 2020; Kibria & Hossain, 2020). Ecuador’s government final consumption expenditure during the period analyzed has proven to be a fundamental instrument of economic reactivation and complementation with other growth factors.

Regarding the performance of scales mentioned by Gujarati and Porter (2010) cited by Feraudi and Ayaviri (2018), the sum of the coefficients of Log (S), Log (FBKF), Log (G), Log(E) and Log(FL) allow considering that (-0.188+0.451+0.249+0.196+0.484) results in approximately 1.193 which means that according to the properties of the Cobb-Douglas function, that the factors considered are involved in Ecuador’s economic growth. This must reflect the presence of economies of scale with increasing returns. This same conclusion is contextualized in research conducted by Chamba et al.,

The Cobb-Douglas production function starts from a fundamental conception that the production or growth of an economy resides in the fundamental variations explained by the level of savings, capital, government final consumption expenditures, exports and the labor force of Ecuador, this means that if an economy wants to increase its growth it must produce more, therefore employ an amount of capital that is destined to government final expenditures, increase the gross formation of capital and labor force, in addition to generating a higher level of exports that allow producing a greater increase in the gross domestic product per capita. For this reason, it is suggested to increase investment in fixed assets, optimize the existing labor force and improve the training of human resources to improve the current situation. This recommendation is based on a study by Yang et al. (2020). Therefore, there is a coincidence in assuming the need to develop economic policies focused on the endogenous economic development of the regions as a way to reduce inequalities between countries.

4.3. Validation of the Econometric Growth Model for Ecuador

To validate the model of economic growth in Ecuador, the Jarque-Bera statistic is used to evaluate whether the residual variable has a normal distribution, based on the formulation of the null hypothesis that the errors or residuals have a normal distribution. Whose conclusion is validated by not being able to reject the null hypothesis through the use of the probabilistic value (P-value > 0.05); that is, there is a probability of 52.68% of normality in the residuals, with a confidence of 95%. In addition to evidencing skewness and kurtosis statistics that validate the residual normality. Another alternative to check the normality of the residuals is by means of the box plot, where the
mean of the residuals is at zero and with the Quantile-Quantile plot, it is assumed that there is normality in the residuals since the points are along the line (See Figure 5).

![Quantile-Quantile Plot](image)

**Figure 5:** Analysis of the residuals of the economic growth model for Ecuador, period 2000-2022.

<table>
<thead>
<tr>
<th>Date: 07/21/23</th>
<th>Time: 18:22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample: 2000 2022</td>
<td>Included observations: 23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Autocorrelation</th>
<th>Partial Correlation</th>
<th>AC</th>
<th>PAC</th>
<th>Q-Stat</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.266</td>
<td>0.266</td>
<td>1.8462</td>
<td>0.174</td>
</tr>
<tr>
<td>2</td>
<td>0.096</td>
<td>0.027</td>
<td>2.0961</td>
<td>0.351</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.103</td>
<td>0.078</td>
<td>2.3959</td>
<td>0.494</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.106</td>
<td>0.066</td>
<td>2.7541</td>
<td>0.600</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>-0.11</td>
<td>-0.17</td>
<td>3.1435</td>
<td>0.676</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>-0.13</td>
<td>-0.06</td>
<td>3.7259</td>
<td>0.714</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>-0.18</td>
<td>-0.15</td>
<td>4.9852</td>
<td>0.662</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>-0.10</td>
<td>-0.00</td>
<td>5.3849</td>
<td>0.716</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>-0.05</td>
<td>0.032</td>
<td>5.5197</td>
<td>0.787</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-0.13</td>
<td>-0.10</td>
<td>6.3341</td>
<td>0.766</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-0.06</td>
<td>0.016</td>
<td>6.5203</td>
<td>0.836</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-0.07</td>
<td>-0.11</td>
<td>6.8491</td>
<td>0.867</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 6:** Correlograms of the residuals of the economic growth model for Ecuador, period 2000-2022

The analysis of the non-significant correlation in the correlograms of the residuals (ACF: Simple Autocorrelation and PACF: Partial Autocorrelation) implies that the stochastic process is white noise (See Figure 6). In addition to the non-presence of heteroscedasticity by means of the White test and the Breusch-Pagan-Godfrey test, which allows concluding that the OLS estimates are MELI (Linearly Unbiased Best Estimators), the evaluation of the non-conclusion of serial autocorrelation of the residuals by the results of the Durbin-Watson statistic. These tests allow to assume the verification of the validity and efficiency of the econometric model.

Furthermore, as a recommendation it is emphasized to estimate this Cobb Douglas production function through cost functions in order to eliminate the effects of the possible presence of multicollinearity present in the overall structure of the identified model. 25,26
4.4 Adequacy of the Predictions of the Ecuadorian Economic Growth Model

At this point, a representation of a dynamic prediction is made for the study period (Year 2000 to 2022), which makes it possible to obtain good predictions with the identified model, according to the value of the Theil coefficient, which offers a value close to zero, or specifically 0.001117 (See Figure 7).

Figure 7. Graphical representation of forecasts and measures of forecast adequacy

RECOMMENDATIONS

Based on the findings of the econometric model developed using the Cobb Douglas production function to analyse Ecuador's economic growth, we can make the following recommendations:

1. Diversify Investment: Given that variations in savings, gross fixed capital formation, labor force, government final consumption expenditure, and exports significantly impact economic growth, it is essential for Ecuador to diversify its investment portfolio. Encouraging private sector investment and reducing reliance on external factors like oil revenues should be a priority.

2. Promote Private Investment: The model's results suggest that Ecuador relies heavily on external factors for economic growth. To counter this, the government should focus on creating a conducive environment for private investment by offering incentives and reducing bureaucratic hurdles.

3. Resilience Planning: Given the erratic growth rates due to natural disasters and external factors, Ecuador should invest in resilience planning and disaster preparedness. A more stable economy can be achieved by reducing vulnerability to such shocks.

4. Sustainable Development: Recognizing that labor force elasticity plays a significant role in economic development, Ecuador should invest in human capital development, education, and skills training to enhance labor productivity and contribute to sustainable growth.

5. Reducing Reliance on Oil: While oil revenues have been a source of growth, Ecuador should gradually reduce its reliance on this sector. Developing alternative sources of revenue and reducing fiscal dependence on oil will enhance economic stability.

6. Fiscal Responsibility: Ensuring sound fiscal management is crucial. Effective tax collection should continue, and resources should be used efficiently to prevent fiscal deficits that can hinder economic growth.

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