CHAPTER 4: AGRICULTURAL VALUE CHAIN: AN APPROXIMATION OF IMPORTS

4.1. Introduction

Imports represent an essential item in the country's economy. Economic activity and stock market activity, measured as volume, traded value, and some operations, are the purpose of financial markets, being the variability that affects the decision-making of investors, who determine its evolution and evaluation in the future. Import and export market. Forecasting volumes of import and export containers are primary in the planning and operation of port agencies. At the seaport level, container forecasts are needed for strategic planning, finance, and accounting activities.

The demand for products has a social and economic nature, which is associated with the demand or quantity of products that are imported or the consumer wishes to acquire, based on the characteristics, price, price of substitutes or complements and the political conditions of the market, country and international trade. In this way, changes in prices, supply and demand of commodities, economic growth in the region, and trade partners, among others, affect the diversity of imports (Carballea-Orihuela et al., 2021; Vergara-Romero, 2022a). The information on the demand and the projection turns out to be a variable in the decision-making of those involved in the commercialization sector, from small companies to international investors; they must have a support of growing potential demand by the representatives of commercial firms and their forecasts of reliable demand predictions to support competitiveness and investment decisions in their derived projects. In addition, in the current times of the pandemic, it can serve as an input in an attempt to promote a collective reflection on the response to the Covid-19 health crisis and its economic and social effects on our societies (Alzúa & Gosis, 2020; Cuadrado-Rodríguez et al., 2021; Hevia & Neumeyer, 2020). At the sectoral level, import studies allow a vision of productive specialization and gains from the exchange in the economy (Fares et al., 2017; Vergara-Romero, & Moreno-Silva, 2019).

Within the commercial import activities of the country, international trade import containers are produced. Monitoring is vital for the work of the government, banks, and the private sector, as it allows them to react appropriately to the economic cycles in which the economy moves.

In Ecuador, the entities in charge of making the projections have historical data to make the projections, the same as in the annual frequency database (Yaselga, 2019), which refers mainly to time series methods related to the variables of the activity economy. Currently, the task of most excellent attention in time series databases is the measurement of the similarity between time series (García et al., 2016; Guillén-Alvarado et al., 2022).

The estimation of the elasticities of projections of supply and demand for imports presents incredible difficulties due to the variation over time in the number of varieties of goods or products existing in an economy (Echavarría et al., 2019). Classic estimates ignore the appearance of new product varieties, resulting in biased and spurious estimates. In Ecuador, many series present problems that make it difficult to use them promptly, which leads to the loss of information; they are long series; on other occasions, the publication of information is delayed to carry out a short-term forecasting analysis. A pattern of specialization with specific characteristics entails a series of risks for the country (Argudo-garcía et al., 2021; Clavijo, 2017).

Considering the importance of highly reliable data for projections, these products with reliable references can be considered, and the objective of this research work is to estimate and project the demand for four imported products for the period 2021. For this, a daily frequency database was considered for the analysis; a monthly series was built, and then processes related to data analysis were applied to estimate and project demand under the time series methodology with AR models, MA, WEAPON, and ARIMA. We believe that the research results can serve as input to improve learning conditions and public policy. Likewise, to be a reference for future studies for the social actors involved in the import of products and supplies sector. The second contribution consists precisely of a contribution to the empirical literature on the subject to reveal the relationship between the demand for products and their variables.

The methodology used in this research can provide the reader with more tools to evaluate demand projections and trade traffic in the different seasons according to the product type. The case study describes the most relevant contributions of the forecast technique and reviews the methodology in the application of the study, after which the results obtained from the information are discussed, reviewing lines of work.

Ecuador, being an agricultural producer after oil producer, needs consumer goods, fuel, raw materials, capital goods, and various products (BCE, 2020b), a market that provides supplies for agricultural production, mainly of bananas and plantains, coffee, corn, cocoa, flowers and non-traditional fruits, agricultural export products at the margin of the economy, according to the Central Bank of Ecuador BCE and the country's trade balance (BCE, 2020a).

The analysis of the historical behaviour of each variable begins with the graphic representation of the information with simple lines that describe its historical behaviour and possible antecedents of the successions in a period. The importance of container throughput for researchers and port managers becomes important according to the methods used to analyze it.

A model that explains the pattern or variation in the data of a real-time series is known as a time series model (Farooqi, 2014; Morejon-Calixto, & Vergara-Romero, 2022). The most significant characteristic of time series is that events that occurred in the past tend to influence future events (Cervantes et al., 2017). For Idrees et al. (2019) and Jiménez et al. (2008), every time series has the following components: "Trend component (T)"; "Cyclic component (C)"; "Seasonal component (S)"; "Irregular component (I)". Regularization is a reasonably straightforward exercise from a computational point of view that seeks to minimize the error in the model data approximation by penalizing the absolute values of the coefficients and effectively reducing the insignificant coefficients to zero at each step (Fokin & Polbin, 2019; Vergara-Romero, Jimber-del-Río et al., 2022).

Studies related to topics such as demand projections indicate that, in general, autoregressive integrated moving average models (ARIMA) are an alternative for short-term estimates (Paniagua, 2017; Merchán-Acosta, & Vergara-Romero, 2022); they have a greater tendency to provide better results with data referring to a quarterly or monthly frequency; and better capture the behaviour of demand (Chang, 2019; Vergara-Romero, Morejón-Calixto et al., 2022). The integrated moving average auto-regressive model is a statistical model based on data variations and regressions to find patterns for a future prediction (Contreras et al., 2016; Flores, 2019). However, accurate prediction of real data is unattainable, as real-time series data are commonly volatile and non-stationary (Kamal et al., 2020).

4.2. Materials and methods

A time series is a sequence of N observations (data) ordered and chronologically equidistant on a typical or several characteristics of an observable unit at different times.

An estimate is a fair value of a condition or action that represents a smaller value and constitutes a reference in the process or market; the expected value of actions import containers are estimated based on variables such as weight, feet of the container, and necessary space among others.

The time series analysis is based on the assumption that the values taken by the observation variable are the consequence of three components: trend, seasonal, and random. For Villavicencio (2018), the series can be denoted as:

$$Z_t = T_t + E_t + I_t Z_t = T_r + E_r + I_r \quad (1)$$

Z_t is considered as the observation at the current time t.

In the analysis of time series, different processes are available. AR(p) autoregressive processes are based on the idea that the current value of the series Z_t can be explained as a function of p past values Z_{t-1}, Z_{t-2} …, Z_{t-p} where p is the number of delays. An autoregressive model of order p is given by:

$$Z_t = c + \varphi_1 Z_{t-1} + \ \ldots + \varphi_2 Z_{t-p} + \alpha_t \qquad (2)$$

C is a constant value of the series; the φ are coefficients corresponding to each of the lags or past observations, at is white noise with zero mean and constant variance.

The models determined by external sources assume linearity, the values of the external source influence the current value of the series Z t. A general linear process Z_t can represent a linear combination of past and present weights with white noise terms. If a finite number of weights are not zero, there is a process called moving average of order q, MA(q); the notation is as follows (Cryer & Chan, 2008).

$$Z_t = \alpha_t - \theta_1 \alpha_{t-1} - \theta_2 \alpha_{t-2} \ \ldots - \theta_q \alpha_{t-q} \qquad (3)$$

at is a white noise with zero mean and constant variance, the coefficients θ correspond to white noise in previous times. This model is known as short memory since the current observation does not depend on past observations.

Pooling these two models results in another model referred to as the ARMA (p, q) moving average autoregressive model. The general notation of the ARMA model is (Idrees et al., 2019), the p-values defined from the autocorrelations, indicative of the lag in the AR, q estimated in the moving average or MA model (Saturnino et al., 2013).

$$Z_t = c + \varphi_1 Z_{t-1} + \varphi_2 Z_{t-2} + \ \ldots + \varphi_p Z_{t-p} + \alpha_t - \theta_1 \alpha_{t-1} - \theta_2 \alpha_{t-2} \ldots - \theta_q \alpha_{t-q} \quad (4)$$

The series is partially autoregressive and partially moving average, the parameter p is referred to as the autoregressive part, and the parameter q to the moving average, c is a constant value of the time series.

There are series that present variable means; these series are non-stationary. These series present positive or negative trends. The name knows the models that allow this type of series to be analyzed by ARIMA.

A stochastic process (Z_t) is integrated of order d (d ≥ 0 integers) if and only if (Z_t) follows a moving integrated autoregressive model of order (p, d, q) or ARIMA (p, d, q) of the type:

$$\emptyset(B)\nabla^d Z_t = \mu + \theta(B)\alpha_t \qquad (5)$$

For all t = 0, ±1, ±2, …

∅ is the coefficient of the autoregressive part, B is the lag operator, d is the number of differences needed to make the series stationary, Z_t is the current observation, θ is the coefficients related to the moving average at noise blank with zero mean and constant variance. A forecast refers to a scientifically expected, being a vital activity for the organization or the state mainly for decision making to future strategies, and must be accurate, reliable, time-efficient, easy to understand, and as simple as possible (Idrees et al., 2019; Puglla et al., 2017; Salazar et al., 2019; Vanegas & Vásquez, 2017).

For the analysis of homoscedasticity, the graph of the residues must be examined, as it presents an increasing or decreasing trend, it will indicate possible heteroscedasticity (Antunez, 2011).

According to Gentleman et al. (2014) and Villarreal (2005), white noise is a covariance stationary stochastic process with zero mean and covariance. $E(\varepsilon_t \varepsilon_t) = \gamma_t$, for t and 0, where is white noise, complete the formula.

AR model (autoregressive model)

$$Z_t = c + \phi 1 Z_t - 1 + \alpha t \qquad (6)$$

MA model (moving averages)

$$Z_t = c + -1 + \alpha t \qquad (7)$$

ARMA model (autoregressive moving average models)

ARIMA models have been used to estimate agricultural products in various countries. For the deductions of estimates with statistical properties with the ARMA and ARIMA parameters, the series used must be stationary in mean and variance and specify the degree of dispersion at any moment in time (Cuenca et al., 2018; Dobson & Barnett, 2018).

A descriptive analysis was carried out; it consists of observing and evaluating specific characteristics of a particular situation related to imports in Ecuador and its behaviour in the years that are analyzed, quantified and forecast. The Cargo Manifests Company database has a record of imports of various products from 2017 to 2019, of 250 products and a total of 508,798 records of the arrival of containers in different periods. Our sample indicates the port of arrival, date of arrival and the number of 20-foot containers, 40-foot containers and gross kilos. We select four relevant products, among which we have: Petroleum derivatives, Fertilizers, Telephone equipment and telecommunications, and Agricultural chemicals.

Once the time series with the same classification was obtained, an analysis of the time series was carried out, the identification or not being stationary, the construction and estimation of graphs and the search for parameters to later identify the models and forecast.

The quantitative forecasting technique based on the analysis of historical data and the behaviour of the products, divided periodically (daily, later combined monthly), corresponds to the import data of the company's cargo manifests of products that arrive at the ports from Guayaquil and Posorja.

The time series are considered below, followed by an adjustment for seasonality. With the identification of trend lines in the data, the need to apply time series forecasting techniques described above is corroborated.

The study of the activity of imports by containers and products between 2017 and 2019 of the manifest companies allows to determine the evolution over time, both internal and external needs of the market and port, in general theory to predict the containers that arrive product of importation into our country, we developed a framework for modelling and forecasting the volatility variability and correlations made, using the WOLFRAM program, the idea is to estimate the number of containers based on the density and estimates of the associated models. A series is considered stationary if the statistical considerations (mean and variance) are constant over time. If the series is not stationary, the data must be transformed until a stationary temporal record is obtained (Delgadillo et al., 2016; Dunn & Smyth, 2018; Vergara-Romero, Márquez-Sánchez, 2021).

4.3. Analysis and Results

Imports for 2018 show an increase of 1.6%, with the products with the highest demand being refined petroleum oils, transport equipment and transport and storage services (BCE, 2020b).

Table 1 shows the behaviour of imports of products between 2017 and 2019. It can see the minimum and maximum values of the containers that arrive at the ports. The importance of each product lies in the significance and contribution to the country for being purely agricultural. In the case of petroleum derivatives, they are manufactured and processed products, such as Vaselines, and oils, among others.

After product specifications and treatment with outliers, an variability and correlation analysis was performed. Currently, there is an excellent variety of methods available to analyze the fit of economic series, with two tendencies to use said fit: the parametric (empirical) approach and the non-parametric (based on models). The first allows estimating unobserved components in a time series without resorting to the specificity of the statistical model; the seasonal adjustment methodology used in the ARMA program and ARIMA are the most used for this type of economic approach (Villarreal, 2005; Vergara-Romero et al., 2020). There is no universally acceptable loss function for ex-post and nonlinear model forecast comparison (Andersen et al., 2001).

Table 10.

Descriptive import statistics of the analyzed products

Items	Pass	Petroleum derivatives	Telephone equipment and telecommunications	Agricultural Chemicals
Half	707	5	35	94
Maximum	1026	13	78	171
Minimum	428	1	12	56
Standard deviation	163.64	3.22	14.47	23.84
Observations	24758	180	1227	3286

It is possible to obtain stationary series from non-stationary homogeneous series if the differentiation process removes certain local and trend levels; a standard process to differentiate the homogeneous series consists in transforming the original series with the lag operator (1- L) d, being L is the delay operator and d is the degree of taxable differentiation in the series (Chaves et al., 2007; Vergara-Romero et al., 2022).

The results of the models adjusted and used for the data evaluation during the years 2017-2019 are shown in Table 2 of the models for each product. Where the first parenthesis evidences a differentiation between the regular part and a moving average parameter, and the second, the autoregressive parameter, with a confidence level of %, in the graphs of the series, for the stability of the time series is modified to obtain seasonality. ARMA indicates the autoregression parameter and differentiation in the regular part of the moving averages parameter in the regular and seasonal parts. When predicting the export and real exchange rate forecasts, they are more accurate under the ARIMA model than the VAR and VAR-LASSO models (Fokin & Polbin, 2019).

Table 11

Models adjusted and used in the evaluation of the data in the period 2017-2019

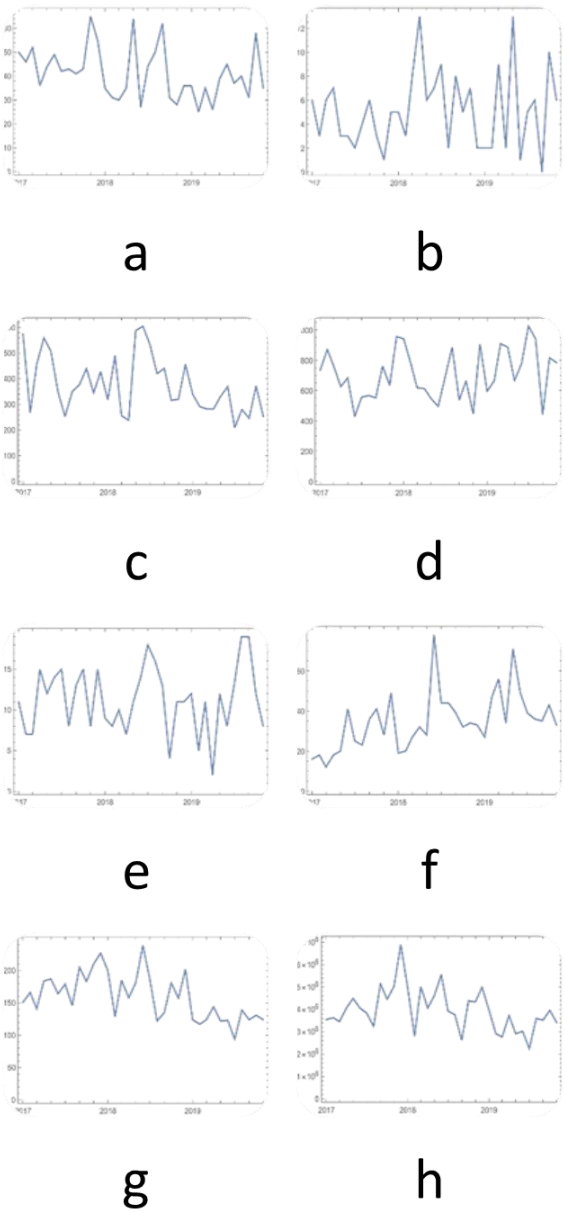
Product	Model	Result	Equation
petroleum derivatives	MAProces (0) 81.4317	$Z_t = c - \Theta 1 a_{t-1} + a_t$	$\mathbf{Z_t} = 5.14+0.1886\ \mathbf{t\text{-}1} + \mathbf{t\text{-}1}$ where **t-1** is the white noise with mean μ=0 and variance $\sigma^2 = 9.80$
Fertilizers	ARMAPro ces(1,2) 352.259	$Z_t = c + \Phi 1 Z_{t-1} - \Theta 1\ a_{t-1} - \Theta 2\ a_{t-2} + a_t$	$Z_t = 763.281 + 0.0790379 Z_{t-1} + 0.419494\ a_{t-1} - 0.0770349\ a_{t-2} + a_t$; where a_t is the white noise with mean μ=0 and variance $\sigma^2 = 26062.5$
Telephone and communicatio n equipment	ARProces s(1) 188.482	$Z_t = c + \Phi 1 Z_{t-1} + a_t$	$Z_t = 24.1222 + 0.311917 Z_{t-1} + a_t$; where a_t is the white noise with mean μ=0 and variance $\sigma^2 = 183.788$
agricultural chemicals	ARMAPro cess(3,1) 220.313	$Z_t = c + \Phi 1 Z_{t-1} + \Phi 2 Z_{t-2} + \Phi 3 Z_{t-3} - \Theta 1 a_{t-1} + a_t$	$Z_t = 116.84 - 0.156786 Z_{t-1} - 0.0948617 Z_{t-2} + 0.00719298 Z_{t-3} + 0.476145 a_{t-1} + a_t$; where a_t is the white noise with mean μ=0 and variance $\sigma^2 = 524.998$

From the results, we can deduce that the equations are based on the demand for the products and their behaviour; thus, petroleum derivatives have an adjusted MA model, telephone and communication equipment an adjusted AR model, while fertilizers and chemical products, agricultural equipment and telephone equipment have ARMA models, the result in the equation will serve to predict their behaviour in the future.

Sankaran (2014), cited by Paniagua (2017), demonstrated the excellent behaviour of the ARIMA models for the demand for fresh vegetable products incorporating seasonal trends (Vergara-Romero, Márquez-Sánchez et al., 2022).

Figure 9.

Products and their adjusted time series (40 Tm). a & b) Petroleum derivates, c & d) Fertilizers, e & f) Telephone and communication equipment, g y h) Agricultural chemical products.



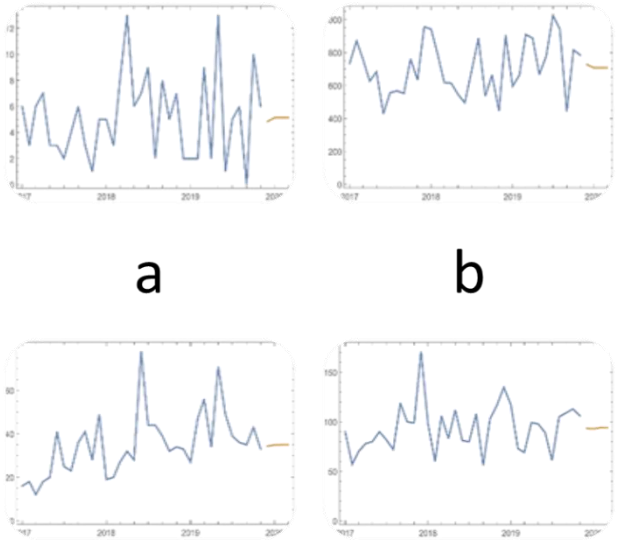
The winter, simple seasonal model, additive evaluation result for import-export volume used in the ports of Korea and China was the ARIMA model (0,1,0) (1,1,0) by import-export volume. export, coastal and transshipment respectively (Kim, 2008; Liu & Park, 2011; Neira et al., 2016; Vergara-Romero, Olalla-Hernández et al., 2020). The "ARMA model" is best suited for stationary time series data, but most real-world time series data show non-stationary behaviour (Idrees et al., 2019). Regarding econometrics, the ARMA model was proposed by Box & Jenkins (1976) and Dos Santos et al (2008).

Next, in the set of figure 8, the distributions by-product every month and container movements are shown for the analyzed products and attach the differences with the adjusted time series.

An early forecast can help predict the net margin; for example, in the CFN product (2017), with the Subscription product for every $100 of subscription sales, $6.7 of net profit remains for the owners. Below is the forecast of the selected products for the following months.

Figure 10.

a) Prediction of petroleum derivatives of 5 with a confidence interval of 1 to 11 containers. b) Fertilizer prediction of 343 with confidence intervals from 135 to 550 containers. c) Prediction of telephone equipment and communication of 34 containers and a confidence interval between 8 and 61 containers. d) Prediction of agricultural chemical products of 93 with a confidence interval between 48 and 138 containers.



Note: For t = ± statistically significant values with a confidence level of 95%

According to the present investigation, the impact of imports of products such as telephone and communication equipment has a more excellent projection or stability to be maintained in 2021; in addition, the projections of fertilizers present better projections for the future considering the average values, petroleum products they have a slight drop similar to that of agricultural chemical products, with a confidence level of 95% it can be defined that the product with the greatest confidence in imports are fertilizers and telephone equipment.

The import and forecast of raw materials for non-traditional products increase according to the unsatisfied needs of consumers. Modifying the seasonality of a series is more stable throughout the year (Flores, 1997). From the economic point of view, imports are explained mainly by household consumption spending and capital formation as an investment measure (Pocaterra, 2019).

4.4. Conclusions

Imports in Ecuador have evolved, primarily through the new product alternatives in the market; however, transportation products continue to predominate within the highly heterogeneous structure. The selected products serve as examples of the projections and models found with differences despite the homogenizations; they serve as a basis for monitoring products that have a diversity of factors influencing demand, such as seasonality and product innovation, especially related to technology.

The models used can forecast the demand for the products after an adjustment, first estimating the consumer's needs, the same ones that presented stable confidence intervals to forecast up to five months in the future. However, it is necessary to consider the observation period to incorporate new data that generates a series to run the model and incorporate this new information. The usefulness of forecasts in investors' decision-making is demonstrated; consequently, it reduces uncertainty in operations and allows for more precise planning of processes.

According to the results of this study, there are similarities between series and differences between products. In the case of fertilizers, the series shows higher imports than products; Telephone and communication equipment, agricultural chemical products, and petroleum derivatives depend on the investments, acquisition capacity, and location in the port, among other factors. However, the economic levels considered in the time series indicate a growth in the number of products. After comparing the series, we must be more competitive in the

prediction; the order of influence of factors helps to have greater clarity and efficiency in future works in the collection and analysis of other products in more extended periods, using the methodology of cause and effect of the series of time in future studies.

4.5. Recommendations

It is proposed to carry out the implementation of the primary methodology for purging the data of each of the products, in a cyclical manner of at least three annual periods, the purging of all the imported products, a time in which the results of the implementation of this methodology that count the ports, socialize with organizations that require making inferences and standardization of requirements in the units. For the logistics and decision-making of the service, an added value to the budget is understood and conducive to generating strategies and, therefore, optimising resources. The predictive model may present periodic imbalances, possibly due to structural changes, so it is advisable to periodically evaluate the models to improve the accuracy of the forecasts. Practical experience shows that we have to model and obtain different results from different models and generate greater confidence in the prediction at the time of decision making. It is recommended to use specific indicators when possible, consider important events that affect the study factor, correct atypical observations, follow up on prediction errors in case of applying corrections to the mean, and plot the predictions with the respective confidence intervals.

Concerning economic forecasts, possibly factors such as inflation, supply and demand, and external factors (pandemic) can affect the volatility values in variables subject to exogenous changes with economic insecurity, uncertainty and expectations; the models are difficult to model, and therefore, the prediction results would tend to have a high error component.

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