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Analyzing the Ecuadorian purchasing power: family income vs. basic market basket

Análise do poder de compra dos equatorianos: renda familiar vs. cesta básica

Análisis del poder adquisitivo de los ecuatorianos: renta familiar vs. canasta básica

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This study provides a specific approach using SVR for forecasting BMB prices and analyzing purchasing power trends in Ecuador, offering valuable insights for economic decision-making and household financial management.

ABSTRACT

The basic market basket (BMB) is a set of goods and services that are essential for meeting the basic needs of a household comprising four members. The family income in Ecuador is calculated from the monthly salary of the household members, where 1.6 out of the four members contribute to the family income. Specifically, purchasing power is the ability of a person or a group as consumers to acquire a set of goods and services. The study was divided into three main parts. In the first part, we looked for correlations among the BMB, the family income, and the purchasing power of Ecuadorians. In the second part, we forecasted the price of the BMB for each remaining month of 2023. The best model was SVR, this model obtained a MAPE= 0.3666% in the testing step and a MAPE= 0.1466% in the validation step. Furthermore, the third phase involved the analysis of the monthly Ecuadorian purchasing power for 2023. In this case, the Purchasing power starts at 9.66% in April and ends at 8.07(%) in December, meaning a surplus from $74.01 to $62.69 respectively. According to the SVR predictions, an Ecuadorian family earning the minimum family income (i.e. $840 for 2023) can save $839.59 a year. This means a family has to save almost 18 years to buy a brand new cheap family car, or it takes an Ecuadorian family more than 24 years to save for a 60m2 average cheap house.

Keywords: Purchasing Power, Basic Market Basket, Family Income, Minimum Wage, Ecuador

RESUMO

A cesta básica de mercado (CB) é um conjunto de bens e serviços essenciais para atender às necessidades básicas de uma família composta por quatro membros. A renda familiar no Equador é calculada com base no salário mensal dos membros da família, sendo que 1,6 dos quatro membros contribuem para a renda familiar. Por outro lado, o poder de compra é a capacidade de uma pessoa ou de um grupo de consumidores de adquirir um conjunto de bens e serviços. O estudo foi dividido em três partes principais. Na primeira parte, procuramos correlações entre a CB, a renda familiar e o poder de compra dos equatorianos. Na segunda parte, fizemos uma previsão do preço da CB para cada mês restante de 2023. O melhor modelo foi o SVR, que obteve um MAPE = 0,3666% na etapa de teste e um MAPE = 0,1466% na etapa de validação. Por outro lado, a terceira fase envolveu a análise do poder de compra mensal do Equador para 2023. Nesse caso, o poder de compra começa em 9,66% em abril e termina em 8,07(%) em dezembro, o que significa um excedente de US$ 74,01 a US$ 62,69, respectivamente. De acordo com as previsões do SVR, uma família equatoriana que recebe a renda familiar mínima (ou seja, US$ 840 em 2023) pode economizar US$ 839,59 por ano. Isso significa que uma família precisa economizar quase 18 anos para comprar um carro familiar novo e barato, ou que uma família equatoriana precisa de mais de 24 anos para economizar para comprar uma casa barata média de 60 m2.

Palavras-chave: Poder de compra, cesta básica de mercado, renda familiar, salário mínimo, Equador

RESUMEN

La canasta básica (CB) es un conjunto de bienes y servicios esenciales para satisfacer las necesidades básicas de una familia compuesta por cuatro miembros. La renta familiar en Ecuador se calcula a partir del salario mensual de los miembros de la familia, aportando 1,6 de los cuatro miembros a la renta familiar. El poder adquisitivo, por su parte, es la capacidad de una persona o grupo de consumidores para adquirir un conjunto de bienes y servicios. El estudio se dividió en tres partes principales. En la primera parte, buscamos correlaciones entre la CB, la renta familiar y el poder adquisitivo de los ecuatorianos. En la segunda parte, pronosticamos el precio del BC para cada mes restante de 2023. El mejor modelo fue el SVR, que obtuvo un MAPE = 0,3666% en la etapa de prueba y un MAPE = 0,1466% en la etapa de validación. La tercera etapa consistió en analizar el poder adquisitivo mensual de Ecuador para 2023. En este caso, el poder adquisitivo comienza en 9,66% en abril y termina en 8,07(%) en diciembre, lo que significa un superávit de entre US$74,01 y US$62,69, respectivamente. Según las previsiones del SVR, una familia ecuatoriana que perciba el ingreso familiar mínimo (es decir, 840 dólares en 2023) puede ahorrar 839,59 dólares al año. Esto significa que una familia necesita ahorrar durante casi 18 años para comprar un coche familiar nuevo y barato, o que una familia ecuatoriana necesita ahorrar durante más de 24 años para comprar una casa barata media de 60 m2.

Palabras clave: Poder adquisitivo, cesta básica de la compra, renta familiar, salario mínimo, Ecuador

INTRODUCTION

The evaluation of a nation's economic well-being and the living standards of its population is intricately tied to the concept of purchasing power. Purchasing power represents the ability of individuals or families to afford goods and ser- vices essential for their well-being and sustenance. Understanding the dynamics of purchasing power is particularly crucial in developing countries like Ecuador, where economic conditions and income disparities can significantly impact the daily lives of its citizens. In Ecuador, a country with an unstable economy (Bernal et al., 2021). The assessment of purchasing power is a complex task that necessitates a comprehensive analysis of various factors. One of the key aspects in examining the purchasing power of Ecuadorian households lies in comparing family income against the cost of the Basic Market Basket (BMB), which encompasses essential goods and services required for a decent standard of living.

This paper aims to delve into the Ecuadorian purchasing power landscape by conducting a thorough analysis of family income vis-à-vis the BMB. By studying this relationship, we seek to uncover the challenges faced by Ecuadorian households in meeting their fundamental needs, as well as to gain insights into the potential discrepancies and disparities that exist within the country's eco- nomic fabric. To achieve this objective, we will analyze the two economic indicators mentioned before, representing the earnings and spending's of an average Ecuadorian family. By utilizing this data, we will gather comprehensive information on family income levels, expenditure patterns, and the changes in the price of the BMB in Ecuador. This data-driven analysis will enable us to identify the key factors influencing purchasing power, such as inflation rates (Bertuah et al, 2019), employment dynamics, and family composition, among others (Wildan, 2021; Picchioni et al, 2022).

Furthermore, this study will provide policymakers, economists, and social researchers with a deeper understanding of the challenges faced by Ecuadorian households in accessing basic goods and services, Also with the implications of these challenges on poverty alleviation, income redistribution, and overall social development. By shedding light on the intricacies of Ecuador's purchasing power dynamics, this research endeavors to contribute to the formulation of evidence- based policies that promote economic stability, social equity, and sustainable growth in the country. This research was driven by the need seen of making an informed decision according to the Ecuadorian economic reality, when raising the minimum wage. The last years, the Ecuadorian government has raised the minimum wage obeying political promises instead of performing a study to evaluate the minimum wage for the next year.

Analyzing the Ecuadorian purchasing power by comparing family income against the BMB is an essential endeavor to comprehend the economic conditions and well-being of its population. This research analyze the purchasing power of the Ecuadorians for 2023. First, we have to establish a relationship be- tween the wage and the cost of living in Ecuador to calculate the surplus. Next, we forecast the cost of living in Ecuador, represented by the BMB. Finally, we calculate the purchasing power from the surplus of the predicted values. This paper aspires to provide valuable insights into the factors shaping purchasing power in Ecuador and foster a better understanding of the challenges faced by households in securing their basic needs. Ultimately, the findings of this study will serve as a foundation for informed decision-making aimed at improving the living standards and quality of life for all Ecuadorians.

The remaining of this paper is structured as follows: an introductory literature overview, extend the background of this work and explains similar works to the one proposed in this study. The following section describes the general methodology implemented during the research, main concepts definitions and formulas, data sets, metrics and overviews the proposed forecasting methods. The results and discussion section, that gathers the main insights obtained from the experiments and explores the significance of the work's results. Finally, the concluding remarks are presented in last section.

Literature Overview

Bure et al (2021) examine the changes in the cost of the BMB in Ecuador over two decades. The BMB serves as a crucial indicator of the income level, encompassing essential food items needed to meet families' basic needs. Using a documentary investigation and analytical method-synthetic approach, the study analyzes five presidential periods to assess the impact of economic and social policies on the BMB's price. Results indicate an overall increase in family in- come and an improved quality of life in the last decade. However, a significant portion of the economically active population lacks stable income, limiting their access to the entire BMB. The study recognizes the BMB's importance as an indicator to quantify the income needed for families to meet basic needs adequately. Yet, it highlights certain limitations, neglecting savings, extra income, and debts that families may have, and oversimplifying people's quality of life. Despite these limitations, the research reveals Ecuador's economic growth over the years, contributing to increased family income and access to the BMB. Such growth is influenced by factors like oil prices, increased exports, and production, shaped by presidential economic and social policies.

Moreover, Cisneros et al (2014) aimed to explain the connection between the variables of the BMB and the minimum wage while emphasizing the existing gap between them. The methodology used in this study is descriptive analytic, focusing on evaluating the behavior of the variables that determine the minimum wage. The research focuses on the economic context

of Nicaragua, where the problem lies in the combination of low wages and high prices of essential food products. As a consequence, the study predicts that the gap between the minimum wage and the cost of the BMB will continue to widen, making it challenging to achieve a minimum wage that can adequately cover the cost of living. The low mini- mum wage is attributed to the statistical preparation of the variables used for its estimation, resulting in lower values. This limitation hinders effective negotiations for higher minimum wages. The study emphasizes that the issue lies not in the high price of the BMB itself, but rather in the methods used to estimate the Consumer Price Index (CPI) that determines inflation and the real Gross Domestic Product (GDP) that determines Economic Growth. To address this concern, the authors suggest considering the Fischer index as an alternative to calculating the CPI and/or the GDP Deflator, which could potentially lead to more accurate and fair minimum wage determinations.

The research performed in Cruz & Maldonado (2017) aimed to analyze the factors influencing food security, with a particular focus on family income as a key means of access. Using data from the National Survey of Employment, Unemployment, and Underemployment (ENEMDU), the study examines the relationship between family income and access to the BMB, where the dependent variable indicates access or lack of access based on income thresholds. The main independent variables include human capital, work experience, economic sector, and geographical area. The research findings demonstrate that access to food security increases with higher levels of human capital and urban residence. Individuals working in the private sector, and those who identify as indigenous or Afro-descendant, are more likely to face challenges in accessing the BMB. The main determinants affecting food security for Ecuadorian families are analyzed, with a particular emphasis on education as a crucial factor to counteract this problem. The paper suggests that to mitigate food insecurity, structural national policies should be implemented to reduce vulnerability, such as generating employment, increasing family in- come, and ensuring universal access to quality food and distribution of national income. Detailed studies of all segments of the region's agri-food value chains are crucial for addressing issues effectively and correcting data gaps. Overall, the research underscores the importance of education and comprehensive policies in enhancing food security and well-being for Ecuadorian families.

METHODS

This section presents the methodology used during the research. We divided the study in three main parts. In the first part we looked for correlations among the BMB, the minimum wage and the purchasing power of Ecuadorians. During this step, we defined the formulas used to calculate the purchasing power. In the second part we forecasted the price of the BMB for each remaining month of 2023. We used three different well-known models to predict the price of the BMB from April 2023 to December 2023. While, the third phase involved the analysis of the monthly Ecuadorian purchasing power for 2023. Using the predictions obtained in the previous step we calculated the Ecuadorian purchasing power for 2023.

Basic Market Basket

The BMB or basic family basket is a set of goods and services that are essential for meeting the basic needs of an average Ecuadorian household comprising four members. The BMB contains 75 products out of the 359 of the consumer price index (CPI) market basket, therefore these two indicators are closely related and both can be used to calculate inflation. It is important to make a distinction between the BMB and the vital market basket (VMB). The VMB contains less and lower quality products to satisfy the minimum energy and protein needs of a family, hence its lower price.

Family income

The family income in Ecuador is calculated from the monthly salary of the household members. Specifically, in Ecuador it is determined that an average household has four members and 1.6 out of the four members contribute to the family income. In Ecuador it is mandatory that the employer pays an extra wage and minimum wage each year in specific months or distributed over the 12 months. They are called the thirteenth and fourteenth wages, and they also contribute to the monthly family income. During this research we established the salary as the Ecuadorian minimum wage and calculated the family income and purchasing power based on this value. The monthly family income (FI) in Ecuador is computed following either Equation 1 or the compact Equation 2.

$$FI = 1.6\left(MW + \frac{MW}{12} + \frac{MW}{12}\right) \quad (1)$$

$$FI = \frac{28}{15}MW \quad (2)$$

Where MW is the minimum wage and the terms *MW/12* corresponding to the thirteenth and fourteenth wages.

Purchasing power

Purchasing power is defined by Mahaputra & Saputra (2022) as the ability of a person or a group as consumers to acquire a set of goods and services. Then, it depends on the price of the goods and services and the income of a person or group. If the income is low, the purchasing power is low and the other way around. While, if the prices of the products being consume is low, the purchasing power on the person or group is higher. In this work we defined the group as the average family in Ecuador (four members), the income is the family income defined in the previous section and the set of good and services is the BMB. Then, the purchasing power is the percentage of the actual value of the BMB that a family is able to buy with the surplus of the family income. In other words, it is the ratio between the surplus and the BMB value. The monthly purchasing power (*PP*) is calculated by the following Equation 3.

$$PP = 100\left(\frac{FI - BMB}{BMB}\right) \qquad (3)$$

Where *BMB* is the monthly BMB value, *FI* is the family income for the same month and *FI−BMB* is the surplus of the family income after buying the BMB. If the surplus (and consequently the purchasing power) is positive, it means it is possible for the family to save some money or buy something else after spending in the basic needs that month. In other words, they have purchasing power. While if the surplus is negative, it is deficit in the family income. It means the family could not even buy the complete BMB that month or they have to get into debt to buy it.

Data sets

The data sets used during this research are the "Basic Market Basket of Ecuador" (BMBE) and the "Minimum Wage of Ecuador" (MWE). Both are values publicly published by the National Institute of Statistics and Census (INEC); the BMBE is a monthly record measured in US dollars ($), while the MWE is normally updated annually and it is also measured in US dollars ($). After pre-processing the data, we obtained two time series that we used to perform the experiments.

The first time series was created from the BMBE data set, we kept only the records from January 2001 to March 2023. The second time series is the "Family Income of Ecuador" (FIE) obtained from the MWE by applying Equation 2 to the data set. As the minimum wage is an annual record, we transform the data set to monthly records repeating the same value each month of the year. After this process we obtained the FIE time series with records from January 2001 to December 2023. The general description of the two data sets is presented in Table1. The final data sets and Python code (Jupyter Notebooks) used for all the experiments, as well as the results of the experiments can be found at https://github.com/ColdRiver93/BMB-FI.

Table 1. Description of the final time series used during the research

Dataset	Count	Min	Max	Avg	SD
BMBE	267	269.77	767.11	563.09	139.48
FIE	276	159.88	840	505.09	207.42

Source: own elaboration with research data

Forecasting methods

To complete the second part of the methodology described above, we needed to apply suitable methods to forecast the values of the BMB for the remaining months of 2023 (April - December). To accomplish this task we used three different forecasting methods: Seasonal Autoregressive Integrated Moving Average (SARIMA), Support Vector Regression (SVR) and Multi-Layer Perceptron (MLP). The three methods have been used before in other works obtaining excellent results when applied to macroeconomic indicators forecasting. The task is a time series forecasting problem, and each method deals differently with this task.

ARIMA is a model first introduced by Box et al (2015) in 1970 and it has been widely used since then. It is a powerful but simple method, that is the reason why it has still being used in recent research. SARIMA model is an ARIMA model that supports a seasonal factor. Dubey et al (2021) explain that ARIMA has three main components: *p*, *d* and *q*. The autoregressive (AR) order is denoted by *p*, which indicates the number of time lags used for the linear regression. The integrated (I) part is represented by *d*. It indicates the degree of differencing (number of times past values where subtracted from the data) applied in the model to make the series stationary. Finally, the moving-average (MA) order is expressed by *q*, which indicates the size of the moving average window for the model. SARIMA has not only the components *p, d* and *q*, but also another four components *sp, sd, sq* and *s* corresponding to the seasonal factor. Where *s* is the seasonal period.

SVR model is a variant of Support Vector Machines (SVM) created for regression problems. Parbat & Chakraborty (2020) explains that SVR is useful for prediction and curve fitting of linear and non linear regression. Furthermore, Lin et al

(2022) point out that the SVR model achieves the nonlinear to linear transformation by using a kernel function to map the training feature data to a high-dimensional space. The basic idea of the SVR model is to select a hyperplane that fits the data and consider a margin distance epsilon such that all data points are located in a band around the hyperplane. Only the examples that are further from the hyperplane than epsilon are taken into account when defining the hyperplane, and these samples are called support vectors. By using kernels to map the input to a higher dimensional space, SVR is able to find the hyperplane that best fits the data.

MLP is a fully connected artificial neural network of the feed-forward type that uses back-propagation to learn as described by Desai & Shah (2021). On the other hand, Car et al (2020) mentions that MLP is composed of neurons arranged in layers, consisting of an input layer, an output layer, and one or more hidden layers. The output layer contains a single neuron, which outputs the value of the model. MLP calculates the values of neurons in a layer by summing the weighted outputs of neurons in the previous layer connected to the neuron, and then applying an activation function that maps the input to the output. Initially, the weights of the neuron connections are random, but they are updated through a back-propagation process in which the error of a forward-propagated MLP result is back-propagated and the weights are adjusted proportionally to the error.

Metrics

In this research we used three different error measures: Mean Absolute Error (MAE), Root Mean Square Error (RMSE) and Mean Absolute Percentage Error (MAPE). They are well-known error metrics normally used to test forecasting models. As Karunasingha (2022) comment in their work, these different metrics allow us to find the hyperparameters of the best model for each forecasting method presented above.

Qi et al (2020) stated that MAE measures the average magnitude of absolute differences between the actual values and the predicted values. The absolute differences means that MAE does not consider the error direction, only its magnitude. One of the principal advantages of using MAE is that it has the same units as the predicted data. The corresponding MAE error is defined in Equation 4.

$$MAE = \frac{1}{N}\sum_{i=1}^{N}|y_i - \hat{y}_i| \qquad (4)$$

Where y_i is the actual observation, $\hat{y}_i$ is the predicted value for the observation and N is the number of predicted observations. According to Chai & Draxler (2014) MAE gives the same weight to all errors, while RMSE assigns more weight to errors with greater absolute values compared to errors with smaller absolute values. RMSE represents the standard deviation of the residuals, which are the prediction errors. It shows the degree of variability in these residuals. Essentially, it informs you about how concentrated the data is around the optimal fit line. RMSE is calculated following Equation 5.

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(y_i - \hat{y}_i)^2} \qquad (5)$$

RMSE also has the same units as the predicted data. On the other hand, MAPE does not have the same units, it is expressed as a percentage (%). As reported by De Myttenaere et al (2016), this measure is the mean of the absolute percentage errors of the predictions. It is a straightforward metric because it shows the magnitude of prediction errors as a percentage relative to the values of the series. A lower MAPE indicates better predictions. Equation 6 presents the formula of MAPE.

$$MAPE = \frac{100}{N}\sum_{i=1}^{N}\left|\frac{y_i - \hat{y}_i}{y_i}\right| \qquad (6)$$

RESULTS AND DISCUSSION

In this section we present the main results derived from this research and discuss the implication of this results[1].

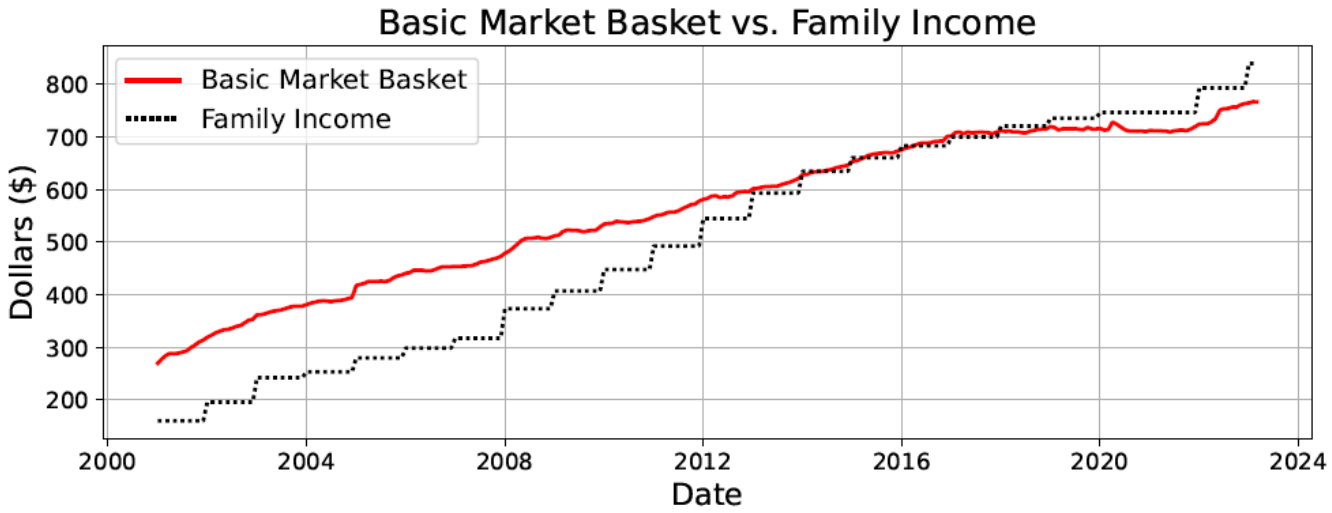
[1] This work is completely reproducible, the data set and Python implementation can be found at https://github.com/ColdRiver93/BMB-FI

Basic market basket and family income relationship

In the first part of this research, we established the relationship between the BMB and the family income. This two concepts are closely related to each other by their definition . First, the BMB is the goods and services needed by an average family, and the family income is the total income of also an average family. Both terms are indicators of the same group, an average Ecuadorian family of four members and 1.6 members contributing to the family income. Second, normally (at least in the last decade) it is intended that the family income is high enough to cover the BMB. As the family income depends directly on the minimum wage in this methodology, the minimum wage adjustments are in line (or they should be) with the variation of the BMB price. Finally, and most important for this work, this two concepts are related under the same metric defined before, the purchasing power. Another metric that the INEC also calculates is the surplus. The only difference is that INEC calculate the surplus as $BMB - FI$ instead of $FI - BMB$ as proposed in this work. After defining the relationship between the BMB and the family income, we present the visual representation of the relationship expressed above. Figure 1 shows the comparison between the BMB time series and the family income time series throughout the last two decades. It is important to understand that where the family income time series is above the BMB time series it means the family has purchasing power (positive surplus) that month.

There are three interesting things to notice in Figure 1. First, 2014 was the first year Ecuadorians could buy the entire BMB and have remaining money. This was due to the fact that Ecuador applied better public policies, and also due to higher percentage increases in the minimum wage compared to the previous minimum wage. The percentage of increase is calculated dividing the increased amount to the new minimum wage in dollars by the value of the previous minimum wage ($increase(\%) = 100 \times increased\_amount/previous\_wage$). Second, since around the beginning of 2017 there was a low or none inflation that lasted about 5 years. This low inflation let the Ecuadorians have a greater purchasing power throughout the last years. Third, normally the surplus is greater at the beginning of the year (January), slowly decreasing until the end of the year (December). This is caused because the adjustments to the minimum wage are applied in January, greatly increasing the surplus that month. Whereas, normally the cost of the BMB increases during year, decreasing the surplus.

Fig. 1. Comparison between BMB and family income of Ecuador, from January 2001 to March 2023

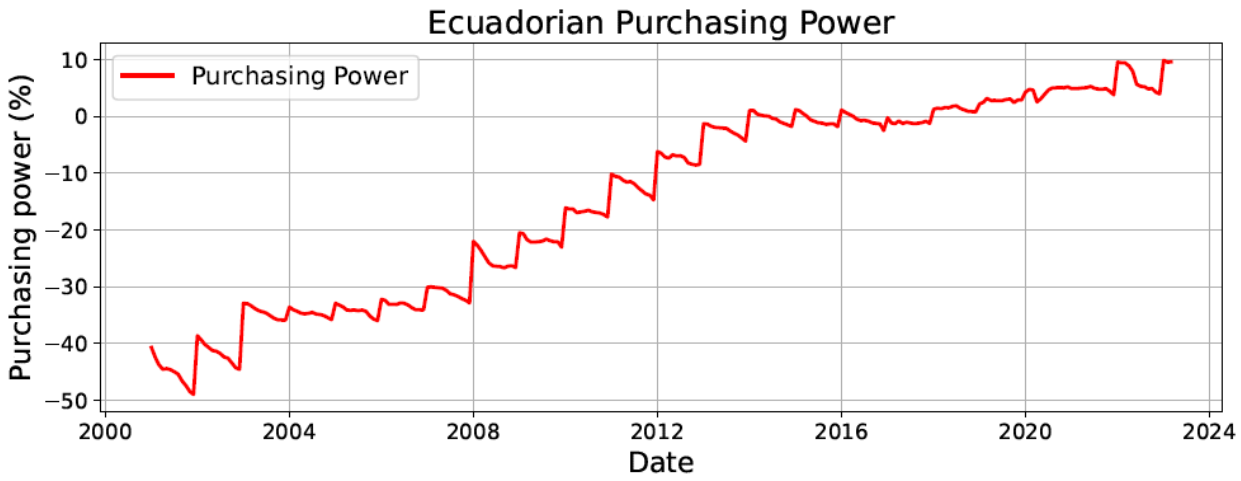


Source: own elaboration with research data

This behavior can be easily modeled by the purchasing power. Figure 2 shows the purchasing power time series, establishing the relationship between the BMB and the family income. It is easy to see the seasonal component in this time series. This corresponds to the statement made before, the Ecuadorian purchasing power decreases throughout the year and increases at the beginning of the new year if the minimum wage is adjusted. It can also be observed that Ecuadorians have a constant positive purchasing power just since 2017, because of the low inflation since that year. Ecuadorian purchasing power have never reached more than 10% of the BMB.

On the other hand, before 2014 the average family in Ecuador could not afford all the items in the BMB. Even worst, in December of 2001 the Ecuadorian families could not afford almost half of the BMB. This shows an improvement in the economic conditions of the people in Ecuador in the last 20 years.

Fig. 2. Percentage of purchasing power of an average Ecuadorian family, from January 2001 to March 2023.



Source: own elaboration with research data

Basic market basket forecast

In the second part of this work, we forecasted the BMB values for the remaining months of 2023. The chosen methods, explained before were SARIMA, SVR and MLP. The BMBE data set was divided into three data sets: training, testing and validation. The training data set covers the dates from January 2001 to December 2021 (252 monthly records). The test data set contains 12 monthly records, corresponding to all the months of 2022. While, the validation data set has only three records from January to March 2023. We choose this split to train a model that can accurately forecast the next 12 months. A grid search was performed to get the best hyperparameters, and we used the model that had the best scores in the testing step to forecast the BMB values from April to December 2023.

The input to train the SARIMA models was the time series as it was, this is mentioned because the inputs for the SVR and MLP models are different. The best model in the testing step had the hyperparameters (p = 1,d = 1,q = 2) and (sp = 1,sd = 2,sq = 1,s = 3). This model obtained a MAPE= 0.6065% in the testing step and a MAPE= 0.2610% in the validation step.

The SVR and MLP models needed two inputs X and y. Where X is a matrix, each row has 12 observations of the previous months and y is a vector of the next value. Then, the models were trained to receive the values of the 12 previous months and predicts the value of the next month. We used a polynomial kernel for the SVR models; the model that excelled during testing was of degree = 2, kernel coefficient (gamma) = 1, independent term (coef0) = 0.1, tolerance for stopping criterion (tol) = 0.001, regularization parameter (C) = 3, epsilon distance (epsilon) = 0.01, and a maximum iteration (max_iter) = 10^8. This model obtained a MAPE= 0.3666% in the testing step and a MAPE= 0.1466% in the validation step.

The MLP artificial neural network used the same input as the SVR model. The best model had 200 hidden layers, an identity activation function, the solver of the weight optimization was *lbfgs*, the strength of the L2 regularization term (alpha) = 0.01, an adaptive learning rate, and a maximum number of iterations = 10^3. This model obtained a MAPE= 0.4210% in the testing step and a MAPE= 0.2953% in the validation step. Table 2 presents the testing (t) and validation (v) scores of the best models. Although we performed the final pre- dictions of the BMB value for the next months with the three methods, the best method according to the scores was SVR. Figure 3 illustrates the comparison of the BMB prediction among the three models. While, Table 3 presents the predictions values for the remaining months of 2023 of the three models. The worst-case scenario is given by the SARIMA predictions, the prediction values are the highest out of the three models. While, the SVR model represents the best-case scenario for the Ecuadorians as it predicted the lowest values for the BMB resulting in a highest surplus at the end of the month.

Table 2. Scores of the best models of each method

Method	MAPE-t (%)	MAE-t ($)	RMSE-t ($)	MAPE-v (%)	MAE-v ($)	RMSE-v ($)
SARIMA	0.6065	4.53	5.35	0.2610	2.00	2.85
MLP	0.4210	3.14	5.04	0.2953	2.26	2.52
SVR	0.3666	2.73	4.64	0.1466	1.12	1.18

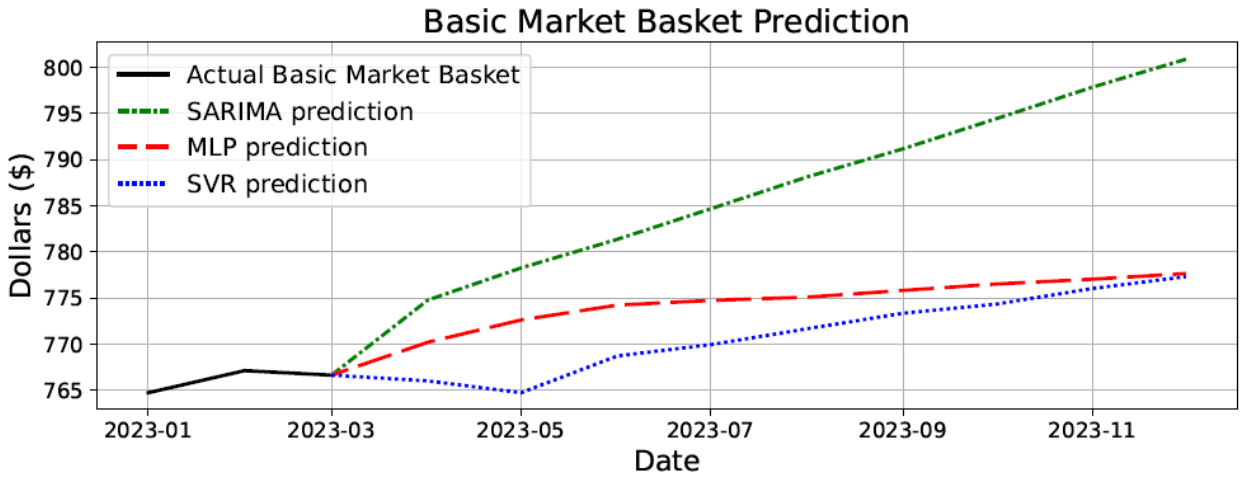
Source: own elaboration with research data

Table 3. BMB predictions ($) of the remaining months of 2023

Method	April	May	June	July	August	September	October	November	December
SARIMA	774.76	778.25	781.35	784.65	788.11	791.17	794.44	797.86	800.88
MLP	770.19	772.61	774.22	774.72	775.80	775.81	776.50	777.30	777.64
SVR	765.99	764.71	768.70	769.92	771.64	773.34	774.33	776.02	777.31

Source: own elaboration with research data

Fig. 3. BMB price predictions for the remaining months of 2023 (April - December) applying SARIMA, SVR and MLP methods.



Source: own elaboration with research data

Ecuadorian purchasing power for 2023

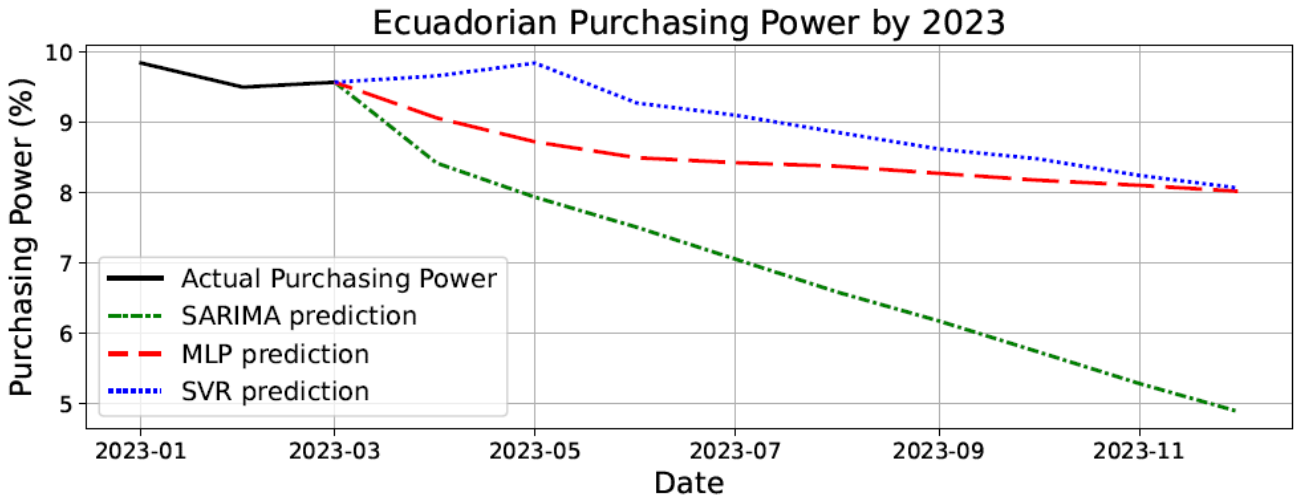
The third and last part proposed in this work, is the analysis of the Ecuadorian purchasing power for 2023. To complete this task we used the predictions of the BMB obtained in the previous section, in order to calculate the purchasing power for the remaining months of 2023. Table 4 and Figure 4 present the Ecuadorian purchasing power for each month of 2023. The purchasing power calculated from the three best models show, in all cases, the same behaviour of being high at the beginning of the year and getting lower towards the end of year. As expected, the purchasing power calculated with the SARIMA predictions had the lowest values, indicating the worst-case scenario. In this case, the Purchasing power starts at 8.42% on April and ends at 4.88% on December, meaning a surplus from $65.24 to $39.12 respectively. While, the best-case scenario is the purchasing power calculated from the SVR predictions. In this case, the Purchasing power starts at 9.66% on April and ends at 8.07(%) on December, meaning a surplus from $74.01 to $62.69 respectively. Lets take the best-case scenario for the analysis. According to the SVR predictions, an Ecuadorian family earning the minimum family income (i.e. $840 for 2023) can save $839.59 a year. This means a family can save an extra family income after working one year (12 months). To give the reader an idea, the average cost of a brand new cheap family car in Ecuador is $15, 000, this means a family have to save almost 18 years to buy a new car. Other main goods for which Ecuadorians save are houses and apartments. According to INEC in 2021 the average price per square meter (m^2) of construction in Ecuador was $339. Fernandes & Guzman (2000) in their study stated that an optimal minimum area per person in a house range from $12m^2$ to $16m^2$, in our case (four members) we established a house of $60m^2$. An average small house costs 20,340, it means it takes to an Ecuadorian family more than 24 years to save for a house.

Table 4. Ecuadorian purchasing power (%) for the remaining months of 2023

Method	April	May	June	July	August	September	October	November	December
SARIMA	8.42	7.93	7.51	7.05	6.58	6.17	5.74	5.28	4.88
MLP	9.06	8.72	8.50	8.43	8.38	8.27	8.18	8.1	8.02
SVR	9.66	9.84	9.28	9.10	8.86	8.62	8.48	8.24	8.07

Source: own elaboration with research data

Fig. 4. Ecuadorian purchasing power for the remaining months of 2023 (April - December) according to SARIMA, SVR and MLP predictions of the BMB



Source: own elaboration with research data.

In this section we discuss the relevance of the results and the limitations of the research. We mostly worked with the methodology followed by INEC in their reports, but it is important to mention that most of the methodology was designed decades ago. It seems necessary to redesign the methodology to fit with the current Ecuadorian reality. For example, the family group may have changed from four members because of new family distribution in the last years; or the assumption that 1.6 members contributes to the family income may vary depending on the rate of employment in the country as concluded in Bustamante et al (2020).

In the forecasting step, it is important to comment that the testing data set only contains 12 records corresponding to the measurements of a whole year. The size of the test data set is relatively small, it is expected that the trained model works better for short-term predictions and losses accuracy with long- term predictions. In the case of SVR and MLP, it is better to predict only one month ahead, once the actual value is released then predict again for the next month with the new value. When we predict the BMB values, we are predicting the inflation as well, this two macroeconomic indicators are closely related to each other. There has been a substantial increase in Ecuadorian inflation in the last couple years, and all the models predicted that inflation in Ecuador will continue to increase this year.

The fact that the Ecuadorian purchasing power always decreases over the year should also be discussed. As commented above, this is due to rising inflation over the year and that the minimum wage (family income) remains constant throughout the year. To avoid great impact on the family economy, the authorities should evaluate the option to readjust the minimum wage twice a year, instead of once. Other countries, like Netherlands, adjust the minimum wage every six months to avoid greater impact like in Ecuador. The authorities should also consider defining a formula to calculate the minimum wage for the next period. The last couple years the increase in the minimum wage has been imposed to fulfil political promises instead of being calculated mathematically considering the national and international economic situation. The increase in the minimum wage should also consider the optimal or desired purchasing power, which will let Ecuadorians to improve their quality of life. This brings the opportunity for future work on the topic of the "Ecuadorian optimal purchasing power", where the amount of surplus necessary to improve the quality of life of Ecuadorians should be discussed.

CONCLUSIONS

This study presents a comprehensive examination of the purchasing power dynamics in Ecuador. The study proposes a novel methodology to assess the purchasing power of Ecuadorians, integrating yearly family income, which is linked to the minimum wage, and the monthly value of the BMB. This approach al- lows for a holistic understanding of the economic well-being of households in the country. Through rigorous analysis, the paper identifies the SVR as the most ac- curate method for forecasting the BMB price for the remaining months of 2023, achieving a testing MAPE of 0.3666. This accurate forecasting method enhances the reliability of the study's results and underscores the potential applicability of the proposed methodology for future economic analyses. The findings reveal a significant pattern in Ecuadorian purchasing power, showing an overall in- creasing trend over the years but experiencing a decline from the beginning to the end of the year. Moreover, all models used in the study consistently project an impending increase in the BMB price towards the end of the

year, leading to a corresponding decrease in Ecuadorian purchasing power during that period. This finding highlights the importance of considering seasonal variations and their impact on household finances when designing economic policies and financial strategies.

These insights have crucial implications for policymakers, economists, and social researchers, as they highlight the challenges faced by Ecuadorian households in accessing basic goods and services. The study emphasizes the importance of understanding the fluctuations in purchasing power throughout the year to design effective policies and measures that can support families in their financial planning and enhance their economic well-being. Furthermore, the study's predictions provide valuable information for individuals and families in Ecuador, particularly those with minimum family income. Saving opportunities identified by the study, such as the potential to save $839.59 a year, can empower families to plan for significant investments, like purchasing a car or a house. However, it also brings attention to the length of time required to achieve these goals, signifying the need for long-term financial planning and support systems. Overall, this research sheds light on the complexities of the Ecuadorian economy and offers valuable insights into the economic challenges faced by its citizens. It serves as a foundation for further investigations and policy-making aimed at improving the well-being and financial security of Ecuadorian households.

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Task	**A1**
A. theoretical and conceptual foundations and problematization:	100%
B. data research and statistical analysis:	100%
C. elaboration of figures and tables:	100%
D. drafting, reviewing and writing of the text:	100%
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