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DEMANDA DE IMPORTACIÓN DE CAMARÓN ECUATORIANO EN ESTADOS UNIDOS PARA EL PERIODO 1990-2018

US IMPORT DEMAND FOR ECUADORIAN SHRIMP FOR THE PERIOD 1990-2018

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Resumen

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Gran parte del crecimiento que ha tenido la industria camaronera en el Ecuador se debe a que Estados Unidos históricamente ha sido el principal comprador/importador de camarón ecuatoriano. Es por ello, que esta investigación tuvo como objetivo estimar la demanda de importación de camarón ecuatoriano de Estados Unidos entre 1990 y 2018. Las variables utilizadas fueron los precios del camarón ecuatoriano y tailandés, la renta de los consumidores americanos explicada a través del PIB de Estados Unidos y la presencia del virus de la mancha blanca en el camarón ecuatoriano como variable dummy. El método de estimación utilizado fue Mínimos Cuadrados Generalizados. Los resultados del modelo mostraron que las variables utilizadas explicaron esta demanda y que el precio del camarón ecuatoriano y la renta de los consumidores americanos, fueron las variables más significativas que deberían analizar los empresarios camaroneros del Ecuador, para ingresar a este mercado o incrementar sus exportaciones.

Palabras clave: Camarón ecuatoriano, Demanda, Estados Unidos, importaciones, Mínimos Cuadrados Generalizados

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Abstract

Great part of the shrimp industry growth in Ecuador is due to the fact that the United States has historically been the main buyer/importer of Ecuadorian shrimp. For this reason, this research aimed to estimate the US import demand for Ecuadorian shrimp between 1990 and 2018. The variables used were the prices of Ecuadorian and Thai shrimp, the American consumers' income explained through the GDP of the United States and the presence of the white spot virus in Ecuadorian shrimp as a dummy variable. The estimation method used was Generalized Least Squares. The results of the model showed that the variables used explained this demand and that the price of Ecuadorian shrimp and the American consumers' income were the most significant variables that Ecuadorian shrimp businessmen could analyze to enter this market or increase their exports.

Keywords: Ecuadorian shrimp, Demand, The United States, imports, Generalized Least Squares

Introduction

The expansion of the shrimp industry in Ecuador dates back to the 1970´s, where the availability of resources, such as extensive saline areas and a suitable climate, made it possible to obtain a high-quality, competitive and profitable product (Food and Agriculture Organization of the United Nations, 2013). This prompted shrimp entrepreneurs in the country to start exporting early, with the United States being the main destination, followed by Europe and Asia (Sarmiento et al., 2019).

The areas dedicated to shrimp production expanded until the mid-1990s and were financed by private investment. In this way, by 1998, the shrimp industry became the country's second most relevant non-oil export product, being a fundamental axis for the economy (Food and Agriculture Organization of the United Nations, 2013). In addition, this year the ecuadorian shrimp exports represented 66% to the United States ; which placed Ecuador as its second largest shrimp supplier, behind Thailand, with a 20% share (Banco Central del Ecuador, 2019).

Nevertheless, in the years 1999 and 2000, this industry was strongly affected by the white spot virus, which generated a decline in exports of more than 60% compared to 1998. Consequently, thousands of shrimp farms were closed and tens of thousands of workers in the sector lost their jobs; Likewise, the partition of Ecuadorian shrimp in imports from the United States was affected, reducing to only 6% (The United States Departament of Agriculture, 2019).

The repercussions of this virus on shrimp exports lasted for about a decade; reaching only in 2010, similar export numbers close to those obtained in 1998 (Banco Central del Ecuador, 2019). However, this did not have a negative impact on trade relations with the United States, since it continued to be the main export destination for Ecuadorian shrimp, while markets such as Asia and Europe gained more participation and importance.

By 2018, shrimp exports had tripled compared to 2010; positioning it as the country's main non-oil export product (Banco Central del Ecuador, 2019). Nonetheless, the United States did not increase their imports,

according the growth of Ecuadorian shrimp exports, so its participation in these was reduced, from 44% in 2012, to 17% in 2018, placing it in this last year as the third largest importer of Ecuadorian shrimp, while Vietnam and China were the two main importers.

Given this context, it can be said that the United States has had a constant participation in the Ecuadorian shrimp exports, being a fundamental market for the growth of this industry. Therefore, the objective of this research is to estimate the US import demand for Ecuadorian shrimp, from 1990 to 2018 and thereby answering: What variables explain the US import demand for Ecuadorian shrimp? And contribute with factors of analysis regarding the American market in which the Ecuador businessmen make decisions.

1.2 Theorical framework

The term demand refers to the quantity of goods or services that consumers are willing to buy given a certain price (Parkin, 2018). However, it is said that the lower the price of a product, the higher its demand, thus having an inverse relationship between these two variables, giving way to what is known as the law of demand. According to Arroyo et al. (2015), the price is one of the main determinants within the imports demand of a good.

On the other hand, the demand also depends on the price of related goods, on which three types of goods are distinguished: independent, complementary and substitute goods (Colander, 2020). Independent goods are not related to other types of goods and therefore a variation in their price would not affect the quantity demanded of another good. Complementary goods are used together to cover a necessity, so they present an inverse relationship between their price and the quantity demanded of their complement; and, substitute goods are those that allow to satisfy a necessity separately, so they present a direct relationship between their price and the quantity demanded of their substitute (Besanko & Braeutigam, 2020).

In foreign trade, there are other determinants in the import demand of a good, such as the income of national consumers (Rangel et al., 2019). It is inferred that by increasing their income, they increase the demand for all goods (domestic and imported), so an increase in their income will generate an increase in imports. However, it is necessary to note that when presenting this direct relationship between income and quantity demanded, we speak of normal goods; while in the event that an inverse relationship is presented, we speak of inferior goods (Colander, 2020). One of the most common indicators to measure the total income of consumers in a country is the Gross Domestic Product (GDP), which shows the current production of final goods and services within a national territory, in a given period (Larrain, 2020)causing the pole inequality relations between men and women. Therefore, in this study wanted to dismantle the detail view of some theories, both social and feminist about gender relations in the family. Each of these theories (structural functional, conflict and feminist.

The real exchange rate is considered another highly relevant determinant within this framework (Sánchez et al., 2011). This refers to the price of goods and services of one country in relation of another country, in other words, it represents the purchasing power between two countries (Krugman et al., 2018). Nevertheless, it should be noted that between Ecuador and the United States there is no defined real exchange rate, as they have the same currency since 2000 and different base years in the calculation of the consumer price index.

As mentioned above, there are some determinants in the import demand of a good. However, the magnitude of the effect of these depends on the elasticity it presents. Elasticity measures the sensitivity of the quantity demanded of a good in percentage terms to changes in any of its determinants, in other words, it shows the percentage variation that one variable will present in response to a 1 percent increase in another (Pindyck & Rubinfeld, 2018).

The price elasticity of demand measures the degree to which the quantity demanded of a good responds to a change in its price (Colander, 2020). Three results are distinguished in elasticity: elastic, inelastic and unitary. When demand is elastic, it is greater than 1 in absolute terms, which means that there is a percentage change in the quantity demanded greater than the change in its price. When demand is inelastic, it is less

than 1 in absolute terms, which means that the percentage change in price is greater than that in quantity demanded. Finally, when the demand is unitary, it is equal to 1 in absolute terms, which means that the change in the quantity demanded is equal to its price as a percentage (Parkin, 2018).

On the other hand, the cross elasticity of demand measures the degree on which the demanded quantity of a good responds to changes in the prices of related goods (Besanko & Braeutigam, 2020). Substitute goods in this framework have an elasticity with a positive sign; while complementary goods have an elasticity with a negative sign; and, the independent goods show an elasticity equal to zero.

It is also essential to talk about the income elasticity of demand, which measures the degree on which the demanded quantity of goods responds to a change in consumer income (Colander, 2020).When this elasticity has a positive sign, it is a normal good, while when it has a negative sign, it is an inferior good; thus fulfilling the two types of relationships that income can present with respect to the consumption of a good. In addition, it should be noted that, within normal goods, two types are distinguished: necessary goods and luxury goods. When it comes to basic necessities, it is expected that these present a low elasticity, since it is difficult for them to stop consuming despite changes in income, while when it comes to luxury goods, the opposite is expected (Mankiw et al., 2020).

Finally, it is necessary to highlight that the elasticity analysis is very useful to explain the behavior of foreign trade. For example, when analyzing the trade balance of a country, and obtaining that the income elasticity of imports is greater than the income elasticity of exports, it means that there is a trend towards a trade deficit; whereas, when the income elasticity of exports is higher, there is a tendency towards a trade surplus; having finally, that when these are equal, there is a tendency towards equilibrium (Zack & Dalle, 2015). However, it should be noted that the result of these elasticities is usually sensitive to the type of variables and the period of time considered for its calculation (Albornoz, 2018).

2. Literature review

2.1 Domestic demand estimations

There are various studies on import demand models. In general, these focus on the analysis of the demand for a specific product, for a given market, and in some cases, it is intrinsically explained through domestic demand. Therefore, within this literature review, some relevant research has been selected, which will allow a greater insight into the determinants used to explain an import demand model and the different estimation methods. Next, the investigations are ordered starting with general goods up to those related to shrimp.

In the study carried out by Moreno et al. (2021), it was estimated the beer demand in Mexico, for the period 2007-2019. The estimation method used was Ordinary Least Squares (OLS). The explanatory variables of this demand were the beer price index as a proxy for the price and the general index of economic activity as a proxy for the income of the Mexican people. The results showed that beer was an elastic good and that the variable that had the greatest effect on its demand was price.

Rebollar et al. (2020), estimated the demand for chicken meat in Mexico, for the period 1996-2018. In the same way, OLS was used in this research. The variables used were the real price of chicken meat, the real GDP of Mexico, the real price of bovine meat, the real price of pork meat and the population. Among the main results, they found that the demand for chicken meat was inelastic in Mexico and that beef was considered a substitute good, while pork meat was considered a complementary good.

Figueroa et al (2019) estimated the demand for bovine meat in Mexico, for the period 1996-2017. To do this, it was used the OLS method through a double logarithm model, having as explanatory variables of this demand the real price of bovine meat, the real price of pork meat and the real GDP per capital of Mexico. As results, it was found that this demand was inelastic in the Mexican market, with real income being the variable that had the greatest influence on it.

Another study of demand applied in Mexico was the one carried out by Moreno et al (2017) where it was estimated the domestic demand for corn, for the period 1980-2011. In this case, they used as estimation method Two-Stage Least Squares through simultaneous equations. The variables used were the price of corn, GDP, population and as a dichotomous variable the period of the North American Free Trade Agreement (NAFTA). Among the main results, they found that the price and NAFTA were the variables that best explained the domestic demand for corn in Mexico; furthermore, they found that price and income were elastic.

León and Tonon (2020) made a recent contribution locally on a US demand model, which was focused on estimating the domestic demand for bananas, for the period 2001-2016. The estimation method they used was OLS, through a double logarithm model. As result, it was found that this product was considered an inelastic and normal good in the US market and that the local banana demand was explained by the consumer price index for bananas, the per capita income of that country and the quantity demanded of bananas lagged a period. It should be noted that the apple consumer price index was excluded from the model, since it turned out to be a non-significant variable individually.

In the research made by Alonso et al (2017) they estimated in the same way a demand model in relation to a fruit, being the guava in the Colombian market, based on the 2006-2007 National Income and Expenditure Survey. The estimation method used was the Almost Ideal Demand System (AIDS). To explain this demand, they used the price of guava and household spending. Among its main findings, they found that the demand for guava in Colombia was inelastic and considered a normal good.

On the other hand, in the study of García del Hoyo et al (2017) the demand for canned tuna in Spain for the period 2007-2015 was estimated. The method was AIDS and the variables used to explain this demand were the share of the cost of canned sardines, as well as canned tuna, the price of sardines and canned tuna, and the price of other canned fish. Among the different results found in this research, it stands out that the Spanish demand for canned fish was quite inelastic with respect to price and in relation to spending, tuna was classified as a luxury good.

Tokunaga (2017) likewise carried out a demand study on tuna, but in this case applied to the Japanese market, where he estimated the price elasticity of demand for Pacific bluefin tuna for the period 2004-2014. To do this, he used the instrumental variables approach, through a dummy variable that indicated the years of low fishing catch and another that indicated the average annual catch per fishing trip. Among the main results of his research, he found that the demand for Pacific bluefin tuna was elastic in the Japanese market and that this product became a luxury food.

2.2 Import demand estimations

In the investigation by García (2017), the world demand for Argentine dairy products was estimated, through its main importers, for the period 1990-2013. The method used was panel data and the explanatory variables were the income explained by the GDP per capita and the real exchange rate. As result, it was found that the variable that had the greatest influence on the demand was consumer income, which presented an elastic result, while the real exchange rate presented an inelastic result.

Liu and Song (2021)estimated the Chinese import demand for wine, for the period 2002-2018. The estimation method used was Autoregressive Distributed Lag Model and the determinants of this demand used were the GDP of China, the level of prices of imported wine, the price index of all alcoholic beverages in China and the real effective exchange ratio. The results showed that income was the most important determinant in this demand and the price had a significant role only for certain markets.

In the case of the research carried out by Dellal and Koç (2003), the import demand for apricots from Turkey for the period 1987-2000 was estimated. The estimation method used was OLS. The variables used in the model were the price per kilogram of apricot and the per capita income of the different destination countries. The main result they found was that the variable that had the greatest influence on this demand was price.

Nguyen et al. (2019), estimated US import demand for spices and medicinal herbs from North America, Asia, South America, and Europe, for the period 1990-2018. The variables used were price and real income, and the estimation method was through the Rotterdam model. The re-

sults indicated that the demand for both spices and medicinal herbs was inelastic for all suppliers, also, an increase in rent's income would benefit mostly Asia and South America.

In the study carried by Sánchez et al. (2011), the OLS estimation method was used in the same way as investigations mentioned above. In this case the US import demand for Mexican Persian lime was estimated, for the period 1994-2008. The main variables of the model were US GDP to explain income, the unit price of imports and the real exchange rate peso/dollar. As result, it was found that this product was considered a superior normal good in the American market and that the inhabitants' income turned out to be the variable that mostly explained the behavior of this demand.

Nahuelhual (2005) estimated the US import demand for Chilean table grapes, for the period 1989-2002. The estimation method was AIDS and the explanatory variables implemented in their model were price (cif/kg) and the participation in grape imports from the United States. As results of the model, it was found that this demand was inelastic, and that the Mexican grape presented a substitute relationship to the Chilean grape in this market; however, it was determinate that there is no preference from the final consumer in the origin of the grape.

Another investigation on the US demand for imports was carried out by Seale et al. (2013), which was focused on estimating the demand for fresh tomatoes, melons, onions, oranges and spinach from its main suppliers, such as Mexico, Canada, Chile, among other countries, for the period 1989-2010. The variables used were the price of the exporting country and the participation in the expenditure of the fruit or vegetables of the exporting country. The estimation method was OLS and among the different results of the study, it was found that all these products presented an inelastic behavior with respect to price and in the case of products from Mexico and Chile they presented an elastic behavior with respect to spending.

Hatab & Surry (2022) estimated the demand for potato imports from Germany, Italy and the United Kingdom, with the aim of analyzing the competitiveness of potatoes from Egypt, for the period 1994-2018. To do this, they used the import price (cif/kg) and the annual expenditure on potatoes as explanatory variables, additionally, the estimation method

was AIDS. The results indicated that Egyptian potatoes presented an elastic demand with respect to price and spending in these markets, reaching the conclusion that they were competitive due to the seasonality of their exports.

In the case of the investigation made by Arroyo et al. (2015), they analyzed the Mexican demand for imports of American peach, for the period 1982-2011. As explanatory variables they used Mexico's GDP, the peach import unit price and the real peso/dollar exchange rate. The estimation method of the model was OLS and among the main results, they found that the American peach in the Mexican market presented an elastic demand and was considered a necessary good.

For his part, Collantes (2015) estimated the demand for Peruvian imports of yellow corn, for the period 2003-2015. The method used for this research was the Johansen and Jusilius cointegration methodology. The variables used were the real GDP and the relative price of imports, with which prolonged, that the demand for imports of this good, depended conditionally on these two variables and that the price had a greater influence than the income.

Giancinti et al (2020) estimated the international demand for pears from the main importers in the world, for the period 1990-2015. The method used was panel data and the variables considered for the analysis were the pear prices (cif/kg), the per capita consumption of pears, apples and stone fruits, the real per capita income, the consumer price index and the real exchange rate of the countries. As results it was found that this demand was inelastic and that there was not much possibility of intervening in this market.

On the other hand, in the work of Saweda et al (2021) they estimated the domestic demand and the import demand for Nigerian fish, for the period 2010-2015. The method used was the Exact Affine Stone Index (EASI) Demand System. The variables used were the actual food consumption, the fish price index, and some demographic variables. As main results, they found a substantial difference in the consumption of fish between the north and the south of the country, considering imported fish as a normal good for the south, while for the north as a luxury good.

The last research that was included within this literature review is the one made by Tabarestani et al. (2017)Ecuador, India, Indonesia, Mexico, Thailand, Vietnam, and rest of world [ROW] due to its relevance around the subject of study, since they estimated the US import demand for shrimp from its main suppliers, among which were Ecuador, for the period 1995-2014. To do this, they used the Rotterdam Mixed Demand System method, through apparently unrelated regressions. The findings were very significant, highlighting that Ecuador was the country with the most inelastic demand while China had the most elastic demand. Furthermore, the cross elasticities of demand showed that the main US shrimp supplying countries were substitutes for each other in this market.

It has been shown that among the different studies on domestic demands and import demands, the variables that were most used to explain the demand for a product were the price and the income of consumers. On the other hand, it can be noted that, despite the fact that there is no exact formula to estimate an import demand model, among the most widely used methodologies, the one that stands out the most is OLS.

3. Method

The research was of exploratory nature; since, a vast knowledge on the subject in question has not been evidenced. On the other hand, it can be highlighted that this had a quantitative approach; because numerical information, statistical techniques and theory were used to estimate the import demand model.

The study population was US imports of Ecuadorian shrimp measured in tons, in the period 1990-2018. This data was annual, so there were 29 observations. This period was chosen because since the 1990s, Ecuadorian shrimp had a high share of shrimp imports from the United States, with 2018 being the most current data available on Ecuadorian shrimp imports.

The variables that were used to explain this demand were; the price per ton of Ecuadorian shrimp imported by the United States. Followed by the price per ton of Thai shrimp imported by the United States, which represented the price of the related good; where, it should be noted that Thailand was considered, because it was the main supplier of shrimp in this market, within the study period. Additionally, the presence of the white spot virus in Ecuador was taken into account, as a dichotomy variable; which was a shrimp disease that strongly affected its production and therefore exports; and, finally, the GDP of the United States, as a proxy variable for income, as expressed by Sánchez et al (2011).

For the estimation of the model, secondary information was used. The data on the amount of Ecuadorian shrimp imported by the United States (Qi) came from the aquaculture trade database of The United States Departament of Agriculture (2019). The data was made up of imports of frozen, fresh, canned and otherwise prepared shrimp. In addition, it should be noted that the unit of measurement of this data was originally in thousands of pounds, however, for a better interpretation it was transformed into tons.

In the same way, the data about the price per ton of Ecuadorian shrimp imported by the United States (Pe), as well as the price of shrimp from Thailand (Pt) came from the aforementioned database, and were in

current dollars. However, a calculation was required to determinate the value of these variables; which consisted of dividing shrimp imports from the country of origin in thousands of dollars by the amount of shrimp imported in tons.

The data for the Gross Domestic Product of the United States in current dollars (GDP) came from the national database, on the account of national income and products of The United States Bureau of Economic Analysis (2022). The unit of measurement in which GDP was found was billions of dollars.

Regarding the data of the dichotomous variable of the presence of the white spot virus in Ecuadorian shrimp (WS), it was created by entering 1 in the years that this virus existed in Ecuador and 0 in the rest of the years of study. Therefore, the Food and Agriculture Organization of the Unites Nations (2021) was used as a source of information to establish the years that this virus appeared.

On the other hand, to obtain a better adjustment of the model and interpretation of the results, the parameters were transformed in terms of natural logarithms. In this way, the model was specified, through equation 1.

Equation 1

Specification of the US import demand for Ecuadorian shrimp

$$lnQi=B_0-B_1\ lnPe+B_2\ lnPt+B_3\ lnGDP-B_4\ WS+e_t$$

The indicates the natural logarithm of the amount of Ecuadorian shrimp imported by the United States in tons, shows the regression intercept, is the natural logarithm of the price per ton of imported Ecuadorian shrimp, is the natural logarithm of the price per ton of imported Thai shrimp, is the natural logarithm of the US GDP, which indicates income, is the presence of white spot virus in shrimp from Ecuador, and finally shows the error term.

On the other hand, the econometric method that was initially used to estimate the model was Ordinary Least Squares, as it is a method used in various demand models, such as Dellal and Koç (2003), Seale et al. (2013), Sánchez et al. (2011), Arroyo et al. (2015), León and Tonon (2020) and Moreno et al (2021); however, given the presence of autocorrelation in the residuals, it was decided to use Generalized Least Squares (GLS), which is a non-parametric method, which, like OLS, allows obtaining the best linear unbiased estimators (BLUE) (Stock & Watson, 2020).

The advantage of the GLS method is that it gives greater weight to observations with less variability, that is, to those that are closer to the population mean, which unlike OLS assigns equal relevance to all observations despite the fact that have high variability (Gujarati & Porter, 2010).

It should be noted that the statistical software used for the estimation was RStudio and the codes used for it are exposed in appendix 1.

4. Results

Being a non-parametric model, it was not necessary to carry out assumption validation tests, so it proceeds to present the results obtained, through Table 1 and Equation 2:

Table 1

Results of the US import demand for Ecuadorian shrimp

Variable	Coefficient	P-value
C	7,4601*	0,0842
lnPe	-1,0852*	0,0748
lnPt	0,9593	0,1251
lnGDP	0,4611*	0,0758
WS	-0,3315*	0,0698

* Meaning at 10%

Equation 2

US import demand for Ecuadorian shrimp

$$lnQi=7,46-1,085lnPe+0,959lnPt+0,461lnGDP-0,332WS$$

The results of the model indicate that the four variables used together explain the US import demand for Ecuadorian shrimp. However, the natural logarithm of the price per ton of Thai shrimp imported by the United States is not a significant variable individually; although, it's positive sign is as expected, which indicates that it is a substitute good for Ecuadorian shrimp in the American market. In addition, the result indicates that for every 1% increase, the amount of Ecuadorian shrimp imported by the United States will increase by 0.959% ceteris paribus.

On the other hand, the natural logarithm of the price per ton of Ecuadorian shrimp imported by the United States indicates that for every 1% increase, the imported quantity will decrease by 1.085% ceteris paribus, thus having an inverse relationship between price and quantity demanded, which shows that the law of demand is fulfilled. In addition, this result shows that the US import demand for Ecuadorian shrimp is price elastic.

Regarding the natural logarithm of the US GDP, it indicates that for every 1% increase, the amount of Ecuadorian shrimp imported by the United States will increase by 0.461% ceteris paribus, thus having a direct relationship between income and quantity demanded. This result indicates that the US import demand for Ecuadorian shrimp is inelastic with respect to the income of American consumers, which in turn shows that Ecuadorian shrimp is considered a necessary good (normal good) in the American market.

Lastly, the dichotomous variable of the white spot virus indicates that when this virus is present, the amount of Ecuadorian shrimp imported by the United States will decrease by 0.332% ceteris paribus, which shows that this virus did negatively affect the US import demand for Ecuadorian shrimp.

5. Discussion

Firstly, although Thai shrimp price variable turned out not to be individually significant, it was left as part of the model, since it had explanatory power along with the rest of the variables. However, this differs from the results of León and Tonon (2020) where they completely excluded the variable price of the related good from the model, because it was not significant and caused heteroscedasticity problems. Nevertheless, in this case, when using MCG as the estimation method, no assumption was breached, so the inclusion of this variable in the model is valid.

Secondly, the fact that the price of shrimp from Thailand shows a substitution relationship with Ecuadorian shrimp, agrees with the results of Tabarestani et al. (2017)Ecuador, India, Indonesia, Mexico, Thailand, Vietnam, and rest of world [ROW], that the main shrimp-supplying countries of the United States were substitutes for each other in this market. This shows the high competitiveness that exists between the different shrimp exporters. In addition, due to the high demand for this product, as well as its great substitutability, it is possible to affirm that there is no preference in the United States for any specific shrimp origin.

Thirdly, it was found that price is the variable that had the greatest influence on the US import demand for Ecuadorian shrimp, which coincides with the findings of Dellal and Koç (2003) as well as Moreno et al. (2021), in their respective study demands. However, in researches such as the one of García (2017) or the one of Liu and Song (2021) they found that the variable with the greatest influence was income. The main reason why these results differ is because each investigation studies both a different good and a different market; therefore, their demands respond differently to changes in these variables. Knowing the level of influence that the price has on the demand for Ecuadorian shrimp can be very useful for entrepreneurs in this sector, since it represents an important factor of analysis, to strengthen future decisions and increase exports to the United States.

Fourthly, regarding the result about that Ecuadorian shrimp is considered a necessary good, this can be contrasted with the results of Tokunaga (2017) and García del Hoyo et al (2017), where they found that Tuna

was considered a luxury good in Japan and Spain respectively. A similar response would have been expected, since both are seafood products; however, it is not being considered that they are different markets. Therefore, the results of the study carried out by Shamshak et al (2019) on the consumption of seafood in the United States were taken into consideration, which indicate that shrimp became the main seafood consumed in the country; thus showing that shrimp is a necessary good in this market, and, therefore, that there is a different level of response in the consumption of seafood, among these markets. In this way, it can be taken for granted that there will be a demand for Ecuadorian shrimp in the United States, both in periods of abundance and economic recession, being this result a decisive factor when entering this market.

Lastly, it is necessary to underline that the inclusion of the dummy variable of the white spot virus in the model can be considered as a significant contribution to the literature, since in none of the import demand models mentioned in the literature review, the effect of a virus or plague was considered as an explanatory variable. In addition, it can be noted that the effect of this virus had not been studied through a demand model.

6. Conclusion

In conclusion, the stated objective was met, in this way the US import demand for Ecuadorian shrimp, for the period 1990-2018, is explained by the price, the American consumers income (GDP), the price of shrimp from Thailand and the presence of the white spot virus. Noting that the price is the variable with the greatest influence on this demand; while the presence of the white spot virus is the variable with the least influence.

On the other hand, it can be concluded that the price and American consumers income are the most significant variables in the study demand. This is because they represented the main analysis factors that must be taken into consideration when evaluating the demand for a good, according to the theory and literature reviewed. In addition, this are variables that could strengthen the decisions of Ecuadorian shrimp businessmen to enter to the American market or increase exports; which makes them the main beneficiaries of this research, followed by companies that would be favored by growth in the sector, such as laboratories, hatcheries, packers and shrimp traders.

Regarding the results of the econometric model, it can be concluded that Ecuadorian shrimp has an elastic demand in the American market and is considered a necessary good. In addition, Thai shrimp is a good substitute for Ecuadorian shrimp and the presence of the white spot virus negatively affects imports of Ecuadorian shrimp.

In relation to the estimation method used, it was determined that, by using Generalized Least Squares, the information can be better extracted in time series with high volatility; whereas, in Ordinary Least Squares, this can cause problems such as autocorrelation and heteroskedasticity of residuals. Therefore, the use of a non-parametric estimation method was the most appropriate to estimate the US import demand for Ecuadorian shrimp.

It can be noted that there were some limitations at the time of conducting the research, which were linked to the availability of information. In the first place, it was not possible to determine the valuation method used to account Ecuadorian shrimp imports, that is, the Incoterm; since its source does not specify it. Therefore, it is not known if the value of imports includes import costs or not; and secondly, the research could not be conducted with a more current study period, because the data source discontinued updates of US aquaculture data.

Finally, it can be said that this study opens new lines of research to estimate new import demand models between the United States and Ecuadorian products, such as tuna, fish and coffee; which, like shrimp, have great economic relevance for Ecuador and the United States leads the main export destinations. In the same way, applied research could be carried out among other countries and products.

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8. Appendix

Appendix 1

Model estimation in RStudio

```
library(readxl)
Base_de_datos_tesis_procesada_formato_R <- read_excel("C:/Users/
Christopher León/Desktop/Tesis/Datos Tesis/Base de datos tesis
procesada formato R.xlsx")
base2<-Base_de_datos_tesis_procesada_formato_R
attach(base2)
modelo<-lm(Qi~Pe+PIB+Pt+MBE,data = base2)
summary(modelo)

##
## Call:
## lm(formula = Qi ~ Pe + PIB + Pt + MBE, data = base2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.54413 -0.11963  0.06929  0.16477  0.42785
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   4.1852     3.1056   1.348 0.190366
## Pe           -1.6672     0.7834  -2.128 0.043794 *
## PIB           0.5416     0.1356   3.995 0.000534 ***
## Pt            1.8030     0.6377   2.827 0.009320 **
## MBE          -0.4559     0.2045  -2.229 0.035445 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '
1
##
## Residual standard error: 0.2601 on 24 degrees of freedom
## Multiple R-squared:  0.5689, Adjusted R-squared:  0.4971
## F-statistic: 7.918 on 4 and 24 DF,  p-value: 0.0003224

library(lmtest)

## Loading required package: zoo

##
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':
##
```

```
##     as.Date, as.Date.numeric

bgtest(modelo)

##
##  Breusch-Godfrey test for serial correlation of order up to 1
##
## data:  modelo
## LM test = 10.409, df = 1, p-value = 0.001254

dwtest(modelo)

##
##  Durbin-Watson test
##
## data:  modelo
## DW = 0.92601, p-value = 7.059e-05
## alternative hypothesis: true autocorrelation is greater than
0

library(nlme)
modeloajustado<-gls(model=Qi~Pe+PIB+Pt+MBE,data=base2,correla-
tion = corAR1(),method =”ML”)
summary(modeloajustado)

## Generalized least squares fit by maximum likelihood
##   Model: Qi ~ Pe + PIB + Pt + MBE
##   Data: base2
##        AIC      BIC   logLik
##   1.607865 11.17894 6.196067
##
## Correlation Structure: AR(1)
##  Formula: ~1
##  Parameter estimate(s):
##       Phi
## 0.6353106
##
## Coefficients:
##                 Value Std.Error   t-value p-value
## (Intercept)  7.460776  4.141081  1.801649  0.0842
## Pe          -1.085176  0.582632 -1.862543  0.0748
## PIB          0.461088  0.248416  1.856113  0.0758
## Pt           0.959251  0.603553  1.589340  0.1251
## MBE         -0.331477  0.174644 -1.898016  0.0698
##
##  Correlation:
##     (Intr) Pe     PIB    Pt
## Pe  -0.176
## PIB -0.663  0.061
```

```
## Pt  -0.305 -0.831  0.019
## MBE  0.106  0.001  0.001 -0.084
##
## Standardized residuals:
##        Min         Q1        Med         Q3        Max
## -2.2577347 -0.1536553  0.1624145  0.7472326  1.5118184
##
## Residual standard error: 0.2508075
## Degrees of freedom: 29 total; 24 residual
```