

Elasticity of Demand for Avocado to the European Market and the United States, Years 2010 – 2020

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Abstract

The analysis was carried out for the period from 2010 to 2020, where the production and export volumes of avocado to European and North American countries are shown. The objective of this study is to determine the elasticity of demand for avocado in these countries. "Since Alfred Marshall included it in his work Principles of Economics.

An analysis is made of the statistical series of each variable, its historical evolution, as well as its individual trends.

Based on the following econometric model:

$$Qd(t) = \beta_0 + \beta_1(P)t + \beta_2(Yp)t + \beta_3(TC)t + \beta_4(N) + u$$

Eviews 9.0 software was used, applying a log-log econometric model where the data series are given in years.

To measure the elasticity of demand for avocado, the indicators used were consumption, population, per capita income in dollars, and the international price of avocado in dollars.

In the Netherlands, the demand for Peruvian avocado shows the following behavior:

- a. *A 1% increase in price causes a reduction in demand of 0.16 %.*
- b. *An increase in per capita income of 1% causes the demand for avocado to increase by 2.7%.*
- c. *A 1% increase in population causes the demand of avocado to increase by 8.23 %.*

In Spain, the demand for Peruvian avocados shows the following behavior:

- a. *A 1% increase in price generates a reduction in demand of 0.09 %.*
- b. *If per capita income increases by 1%, the demand for avocado increases by 0.13 %.*
- c. *A 1% increase in population generates that the demand for avocado increases by 3.49%.*

In the U.S., demand for Peruvian avocados shows the following behavior:

- a. *A 1% increase in price generates a reduction in demand of 1.25%.*
- b. *If per capita income increases by 1%, the demand for avocado increases by 16.99%.*
- c. *A 1% increase in population causes the demand for avocado to decrease by 1.38%.*

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In ENGLAND, the demand for Peruvian avocado shows the following behavior:

- d. A 1% increase in price generates a reduction in demand of 0.03 %.*
- e. If per capita income increases by 1%, the demand for avocado decreases by 0.47%.*
- f. A 1% increase in population generates that the demand for avocado increases by 3.62%.*

INTRODUCTION

In the last decade, Peru has seen an increase in avocado production, which has led to a surplus of avocado production being exported to European and North American markets, which has been reflected in the behavior of the increase in demand. Thus, for Baroke and Hancock, countries such as “Peru, Mexico, Chile, Dominican Republic, are exporting avocado to the United States, Holland, Spain, England, and China, as a result of this offer, countries are expanding their cultivated areas” (2016, p. 3.). We should also highlight “that the production of Peruvian avocado has grown at an average annual rate of 10.5% in the period 2001-2018, being the region of La Libertad with a growth of 41% of the total produced the one that leads this growth”. (ADEX, 2019, p. 09).

The analysis carried out dates from 2010 to 2020, where the production and export volumes of avocados to European and North American countries are exposed. The objective of this study is to determine the elasticity of demand for avocados in these countries.

THEORETICAL FRAMEWORK

The Demand

The demand for a “good is a function of the price of the item, the buyer's income, the prices of substitute and complementary goods, and his tastes” (Salvatore, 1977, p.09). It is then detailed in the following equation, according to Salvatore:

$$Q_{dx}=f(P_x,I,P_{ob},G,P_s,P_c)$$

Q_{dx} = Quantity demand of good x

P_x = Price of good x

I = Monetary income

P = Population

G = Taste

P_s = Price of substitute products

P_c = Price of complementary products” (1977, p. 09).

According to this demand function, only the relationship of the demand with these factors is shown, now it is necessary to see its variations with the changes of the factors, for this, the elasticity coefficient is used.

ELASTICITY

Alfred Marshall defined elasticity, it is true that before Marshall “the idea of elasticity already existed in its purest meaning, as the proportional change of a variable concerning the change of another related variable” (Miguel Cervantes Jiménez and Abraham Aparicio Cabrera 1993, p. 10). Elasticity is currently used as an instrument of analysis in economics. “Since Alfred Marshall included it in his work Principles of Economics (1890), and since that time it has been used as a means of quantifying the

variations experienced by one variable in the face of changes in another” (Veres Ferrer and José M. Pavía 2012, p.02). The measurement of foreign trade elasticities was promoted by the International Monetary Fund “through the Staff Papers, as expressed by Blejer, Khan and Masson (1995). This generated a wide literature on elasticity, expressed in equations, as well as excerpts of the contributions expressed in compilations” (Maximiliano Albornoz, 2018, p.02).

In the academic literature, there is work on “trade elasticity, framed in developed economies, on foreign trade elasticity (Fullerton, Sawyer, Sprinkle 1999). There is research on elasticity for some countries in the region, but there are no studies that include a larger number of countries” (Fullerton, Sawyer, Sprinkle 1999) (Maximiliano Albornoz, 2018, p. 3).

The coefficient of price elasticity of demand, as indicated by Salvatore, is detailed below:

Price elasticity of demand “is that which calculates the percentage change in the quantity demanded of an item per unit of time, in the face of a percentage change in the price of the same item” (1977, p. 36).

$$e = (\Delta Q / Q) / (\Delta P / P) = (\Delta Q) / (\Delta P) * P / Q$$

e = Price elasticity of demand

ΔQ = Increase in the quantity demanded

ΔP = Increase in the price of the good

Q = Quantity demanded

P = Price of the asset.

The price elasticity of demand according to Salvatore is: “a) Unitary, i.e. it is equal to 1, b) Inelastic, its value is less than 1, the quantities demanded react little to changes in the prices of the merchandise, c) Elastic, it is greater than 1” (1977, p. 36).

MATERIALS AND METHODS

The research used data published by the Central Reserve Bank of Peru on its website. These data are expressed in millions of U.S. dollars (US \$), also with data collected from the Ministry of Agriculture and Irrigation, Sierra y selva exportadora, and ADEX, among others.

Exports (X) were disaggregated for the following countries. England, Holland, Spain, and the United States.

The statistical series for each variable are analyzed along; with their historical evolution, as well as their trends.

Based on the following econometric model:

$$Qd(t) = \beta_0 + \beta_1(P)t + \beta_2(Yp)t + \beta_3(TC)t + \beta_4(N) + u$$

Eviews 9.0 software was used, applying a log-log econometric model where the data series are given in years.

To measure the elasticity of demand for avocados, the indicators used were consumption, population, the exchange rate in soles/dollars, per capita income in dollars, the international price of avocados in dollars, and the international price of avocados in dollars.

Following the proposed objective, we first described the evolution of each of the indicators proposed for each of the variables and then proceeded to develop the proposed econometric model.

RESULTS

WORLD AVOCADO PRODUCTION

Total production, tons (ton), and total planted area, hectares (ha.) are the indicators to be reviewed, taking into consideration the number of producing countries, as well as their degree of importance in world avocado production.

From 2010 to 2022, 17 countries were incorporated into avocado planting and production, which started in 1961 with 48 and by the end of 2019 had reached 65, an increase of 35% (see Table 1).

The demand for a good is a function of the price of the item, the buyer's income, the prices of substitute and complementary goods, and the buyer's tastes (Salvatore, 1977).

To carry out the research, actual data published by the Ministry of Agriculture and Irrigation on its web page was collected on the research variables, considering the period 2010 - 2021.

Total production, tons (ton.), and total planted area, hectares (ha.) are the indicators to be reviewed, taking into consideration the number of producing countries, as well as their degree of importance in world avocado production.

Table 1: Main avocado-producing countries, by Volume, in thousands of MT.

Year	2015	2016	2017	2018	2019	2015 - 2019
Total Production	5,402	5,799	6,131	6,536	6,984	30,852
Mexico	1,644	1,889	2,030	2,185	2,379	10,127
Dominican Rep.	526	601	638	644	727	3,136
Peru	367	455	467	505	536	2,330
Indonesia	383	343	363	410	437	1,936
Colombia	310	294	308	327	352	1,591
Brazil	181	197	213	236	261	1,088
Kenia	136	176	218	234	231	995
United States	208	125	170	169	153	825
Venezuela	129	130	133	140	144	676
Israel	93	102	110	132	137	574
Guatemala	115	122	127	125	134	623
China	118	125	126	129	133	631
South Africa	86	90	63	128	130	497
Chile	147	139	132	125	123	666
Spain	87	92	93	90	97	459
Malawi	95	87	97	92	93	464
Haiti	89	91	92	91	89	452
Cameron	72	73	74/	75	75	369
Australia	49	68	57	63	72	309
Rep. del Congo	66	66	66	66	66	330
Other countries	502	234	554	573	617	2,480

Source: FAOSTAT - Elaboration: UIC-SSE

The production volume of avocado and/or avocado in thousands of MT in the period (2015-2019) of the main countries of the world amounted to 30,852 MT, being the top 3 countries in production, Mexico with 10,127 MT representing 32.82% of total production, Dominican Republic with 3,136 MT, representing 10.16% of total production, Peru with 2,330 MT, representing 7.55 % of total production.

Table 2: Evolution of World Avocado Production (thousands of tons)

Years	Production
2010	3,974
2011	4,266
2012	4,514
2013	4,745
2014	5,160
2015	5,402
2016	5,799
2017	6,131
2018	6,536
2019	6,984
2020	8,059
2021	8,100

Source: FAOSTAT

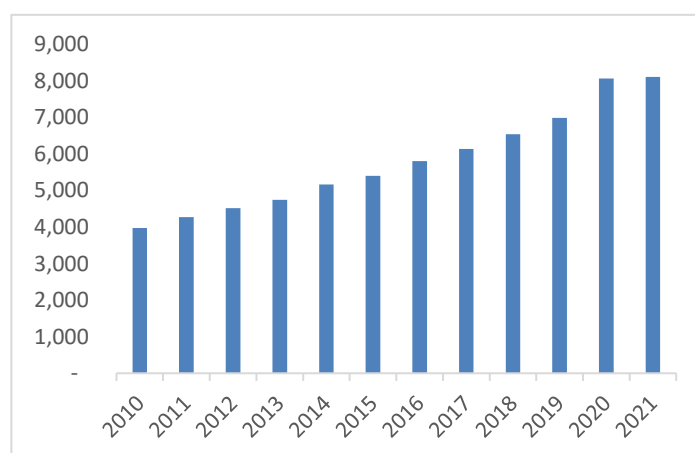


Figure 1. World Avocado Production (thousands of tons)

World avocado production in the period (2010-2021) increased on average between 1.05 and 1.07 % annually, except for the years 2019 and 2020, which amounted to 1.15%, demonstrating that avocado consumption worldwide is favorable for the producing countries in the sense that it generates profits and improves employment in the producing countries.

WORLD AVOCADO EXPORTS

Table 3: Evolution of world avocado exports by country (value in thousands of US\$)

	2015	2016	2017	2018	2019	2015 –19
Total	3330	4377	5826	5842	6499	25874
Export						
Mexico	1662	2051	2828	2562	2790	11893
Netherlands	426	645	797	888	1033	3789
Peru	304	397	581	722	751	2755

Spain	223	275	350	354	392	1594
Chile	162	297	391	274	301	1425
Colombia	10	35	53	63	175	336
EE.UU.	99	129	152	180	154	714
Kenia	53	53	64	78	118	366
France	47	58	71	62	92	330
Dominican Rep.	17	33	49	51	87	237
Israel	53	42	45	48	70	258
South Africa	71	72	64	116	71	394
Belgium	29	42	45	48	70	234
New Zealand	63	88	87	71	70	379
Morocco	17	17	46	56	51	187
Other countries	94	132	170	214	251	861

The volume of avocado and/or avocado exports in thousands of T.M in the period (2015-2019) from the main countries of the world amounted to 25,874 T.M, flourishing the top 3 countries in exports, Mexico with 11, 893 T.M representing 10.78 % of total exports, the Netherlands with 3,789 T.M, representing 3.99 % of total exports, Peru with 2,755 T.M, representing 2.90 % of total exports.

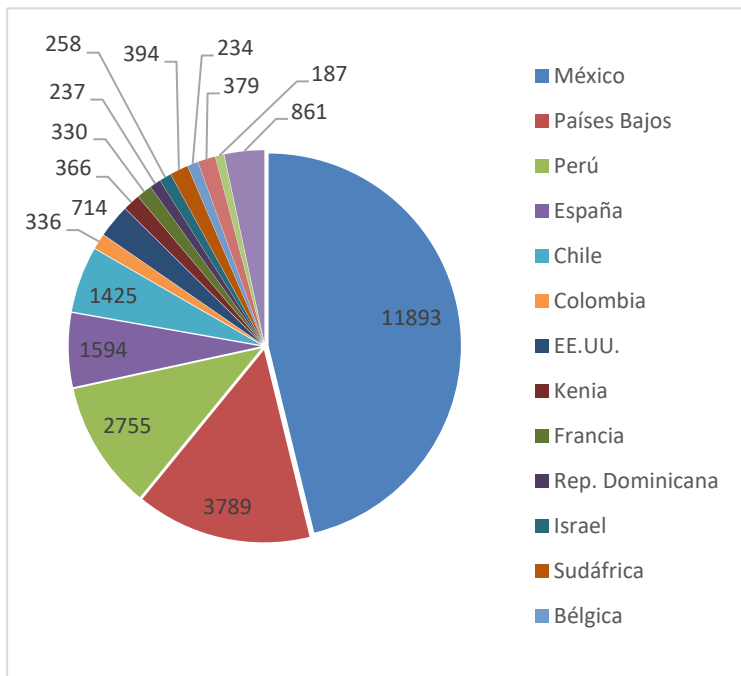


Figure 2. World avocado exports by country, in billions of US\$ (total years 2015 to 2019)

AVOCADO PRODUCTION IN PERU

Table 4: Peruvian avocado production by department, 2011-2021 (in TM)

Department	2,011	2,013	2,014	2,015	2,016	2,017	2,018	2,019	2,020	2,021	2011-2021	T.C
Total	212,830	288,387	335,511	376,602	455,394	466,817	486,954	571,992	672,232	778,791	4,645,510	
Amazon	1,250	1,163	1,319	926	1,051	1,155	1,160	1,400	1,172	1,076	11,672	0.25
Ancash	6,813	26,218	27,927	26,116	20,456	11,473	17,547	20,180	33,363	37,129	227,222	4.89
Apurímac	1,847	2,445	3,072	3,727	3,795	3,945	4,403	4,416	4,957	10,160	42,767	0.92
Arequipa	7,920	9,943	13,585	12,067	12,579	15,862	20,085	22,731	27,528	24,397	166,697	3.59
Ayacucho	4,638	5,291	5,247	5,311	5,219	7,772	6,615	16,640	29,498	30,771	117,002	2.52
Cajamarca	4,769	4,462	5,219	4,745	4,510	5,699	5,003	3,676	4,981	4,921	47,985	1.03
Cusco	4,703	5,694	5,541	6,170	7,861	4,868	4,868	6,475	7,537	8,504	62,221	1.34
Huancavelica	765	671	661	642	729	811	811	2,425	11,883	15,566	34,964	0.75
Huánuco	2,470	2,446	2,454	2,741	2,833	3,297	3,297	3,547	3,698	3,983	30,766	0.66
Ica	30,829	39,439	45,047	56,638	57,049	53,924	53,924	71,591	80,560	81,700	570,701	12.29
Junín	30,540	34,505	32,977	31,917	34,128	36,607	36,607	44,808	45,122	52,100	379,311	8.17
La Libertad	52,409	74,698	97,470	112,775	178,272	197,271	204,526	202,727	215,319	226,700	1,562,167	33.63
Lambayeque	916	1,830	5,392	7,679	8,279	9,924	15,559	62,174	86,008	124,429	322,190	6.94
Lima	46,942	61,249	67,714	81,310	92,070	86,304	83,607	80,192	90,254	124,189	813,831	17.52
Lima Metropolitana				1,634	1,820	1,739	1,504	1,499	1,297	1,394	10,887	0.23
Loreto	2,025	3,330	3,211	3,289	3,453	3,513	3,530	3,555	3,565	3,581	33,052	0.71
Madre de Dios	325	447	473	424	491	423	508	608	611	634	4,944	0.11
Moquegua	2,769	5,551	6,058	6,393	6,156	5,061	6,778	7,556	7,748	8,315	62,385	1.34
Pasco	2,582	1,841	1,977	2,212	2,384	3,066	2,601	2,942	4,493	6,187	30,285	0.65
Piura	3,264	1,700	4,370	4,267	7,025	8,364	7,930	7,679	6,204	5,973	56,776	1.22
Puno	1,915	2,279	2,393	2,430	2,469	2,463	2,460	2,485	2,516	2,499	23,909	0.51
San Martín	996	699	801	723	301	313	356	416	496	597	5,698	0.12
Tacna	185	202	225	378	377	410	280	212	287	421	2,977	0.06
Tumbes	0	0	0		0	0	0	0	0	0	0	0.00
Ucayali	1,956	2,283	2,378	2,088	2,087	2,553	2,995	2,056	3,136	3,566	25,098	0.54

Source: <https://siea.midagri.gob.pe/portal/publicacion/boletines-anales/4-agricola>

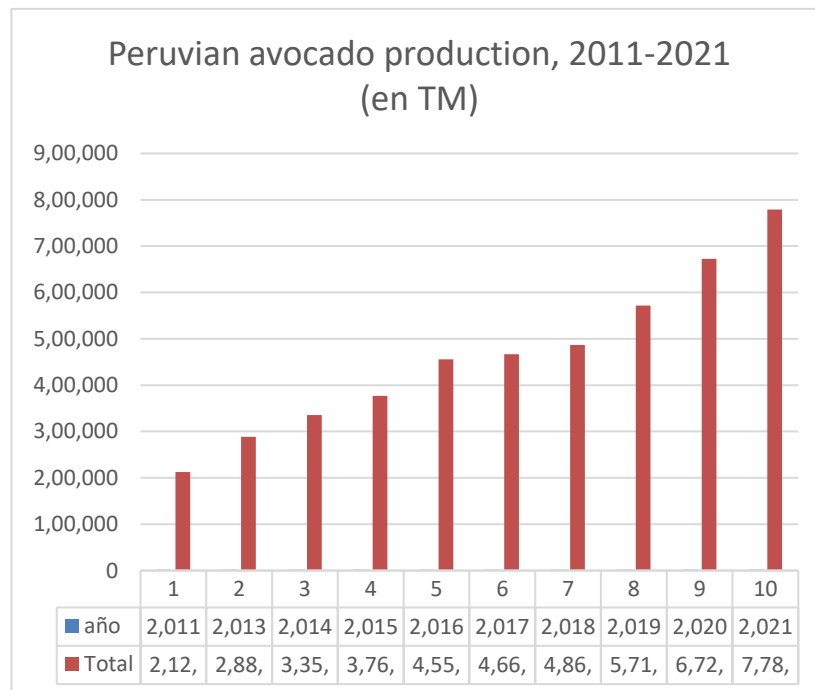


Figure 3. Peruvian avocado production (tons)

Table 5: Avocado HARVESTED AREA in Peru, 2008-2021 (hectares)

Year	Has Harvested	Growth rate
2007	13,522	
2008	14,370	6.3%
2009	16,292	13.4%
2010	17,748	8.9%
2011	19,300	8.7%
2012	21,615	12.0%
2013	27,438	26.9%
2014	30,320	10.5%
2015	33,989	12.1%
2016 P/	37,871	11.4%
2017 P/	39,629	4.6%
2018 P/	40,134	1.3%
2019 P/	46,794	16.6%
2020 P/	51,241	9.5%
2021 P/	55,056	7.4%

The production of avocado and/or avocado in thousands of T.M in the period (2011-2021) of the main departments of Peru amounted to 4'663,072 T.M, highlighting in first place the department of La Libertad with a production of 1'562,167 T.M., which represents 33.63% of the country's total production, followed by Lima provinces with a production of 813,831 MT, representing 17.52% of the total production, Junín with a production of 379,311 MT, representing 8.17% of the total production, Lambayeque with a production of 322,190 MT, representing 6.94% of the total production and Lambayeque with a production of 322,190 MT, representing 6.94% of the total production.

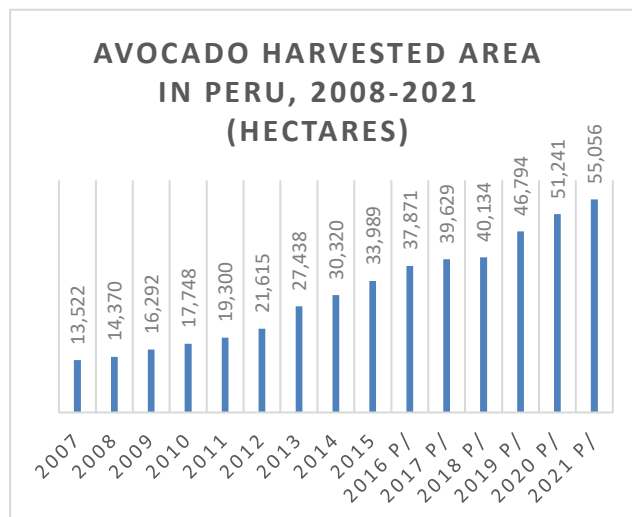


Figure 4: avocado HARVESTED AREA in Peru, 2008-2021 (hectares/year)

According to data from the Ministry of Agriculture and Irrigation, between 2007 and 2021, Peru experienced an average annual harvest of 31,021 hectares of avocado, increasing from 13,522 hectares in 2007 to 55,056 hectares in 2021. The growth of harvested area of avocado in Peru has had a steady growth during the fifteen years shown in Table 5, with 2013 being the year of highest percentage increase (27%); between the years 2011 and 2017 the period of greatest dynamism in the harvested area is observed, a period in which it went from 19,300 to about 40,000 hectares.

Although in the years after 2018, the dynamism of the increase in harvested hectares has slowed down, it can be seen that there is still an increase that has allowed it to reach over 55 thousand hectares harvested in 2021.

Table 6: PERU: avocado exports, main countries of destination between 2010 and 2021 (in US\$)

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2011-21	T.C
NETHERLANDS	38,897	74,381	57,849	84,513	96,581	117,599	163,331	206,002	267,613	249,540	254,458	346,810	1,957,574	35.8
U.S.A.	784	23,484	25,880	39,272	120,965	83,134	74,427	175,117	175,641	231,875	157,937	200,007	1,308,523	23.93
SPAIN	27,808	37,828	33,439	38,374	47,689	50,471	78,077	88,964	110,229	114,845	131,351	173,249	932,324	17.05
CHILE	112	1,439	945	481	3,325	13,380	12,480	10,028	35,287	26,944	44,484	121,234	270,139	4.94
UNITED KINGDOM	6,175	10,715	9,165	10,502	18,685	31,914	44,384	58,050	65,421	58,775	63,604	76,137	453,527	8.29
CHINA			40	37		104	4,580	13,442	30,111	25,703	26,237	29,208	129,462	2.37
OTHERS	11,259	13,372	8,202	10,855	12,866	9,667	19,304	28,796	39,808	44,773	81,055	136,618	416,575	7.62
TOTAL	85,035	161,219	135,520	184,034	300,111	306,269	396,583	580,399	724,110	752,455	759,126	1,083,263	5,468,124	

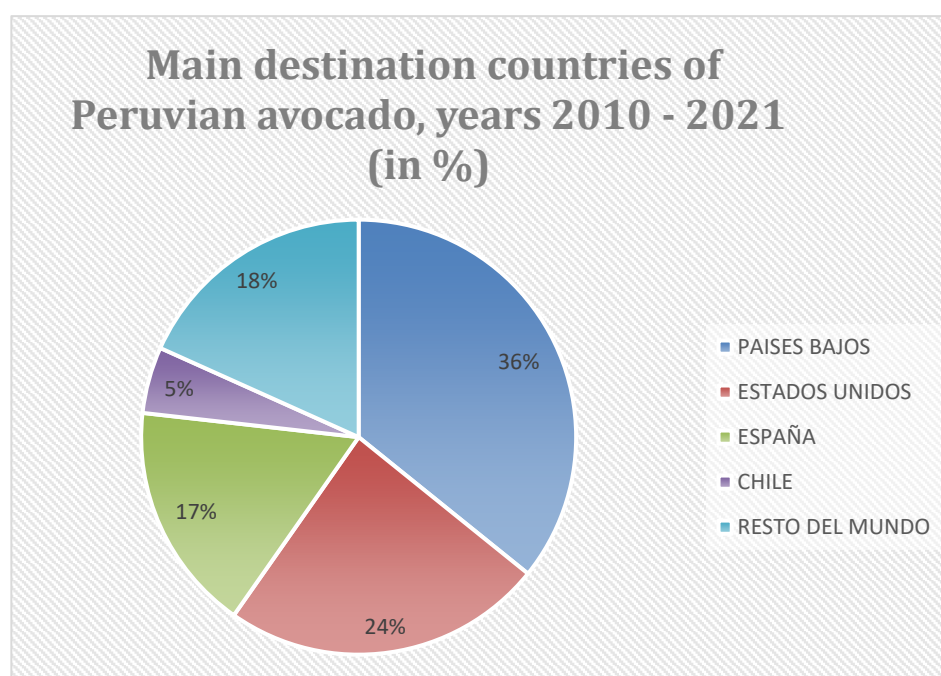


Figure 5. destination of peruvian avocado, years 2010 - 2021

The export of avocado and/or avocado during the period from 2010 to 2021 shows that the countries that have been destinations of our avocado, show the following detail: Netherlands consumes 1,957,574 T.M. which represents 35.50 % of all Avocado sales abroad; USA, is the second of the biggest avocado consumers, with 1,305,523 T.M, which represents 23.93 % of the global consumption of exports, Spain, consumes 932,324 T.M, which represents 17.05 % of the global consumption of exports, United Kingdom consumes 453,527 T.M, which represents 8.29 % of the global consumption of exports.

Table 7: PERUVIAN AVOCADO EXPORTING COMPANIES, IN THE YEARS 2015 TO 2019

	2015	2016	2017	2018	2019	2015-19	T.C
AVOCADO PACKING COMPANY S.A.C.	7,412	9,656	29,656	29,326	30,487	106,537	8.25
SOCIEDAD AGRICOLA DROKASA S.A.	18,896	28,393	22,691	31,116	21,003	122,099	9.46

AGRICOLA CERRO PRIETO S.A.C.	17,070	15,552	11,483	24,363	20,670	89,138	6.91
OL S.A.	22,770	19,940	39,479	44,614	20,486	147,289	11.41
CAMET TRADING S.A.C.	-	11,627	11,819	16,874	16,907	57,227	4.43
CONSORCIO DE PRODUCTORES DE FRUTA S.A.	10,358	9,614	11,131	13,596	15,556	60,255	4.67
VIRU S.A.	3,229	4,379	10,421	15,641	11,103	44,773	3.47
CORPORACION FRUTICOLA DE CHINCHA S.A.C.	7,774	7,061	6,734	9,395	10,800	41,764	3.24
ASR TRADING SOCIEDAD ANONIMA CERRADA	-	827	5,906	10,124	9,159	26,016	2.02
PLANTACIONES DEL SOL S.A.C	-	174	3,212	7,179	8,229	18,794	1.46
INCAVO S.A.C.	2,233	3,337	4,326	7,919	7,511	25,326	1.96
AGRICOLA HOJA REDONDA S.A.	1,934	2,048	1,786	6,154	6,578	18,500	1.43
AGRICOLA LAS MARIAS S.A.C.	3,170	1,722	2,969	6,071	4,614	18,546	1.44
AGRICOLA PAMPA BAJA S.A.C.	749	2,815	1,743	5,394	4,590	15,291	1.18
HASS PERU S.A.	1,874	971	2,888	6,433	4,398	16,564	1.28
AGRICOLA CHAPI S.A.	3,037	2,804	2,829	3,194	4,261	16,125	1.25
PROCESADORA LARAN SAC	3,346	2,925	2,410	3,840	4,057	16,578	1.28
ASICA FARMS S.A.C.	-	1,464	3,788	2,520	3,698	11,470	0.89
AGRICOLA ALPAMAYO S.A. 2, COMPLEJO	2,592	48	-	3,074	3,453	9,167	0.71
AGROINDUSTRIAL BETA S.A.	1,184	1,443	1,457	1,937	3,395	9,416	0.73
OTRAS EMPRESAS	68,054	67,283	70,807	112,600	101,288	420,032	32.54
Total exportado	175,682	194,083	247,535	361,364	312,243	1,290,907	

Source: Veritrade. Elaboration: UIC- SSE

In Peru, an important number of avocado exporting companies exist, of which, as of 2019 20 companies exceeded 3,300 tons of annual exports; in 2015 the total volume of avocado exported by Peruvian companies was 68 thousand tons and in 2018 it reached a total volume of 112 thousand tons, an amount slightly higher (by 10%) than the volume that was reached in 2019.

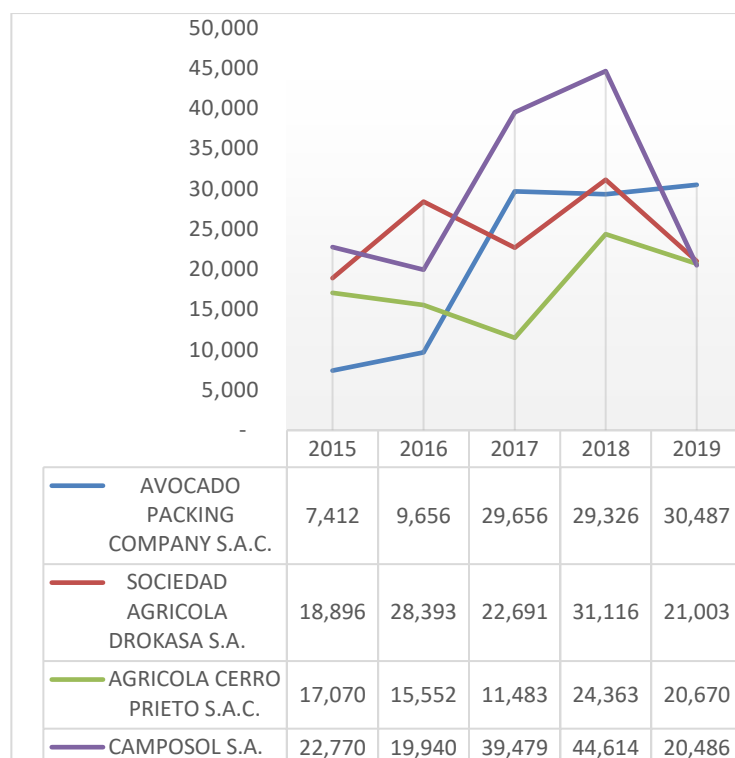


Figure 6: Main Peruvian avocado exporters, years 2015 to 2019

Among the main exporting Companies of avocado and/or avocado from Peru in the period (2015-2029) highlights the company CAMPOSOL S.A with an export production of 147,289 T.M which represents 11.41 % of total exports, the company SOCIEDAD AGRICOLA DROKASA S.A with an export production of 122,099 T.M which represents 9.46 % of total exports, AVOCADO PACKING COMPANY S.A.C., with an export production of 106,537 metric tons, representing 8.25% of the total exports, AGRICOLA CERRO PRIETO S.A.C. with an export production of 89,138 metric tons, representing 6.91% of the total exports, and AGRICOLA CERRO PRIETO S.A.C. with an export production of 89,138 metric tons, representing 6.91% of the total exports.

INTERNATIONAL PRICE OF AVOCADO

Table 8: international price of avocado (US\$ FOB/Kg)

Month	2018	2019	2020	2021
January	2.08	1.94	2.3	2.48
February	2.39	1.995	2.36	2.54
March	2.53	2.24	2.26	2.48
April	2.38	2.06	2	2.21
May	1.98	2.19	1.72	1.95
June	1.81	2.58	1.68	1.82
July	1.95	2.68	1.75	1.69
August	1.99	2.73	1.92	1.81
September	1.89	2.79	2.3	2.07
October	1.5	2.11	1.73	1.76
November	2.01	2.32	2.06	1.87
December	1.96	2.3	2.38	1.99
prom. Annual	2.039			
	2	2.3280	2.0383	2.0560

Source: trademark

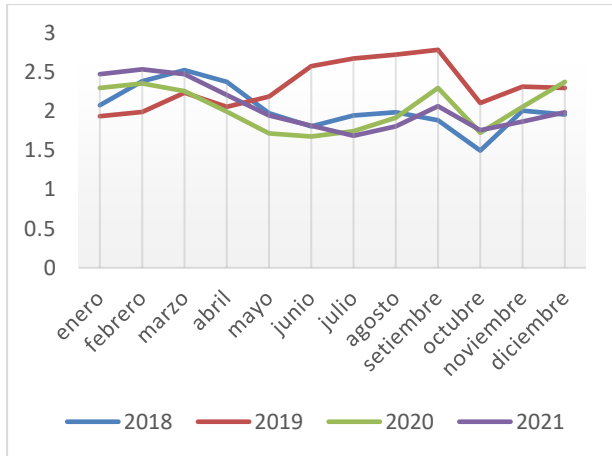


Figure 7: Monthly avocado prices in the international market, years 2018 to 2021.

According to Trademark data, in the last 4 years the average international price of avocado has slightly exceeded US\$2, with its best performance between June and September 2019, when the price of avocado moved from US\$2.68 to US\$2.79; after this boom in the international price, a significant decrease in its international price has been observed, which has led to prices of this fruit reaching prices similar to those of 2018 in 2021, with a tendency to continue decreasing very slowly.

Regarding the seasonality of prices for the four years with data available, it can be observed that, in general, monthly prices, during the year, show a behavior of higher prices at the beginning of the year and then decrease significantly until the middle and third quarter of the year, to recover from the month of September onwards. The above behavior was counter-seasonal in 2019, due to lower world production levels due to climatic factors and a quite dynamic increase in the consumption of this product in developed countries, mainly. The lower production was also influenced by the high level of increase in fertilizer and energy prices, which had a direct impact on producers' costs.

Estimation with econometric model:

The statistical series for each variable are analyzed; their historical evolution, as well as their trends.

Based on the following econometric model:

$$Qd(t) = \beta_0 + \beta_1(P)t + \beta_2(Yp)t + \beta_3(TC)t + \beta_4(N) + u$$

Eviews 9.0 software was used, applying a log-log econometric model where the data series are given in years.

NETHERLANDS

Dependent Variable: TN_HOL
 Method: Least Squares
 Date: 06/24/23 Time: 22:18
 Sample: 2010 2021
 Included observations: 12

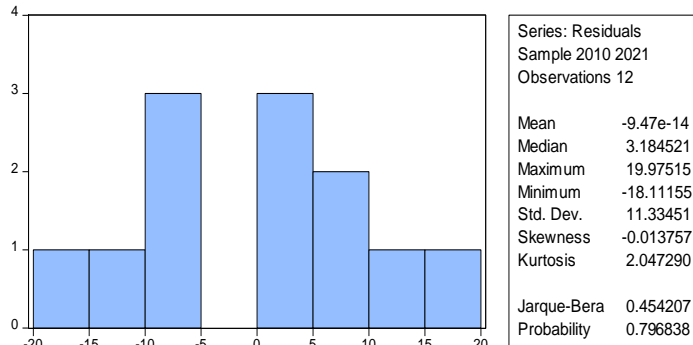
Variable	Coefficient	Std. Error	t-Statistic	Prob.
YP_HOL	2.706632	1.209067	2.238613	0.0555
PRECIO	-0.165403	0.175261	-0.943753	0.3729
P_HOL	8.23E-05	9.28E-06	8.860452	0.0000
C	-1287.691	122.0794	-10.54797	0.0000

R-squared	0.945858	Mean dependent var	84.36800
Adjusted R-squared	0.925555	S.D. dependent var	48.71191
S.E. of regression	13.29089	Akaike info criterion	8.273237
Sum squared resid	1413.182	Schwarz criterion	8.434872
Log-likelihood	-45.63942	Hannan-Quinn criter.	8.213393
F-statistic	46.58642	Durbin-Watson stat	1.870689
Prob(F-statistic)	0.000021		

As shown in the table above, it can be stated that the total demand for avocado in the Netherlands is explained by the price of avocado in the country, as well as by the per capita income and population, and this relationship is supported by the following results:

- When the price of avocado increases by 1, on average the demand in the Netherlands decreases by -0.16 percentage points.
- When the per capita income in the Netherlands increases by 1, on average its demand for avocado increases by 2.7 percentage points.
- When the population in the Netherlands increases by 1, on average their demand for avocado increases by 8.23 percentage points.

NORMALITY TEST



The Jarque Bera test is used to test the normality of the model, where with a result of 0.45 and a probability greater than 0.05 (0.79) it is considered that the errors are normally distributed.

AUTOCORRELATION TEST

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob	
		1	0.229	0.229	0.8002	0.371
		2	-0.269	-0.339	2.0134	0.365
		3	-0.289	-0.154	3.5778	0.311
		4	0.100	0.160	3.7886	0.435
		5	0.176	-0.015	4.5320	0.476
		6	-0.084	-0.149	4.7284	0.579
		7	-0.216	-0.067	6.2907	0.506
		8	-0.150	-0.128	7.2365	0.511
		9	-0.015	-0.120	7.2494	0.611
		10	0.015	-0.074	7.2682	0.700
		11	0.003	-0.029	7.2696	0.777

The autocorrelation test determined by the Durbin Watson statistic, which for the model the result is 1.8706, in that sense, at a significance level of 95% we have that dL and dU

is equivalent to 0.658 and 1.864 respectively; from these values, it is determined that the autocorrelation falls in the non-autocorrelation zone.

HETEROSCEDASTICITY TEST

Heteroskedasticity Test: White

F-statistic	6.402772	Prob. F (9,2)	0.1423
Obs*R-squared	11.59748	Prob. Chi-Square (9)	0.2370
Scaled explained SS	2.699094	Prob. Chi-Square (9)	0.9750

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 06/24/23 Time: 23:27

Sample: 2010 2021

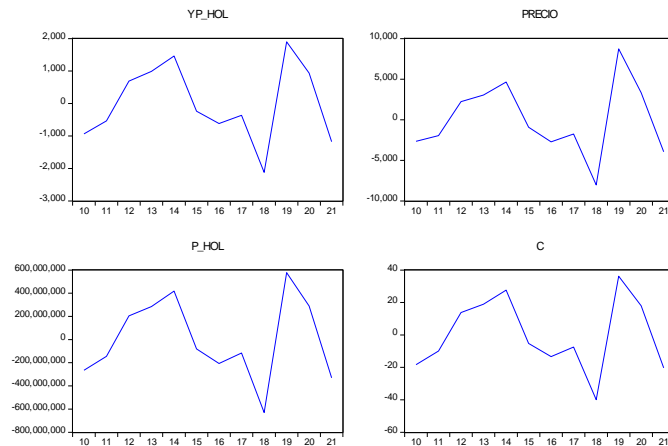
Included observations: 12

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-68917.15	26454.59	-2.605111	0.1211
YP_HOL^2	-0.410349	2.789249	-0.147118	0.8965
YP_HOL*PRE				
CIO	0.493520	0.320547	1.539620	0.2635
YP_HOL*P_H				
OL	-5.16E-05	3.51E-05	-1.470486	0.2792
YP_HOL	768.9419	336.4673	2.285339	0.1496
PRECIO^2	-0.240866	0.066970	-3.596622	0.0694
PRECIO*P_H				
OL	2.12E-05	4.89E-06	4.340922	0.0492
PRECIO	-258.2314	53.45386	-4.830920	0.0403
P_HOL^2	-3.43E-10	9.30E-11	-3.686310	0.0663
P_HOL	0.009329	0.003166	2.946219	0.0985

	Mean	dependent	
R-squared	0.966457	var	117.7652
Adjusted R-squared	0.815513	S.D. dependent var	125.8765
S.E. of regression	54.06634	Akaike info criterion	10.69321
Sum squared resid	5846.338	Schwarz criterion	11.09730
Log-likelihood	-54.15925	Hannan-Quinn criter.	10.54360
F-statistic	6.402772	Durbin-Watson stat	2.157797
Prob(F-statistic)	0.142328		

Positive Autocorrelation	Zone of Indecision	No Autocorrelation	Zone of Indecision	Negative Autocorrelation
Reject Ho		Accept Ho		Reject Ho
0	dl	du	2 4-du	4-dl
	0.658	1.864	2.136	3.342
1.8706				

Results greater than 0.05 show that the homoscedasticity assumption is met, with no heteroscedasticity problem of any order in the model.



SPAIN

Dependent Variable: TN_ESP
 Method: Least Squares
 Date: 06/24/23 Time: 23:35
 Sample: 2010 2021
 Included observations: 12

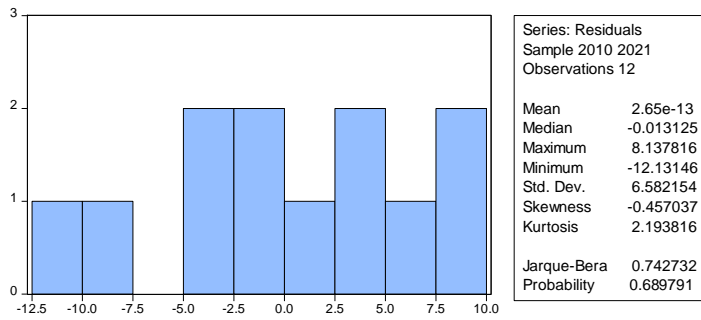
Variable	Coefficient	Std. Error	t-Statistic	Prob.
YP_ESP	0.130640	1.310296	0.099702	0.9230
P_ESP	3.49E-05	4.36E-06	8.003867	0.0000
PRECIO	-0.098734	0.092574	-1.066538	0.3173
C	-1245.560	162.4059	-7.669428	0.0001

R-squared	0.905836	Mean dependent var	42.47350
Adjusted R-squared	0.870525	S.D. dependent var	21.44995
S.E. of regression	7.718260	Akaike info criterion	7.186256
Sum squared resid	476.5723	Schwarz criterion	7.347892
Log-likelihood	-39.11754	Hannan-Quinn criter.	7.126413
F-statistic	25.65282	Durbin-Watson stat	1.826712
Prob(F-statistic)	0.000186		

As shown in Table *, it could be stated that the total demand for avocados in Spain is explained by the price of avocado in the country, as well as by the per capita income and its population, such relationship is subject to the following results:

- When the price of avocado increases by 1, on average the demand in Spain decreases by -0.09 percentage points.
- When the per capita income in Spain increases by 1, on average its demand for avocado increases by 0.13 percentage points.
- When the population in Spain increases by 1, on average its demand for avocado increases by 3.49 percentage points.

NORMALITY TEST



The Jarque Bera test is used to test the normality of the model, where with a result of 0.74 and a probability greater than 0.05 (0.68) it is considered that the errors are normally distributed.

AUTOCORRELATION TEST

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
1		-0.116	-0.116	0.2042	0.651
2		-0.107	-0.122	0.3949	0.821
3		0.058	0.031	0.4579	0.928
4		-0.052	-0.056	0.5155	0.972
5		-0.109	-0.116	0.8020	0.977
6		-0.094	-0.142	1.0470	0.984
7		0.299	0.262	4.0475	0.774
8		-0.256	-0.239	6.8006	0.558
9		-0.153	-0.170	8.1088	0.523
10		0.033	-0.108	8.2028	0.609
11		-0.004	-0.005	8.2058	0.695

Positive	Zone of Indecision	No Autocorrelation	Zone of Indecision	Negative
Autocorrelation				Autocorrelation
Reject Ho		Accept Ho		Reject Ho
0	dL	Du	2 - 4-du	4-dL
	0.658	1.864	2.136	3.342
1.826712				

The autocorrelation test determined by the Durbin Watson statistic, which for the model the result is 1.8267, in that sense, at a significance level of 95% we have that dL and dU are equivalent to 0.658 and 1.864 respectively; from these values, it is determined that the autocorrelation falls in the autocorrelation zone.

HETEROSCEDASTICITY TEST

Heteroskedasticity Test: White

F-statistic	0.894206	Prob. F(9,2)	0.6317
Obs*R-squared	9.611430	Prob. Chi-Square(9)	0.3828
Scaled explained SS	2.549840	Prob. Chi-Square(9)	0.9795

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 06/25/23 Time: 00:04

Sample: 2010 2021

Included observations: 12

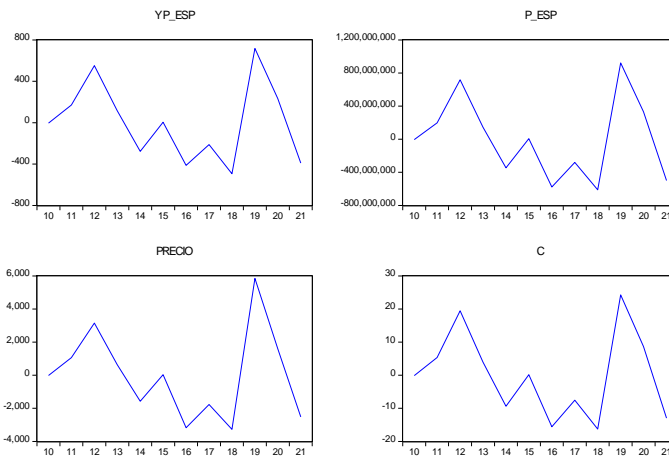
Variable	Coefficient	Std. Error	t-Statistic	Prob.
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645 Elasticity of Demand for Avocado to the European Market and the United States, Years 2010 – 2020

C	70384.49	174092.6	0.404293	0.7251
YP_ESP^2	-11.87994	10.14458	-1.171063	0.3622
YP_ESP*P_ES				
P	-1.00E-05	1.96E-05	-0.511059	0.6601
YP_ESP*PRE				
CIO	0.369081	0.619038	0.596218	0.6115
YP_ESP	975.9213	1056.429	0.923793	0.4531
P_ESP^2	3.55E-11	1.22E-10	0.290494	0.7988
P_ESP*PRECI				
O	5.69E-06	3.48E-06	1.637921	0.2431
P_ESP	-0.003504	0.009367	-0.374127	0.7443
PRECIO^2	-0.084662	0.065684	-1.288926	0.3264
PRECIO	-188.3885	105.4244	-1.786953	0.2159

R-squared	0.800952	Mean dependent var	39.71436
Adjusted R-squared	-0.094761	S.D. dependent var	45.32215
S.E. of regression	47.42095	Akaike info criterion	10.43091
Sum squared resid	4497.492	Schwarz criterion	10.83500
Log likelihood	-52.58547	Hannan-Quinn criter.	10.28130
F-statistic	0.894206	Durbin-Watson stat	2.064093
Prob(F-statistic)	0.631676		

Results greater than 0.05 show that the homoscedasticity assumption is met, with no heteroscedasticity problem of any order in the model.



EE.UU.

Dependent Variable: TN_EU
 Method: Least Squares
 Date: 06/25/23 Time: 00:17
 Sample: 2010 2021
 Included observations: 12

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YP_EU	16.99038	25.40450	0.668794	0.5225
PRECIO	-1.253821	1.565937	-0.800684	0.4464
P_EU	-1.38E-05	2.00E-05	-0.689655	0.5099
C	2960.848	3810.136	0.777098	0.4595

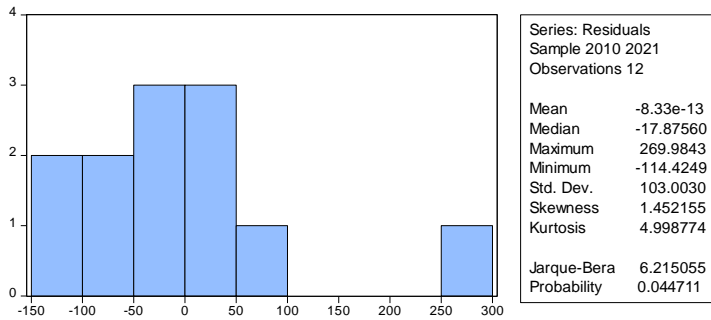
R-squared	0.175385	Mean dependent var	86.60792
Adjusted R-squared	-0.133846	S.D. dependent var	113.4291

squared			
S.E. of			
regression	120.7818	Akaike info criterion	12.68705
Sum squared			
resid	116705.9	Schwarz criterion	12.84868
Log likelihood	-72.12230	Hannan-Quinn criter.	12.62721
F-statistic	0.567165	Durbin-Watson stat	1.215891
Prob(F-statistic)	0.651960		

As shown in Table *, it could be stated that the total demand for avocado in the U.S. is explained by the price of avocado in the country, as well as by the per capita income and its population, this relationship is subject to the following results:

- When the price of avocado increases by 1, on average U.S. demand for avocado decreases by -1.25 percentage points.
- When U.S. per capita income increases by 1, on average their demand for avocado increases by 16.99 percentage points.
- When the U.S. population increases by 1, on average your demand for avocado increases by -1.38 percentage points.

NORMALITY TEST



The Jarque Bera test is used to test the normality of the model, where with a result of 6.21 and a probability of less than 0.05 (0.044) it is considered that the errors are abnormally distributed.

AUTOCORRELATION TEST

Date: 06/25/23 Time: 00:47						
Sample: 2010 2021						
Included observations: 12						
Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob	
1	0.047	0.047	0.0338	0.854	0.854	
2	0.126	0.124	0.3016	0.860	0.860	
3	0.083	0.073	0.4289	0.934	0.934	
4	-0.050	-0.074	0.4825	0.975	0.975	
5	-0.055	-0.072	0.5552	0.990	0.990	
6	-0.110	-0.100	0.8957	0.989	0.989	
7	-0.075	-0.044	1.0839	0.993	0.993	
8	-0.136	-0.103	1.8631	0.985	0.985	
9	-0.102	-0.075	2.4495	0.982	0.982	
10	-0.099	-0.076	3.2659	0.974	0.974	
11	-0.128	-0.112	6.0226	0.872	0.872	

Positive Autocorrelation	Zone of Indecision	No Autocorrelation	Zone of Indecision	Negative Autocorrelation
Reject Ho	Accept Ho	Reject Ho		
0	dl	du	2	4-du
	0.658	1.864	2.136	3.342
1.2158				

The autocorrelation test determined by the Durbin Watson statistic, which for the model the result is 1.2158, in that sense, at a significance level of 95% we have that dL and dU is equivalent to 0.658 and 1.864 respectively; from these values, it is determined that the autocorrelation falls in the positive autocorrelation zone.

HETEROSCEDASTICITY TEST

Heteroskedasticity Test: White

F-statistic	7.491860	Prob. F(8,3)	0.0626
Obs*R-squared	11.42798	Prob. Chi-Square(8)	0.1786
Scaled explained SS	10.15509	Prob. Chi-Square(8)	0.2543

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 06/25/23 Time: 00:57

Sample: 2010 2021

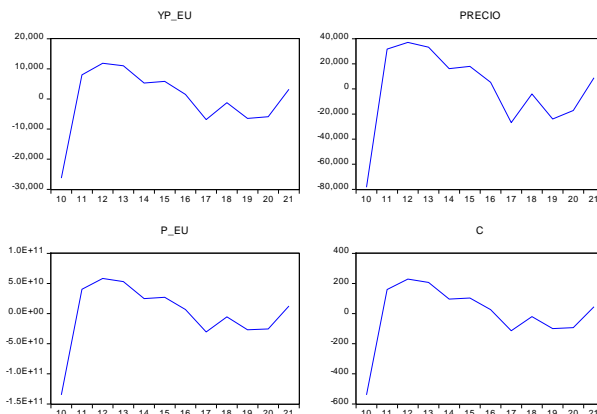
Included observations: 12

Collinear test regressors dropped from specification

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8544113.	4218119.	2.025574	0.1359
YP_EU^2	-771.6358	1006.256	-0.766838	0.4990
YP_EU*PRECIO	-187.9659	131.2020	-1.432645	0.2474
YP_EU*P_EU	0.001026	0.000921	1.114653	0.3463
YP_EU	-145110.9	106044.4	-1.368397	0.2647
PRECIO^2	-4.884706	11.27915	-0.433074	0.6942
PRECIO*P_EU	0.000222	9.79E-05	2.267356	0.1082
PRECIO	-45706.42	18113.84	-2.523287	0.0859
P_EU^2	-1.93E-10	1.27E-10	-1.515091	0.2270

R-squared	0.952332	Mean dependent var	9725.490
Adjusted R-squared	0.825216	S.D. dependent var	20312.77
S.E. of regression	8492.193	Akaike info criterion	21.04539
Sum squared resid	2.16E+08	Schwarz criterion	21.40907
Log likelihood	-117.2723	Hannan-Quinn criter.	20.91074
F-statistic	7.491860	Durbin-Watson stat	1.626522
Prob(F-statistic)	0.062636		

Results greater than 0.05 show that the homoscedasticity assumption is met, with no heteroscedasticity problem of any order in the model.



ENGLAND

Dependent Variable: TN_ING
 Method: Least Squares
 Date: 06/25/23 Time: 01:07
 Sample: 2010 2021
 Included observations: 12

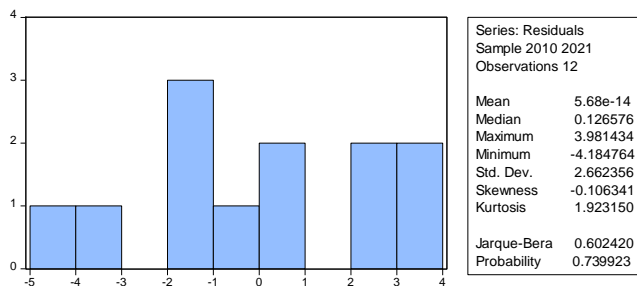
Variable	Coefficient	Std. Error	t-Statistic	Prob.
YP_ING	-0.476120	0.414108	-1.149748	0.2835
PRECIO	-0.035452	0.043692	-0.811409	0.4406
P_ING	6.62E-06	6.79E-07	9.756830	0.0000
C	-311.7954	31.40058	-9.929608	0.0000

	Mean	dependent	
R-squared	0.951215	var	18.62392
Adjusted R-squared	0.932921	S.D. dependent var	12.05383
S.E. of regression	3.121889	Akaike info criterion	5.375955
Sum squared resid	77.96951	Schwarz criterion	5.537590
Log likelihood	-28.25573	Hannan-Quinn criter.	5.316112
F-statistic	51.99545	Durbin-Watson stat	1.526176
Prob(F-statistic)	0.000014		

As shown in table *, it could be stated that the total demand for avocado in England is explained by the price of avocado in the country, as well as by the per capita income and its population, this relationship is subject to the following results:

- When the price of avocado increases by 1, on average demand in England decreases by -0.03 percentage points.
- When England's per capita income increases by 1, on average its demand for avocado increases by -0.47 percentage points.
- When the population in England increases by 1, on average its demand for avocado increases by 6.62 percentage points.

NORMALITY TEST



The Jarque Bera test is used to test the normality of the model, where with a result of 0.60 and a probability of less than 0.05 (0.73) it is considered that the errors are normally distributed.

AUTOCORRELATION TEST

Date: 06/25/23 Time: 01:12					
Sample: 2010 2021					
Included observations: 12					
Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
		1 -0.162	-0.162	0.4025	0.526
		2 0.203	0.182	1.0981	0.577
		3 -0.179	-0.130	1.6972	0.638
		4 -0.309	-0.414	3.7043	0.448
		5 -0.173	-0.278	4.4206	0.491
		6 0.083	0.170	4.6115	0.595
		7 -0.248	-0.328	6.6746	0.464
		8 0.325	-0.060	11.114	0.195
		9 -0.114	-0.078	11.836	0.223
		10 0.092	-0.107	12.545	0.250
		11 -0.018	-0.197	12.602	0.320

Positive Autocorrelation	Zone of Indecision	No Autocorrelation	Zone of Indecision	Negative Autocorrelation
Rechazo Ho		Acepto Ho		Rechazo Ho
0	dL	dU	2	4-dL
	0.658	1.864	2.136	3.342
1.5261				

The autocorrelation test determined by the Durbin Watson statistic, which for the model the result is 1.5261, in that sense, at a significance level of 95% we have that dL and dU is equivalent to 0.658 and 1.864 respectively; from these values, it is determined that the autocorrelation falls in the positive autocorrelation zone.

HETEROSCEDASTICITY TEST

Heteroskedasticity Test: White

F-statistic	0.526283	Prob. F(9,2)	0.7951
Obs*R-squared	8.437343	Prob. Chi-Square(9)	0.4907
Scaled explained SS	1.730874	Prob. Chi-Square(9)	0.9950

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 06/25/23 Time: 01:22

Sample: 2010 2021

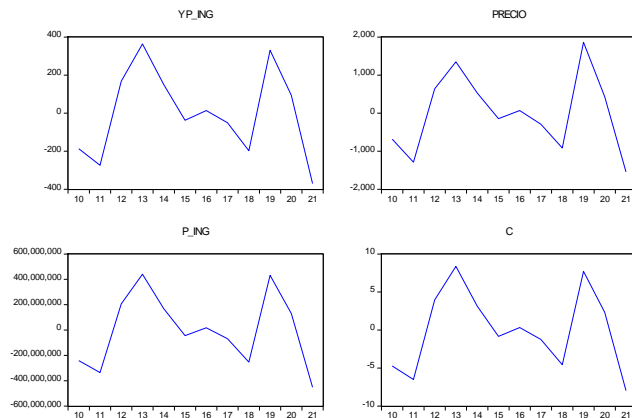
Included observations: 12

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4524.400	6977.843	0.648395	0.5832
YP_ING^2	-0.785751	0.640092	-1.227560	0.3445
YP_ING*PRECI				
O	-0.046409	0.201876	-0.229890	0.8395
YP_ING*P_ING	1.43E-07	1.09E-06	0.131305	0.9076
YP_ING	70.56853	89.85638	0.785348	0.5145
PRECIO^2	0.002812	0.017683	0.159039	0.8882
PRECIO*P_ING	-2.17E-09	3.87E-07	-0.005622	0.9960
PRECIO	0.983610	9.369468	0.104980	0.9260
P_ING^2	2.07E-12	2.32E-12	0.892062	0.4665
P_ING	-0.000229	0.000296	-0.773487	0.5201

R-squared	0.703112var	Mean dependent	6.497459
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Adjusted R-squared	-0.632884	S.D. dependent var	6.520397
S.E. of regression	8.332048	Akaike info criterion	6.953003
Sum squared resid	138.8460	Schwarz criterion	7.357092
Log likelihood	-31.71802	Hannan-Quinn criter.	6.803395
F-statistic	0.526283	Durbin-Watson stat	2.994094
Prob(F-statistic)	0.795068		

Results greater than 0.05 show that the homoscedasticity assumption is met, with no heteroscedasticity problem of any order in the model.



CONCLUSIONS

1. In the years for which data are available, in general, monthly prices show behavior of higher prices at the beginning of the year and then decrease significantly until the middle and third quarter of the year, to recover from September onwards.
2. As of 2019, 20 companies in Peru exceeded 3300 tons of annual exports.
3. Between 2010 and 2021, the Netherlands represented 35.50 % of all our avocado sales abroad; the USA, 23.93 %, Spain 17.05 % of the global consumption of our exports, while the United Kingdom, with a consumption of 453,527 MT, represents 8.29 % of our exports.
4. Between 2007 and 2021, Peru has had an average annual avocado harvest of 31,021 hectares.
5. The demand for Peruvian avocados in the Netherlands has the following behavior:
 - a. A 1% increase in price generates a reduction in demand of 0.16 %.
 - b. If per capita income increases by 1%, the demand for avocados increases by 2.7%.
 - c. A 1% increase in population generates that the demand for avocado increases by 8.23 %.
6. In Spain, the demand for Peruvian avocados shows the following behavior:
 - a. A 1% increase in price generates a reduction in demand of 0.09 %.
 - b. If per capita income increases by 1%, the demand for avocado increases by 0.13 %.

- c. A 1% increase in population generates that the demand for avocado increases by 3.49%.
7. In the U.S., the demand for Peruvian avocados shows the following behavior:
 - a. A 1% price increase generates a reduction in demand of 1.25%
 - b. If per capita income increases by 1%, the demand for avocado increases by 16.99%.
 - c. A 1% increase in the population generates that the demand for avocado decreases by 1.38%.
8. In ENGLAND, the demand for Peruvian avocados has the following behavior:
 - a. A 1% increase in price generates a 0.03% reduction in demand%
 - b. If per capita income increases by 1%, avocado demand decreases by 0.47%.
 - c. Un aumento de 1% en la población genera que la demanda de palta se incrementa en 3.62%.

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