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ORIGINAL ARTICLE

Pronóstico de la competitividad exportadora del café peruano en los principales países importadores utilizando el modelo autorregresivo integrado de media móvil

Forecasting the export competitiveness of peruvian coffee in major importing countries using the integrated autoregressive moving average model

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RESUMEN

Este estudio examina la competitividad de las exportaciones de café peruano utilizando el modelo autorregresivo integrado de medias móviles (ARIMA) para predecir las tendencias de los principales países importadores. Mediante el análisis de series temporales de datos sobre volúmenes y precios de exportación, el modelo ARIMA demostró su eficacia en la predicción de tendencias futuras, proporcionando información valiosa sobre los factores que influyen en la rentabilidad y sostenibilidad del sector. Los resultados revelan que el mercado peruano del café está sujeto a importantes fluctuaciones, influidas por la volatilidad de los precios mundiales y la competencia. Además, el estudio subraya el papel fundamental de la mejora de las infraestructuras y el apoyo gubernamental para impulsar la competitividad del sector, existen también mejoras internas, como la optimización de los procesos y la adopción de tecnología, para que los productores peruanos de café mantengan su posición en el mercado. En consonancia con la literatura, el estudio confirma que las economías de escala son fundamentales para reducir los costes de producción y mejorar la eficiencia. Aprovechando modelos predictivos como ARIMA, los productores y los responsables políticos pueden tomar decisiones estratégicas informadas, asegurando la competitividad a largo plazo del café peruano en el mercado mundial.

Palabras clave: Competitividad, ARIMA, exportación, café.

ABSTRACT

This study examines the competitiveness of Peruvian coffee exports using the autoregressive integrated moving average model (ARIMA) to predict trends in major importing countries. By analyzing time series data on export volumes and prices, the ARIMA model proved to be effective in predicting future trends, providing valuable information on the factors that influence the profitability and sustainability of the sector. The results reveal that the Peruvian coffee market is subject to significant fluctuations, influenced by world price volatility and competition. In addition, the study highlights the critical role of improved infrastructure and government support in boosting the competitiveness of the sector, there are also internal improvements, such as process optimization and technology adoption, for Peruvian coffee producers to maintain their position in the market. In line with the literature, the study confirms that economies of scale are key to reducing production costs and improving efficiency. By leveraging predictive models such as ARIMA, producers and policy makers can make informed strategic decisions, ensuring the long-term competitiveness of Peruvian coffee in the world market.

Keywords: Competitiveness, ARIMA, exportation, coffee.

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INTRODUCTION

The Peruvian coffee sector has played a crucial role in the country's economy, standing out as one of its main export products (Valdiglesias, 2024) and is recognized for its diverse ecosystems. It offers a wide variety of high-quality coffees, including the renowned Arabica and Robusta varieties (Dilas et al., 2021). Coffee-producing regions such as Cajamarca, Junín, and San Martín are famous for their beans, which possess unique flavor profiles that are highly valued in international markets (Dilas & Cernaqué, 2017; Rojas et al., 2021).

The export of Peruvian coffee has shown consistent growth, contributing significantly to the national economy (Díaz et al., 2018). However, the sector faces challenges related to international price volatility and global competition (Rivera, 2022). Factors such as production costs, supply chain efficiency, and the producers' ability to achieve economies of scale play a crucial role in the sector's competitiveness (Montes & Oblitas, 2023). Operational improvements and industry evolution are essential to understand how coffee producers in Peru can increase efficiency and minimize costs as they expand their production and exports (Cerquera et al., 2020). Internal improvements focus on benefits that each company gains by increasing production volume (Figueroa et al., 2019), such as process optimization and adopting new technologies. On the other hand, external improvements refer to advancements across the entire Peruvian coffee industry, which may include developing better infrastructure, such as roads and processing technology (Vera et al., 2024), as well as implementing government policies that support the sector's growth and competitiveness at the global level. These improvements benefit not only large companies (Sacco et al., 2011), but also help small producers better integrate into international markets.

In this study, we analyze the impact of export competitiveness in the Peruvian coffee sector, focusing on export volumes and prices (Ortiz et al., 2004), using the Autoregressive Integrated Moving Average method (ARIMA). Utilizing this methodology, we will model and evaluate export trends, providing a deeper understanding of the factors influencing the profitability and sustainability of this vital sector for the Peruvian economy. The ARIMA model is particularly suitable for this analysis due to its ability to model and predict time series data that may show trends and seasonal patterns (Sánchez et al., 2013). This methodology allows us to identify demand dynamics in major importing markets and predict future price and export volume trends (González, 2009). The accuracy of ARIMA in the context of coffee trade is due to its integrated approach that considers both historical fluctuations and seasonal variations (Camones, 2022), which is crucial for developing effective export strategies. This analysis provides producers and policymakers with valuable insights to make informed and strategic decisions aimed at maximizing competitiveness and reach in international markets (Aguilar, 2022).

MATERIALS AND METHODS

The ARIMA model is a fundamental tool in time series analysis, widely used in statistics and econometrics to predict future data from historical values. Defined as ARIMA (p, d, q), the model combines autoregressive terms (p), differentiations (d) to achieve stationarity, and moving average terms (q) to adjust prediction errors. This flexible structure allows ARIMA to capture temporal dependencies and underlying patterns in data, offering a robust and adaptable representation applicable in fields as diverse as economics and engineering (Chávez, 1997).

Autoregression - AR(p)

A part of the ARIMA model is the autoregressive model of order p (AR(p)), which uses dependencies between successive observations. The equation is:

$$X_t = c + \phi_1 X_{t-1} + \phi_2 X_{t-2} + \ldots + \phi_p X_{t-p} + \epsilon_t$$

Where:
$\phi_1, \phi_2 \ldots, \phi_p$ are the parameters of the model
c is a constant
ϵ_t is the error term at time t

Integration - I(d)

The integration (I) of order d in ARIMA indicates that the time series has been differenced d times to achieve stationarity.

$$\nabla^d X_t = (1 - B)^d X_t$$

B is the delay operator

Moving Average - MA(q)

The moving average of order q (MA(q)) models the error term as a linear combination of error terms in past observations:

$$\epsilon_t = \theta_{1\epsilon_{t-1}} + \theta_{2\epsilon_{t-2}} + \ldots + \theta_{q\epsilon_{t-q}} + \eta_t$$

$\theta_1, \theta_2 \ldots, \theta_q$ are the parameters of the moving average

η_t is the white noise

Full ARIMA Model (p, d, q)

$$\left(1 - \phi_1 B - \ldots - \phi_p B^p\right)(1 - B)^d X_t = \left(1 + \theta_1 B + \ldots + \theta_q B^q\right)\epsilon_t$$

Dickey-Fuller test to verify stationarity and determine d.

ACF and PACF plots to determine p and q.

AIC/BIC-based model selection to fit the most appropriate model.

RESULTS

Table 1

World trend of the main coffee importing countries 2004 - 2023 (greater than 2k Tons) main exporting countries of unroasted and decaffeinated coffee exported by Peru.

Item	World	Alemania	USA	Belgium	Colombia	Sweden	Canada	Korea	Italy	France	UK	Netherlands	Japan	Spain
2004	191131	67315	48978	22458	700	3917	5794	3179	1633	6816	5443	10258	2530	1207
2005	142151	46470	32780	7522	3858	5535	4782	3545	2200	6300	4675	10866	2596	2149
2006	238063	83468	50972	32921	5715	6750	5381	4848	2677	4513	4371	13745	7873	2240
2007	173615	54868	52739	15504	1037	7869	5321	5609	2436	2606	4382	7886	2208	2443
2008	224648	73091	55978	34005	3937	9275	5023	8031	6330	1860	4573	2821	3073	2410
2009	197470	61952	43214	23770	20285	7048	3986	5913	4548	3182	3093	2393	2642	1347
2010	229617	81226	48748	23235	13683	9052	7244	8351	6820	4838	5045	2031	3029	1962
2011	296348	84920	65235	48368	24974	8121	8106	9051	6453	3940	5346	4861	3117	2048
2012	266288	89018	43690	35873	30374	9366	8854	8376	6411	5633	4449	4080	1780	1188
2013	238645	82439	52162	23627	13861	11032	6270	11007	6749	6497	5032	2733	3279	1347
2014	185138	50885	44246	20582	6915	9217	6268	11651	6415	5243	4581	2760	1376	1012
2015	174999	50360	42575	19017	2182	9430	8635	10299	3606	5331	4519	2428	1756	1122
2016	239331	59062	65014	23488	8834	11349	9463	9030	7957	7084	6165	4832	1585	1809
2017	245735	54543	58784	22847	16253	14004	11535	10153	10241	4065	6862	5683	2951	2890
2018	256272	57064	62971	28410	23232	14201	11504	7005	8824	6900	8422	4764	4637	1473
2019	226540	50424	57995	21419	11877	13070	11449	8546	8861	7501	6977	5469	4918	1947
2020	213215	46749	53113	18445	17780	10700	9502	9095	9680	10746	5218	1972	4312	2285
2021	191600	38748	42863	20294	22066	9055	9601	6421	8378	8013	6574	2895	2459	2266
2022	246471	50086	54478	29696	23503	12447	10954	6774	8823	6571	8963	7512	5607	3675
2023	204547	37625	56025	18408	12690	8766	12150	4710	8764	7554	6667	8679	4001	2708

Note: Fluctuations are observed with peaks as in 2011, when exceptionally high volumes were recorded globally, especially in Germany, the United States and Belgium. Regional variability is evident, with some countries maintaining consistently high volumes, while others, such as Korea and Spain, show more modest but fluctuating volumes. These variations can be influenced by external factors such as trade policies, coffee production and quality, and global economic conditions, thus offering a comprehensive view of the dynamics of the global coffee market. TRADEMAP, (2024).

Figure 1

World trend of the main coffee importing countries 2004 - 2023 (greater than 2k Tons) main exporting countries of unroasted and decaffeinated coffee exported from Peru

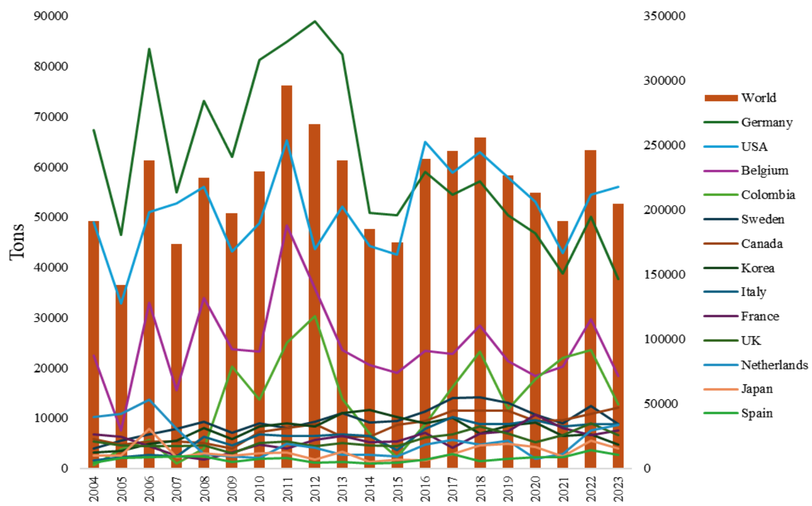


Table 2

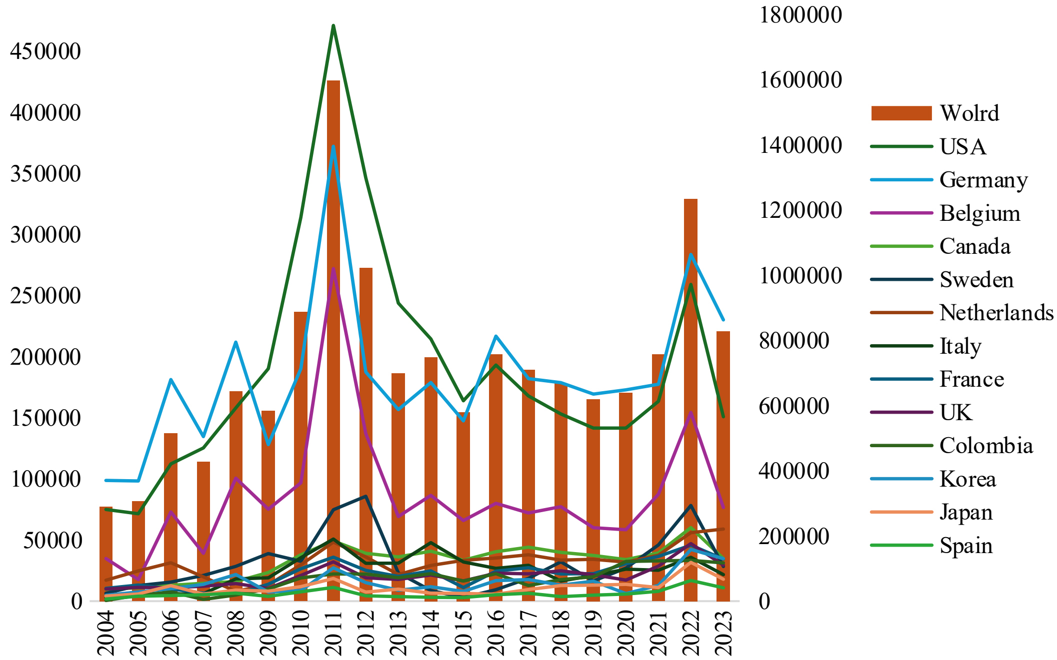
World trend of the main coffee importing countries 2004 - 2023 (greater than 3K thousand USD) main exporting countries of unroasted and decaffeinated coffee exported by Peru

Item	World	USA	Germany	Belgium	Canada	Sweden	Netherlands	Italy	Francia	UK	Colombia	Korea	Japan	Spain
2004	289844	74902	98755	34788	9653	6336	17088	2533	10411	9887	490	4797	4111	1691
2005	306075	71429	98335	17549	10915	12709	24771	4572	13130	11155	4942	7428	5853	3976
2006	514918	112257	181239	72900	12869	15518	31368	5803	9953	10964	7449	10137	12593	4544
2007	426884	125259	134614	39070	14532	20973	19757	6082	6548	12183	1365	13673	5767	5167
2008	643800	158008	211851	100560	15943	28407	8093	18210	5333	14359	4991	21696	9062	6486
2009	583784	190183	128058	75195	23375	38822	13250	19075	13783	10303	9850	7307	8095	3886
2010	887045	314029	190216	96780	37874	32582	29683	35476	26502	21067	18948	8689	11836	7554
2011	1596751	470985	372175	271974	49248	74707	48270	50784	35921	32158	22133	27157	18421	11198
2012	1022848	346328	187425	136966	39123	85708	36095	30865	25112	19086	22086	15105	7377	4288
2013	698758	243740	156695	69200	36162	23005	21756	30960	20222	17721	19109	8847	9719	3704
2014	747838	214517	178909	86476	40829	8706	29187	47792	24721	21345	22451	11744	6475	3127
2015	579586	163961	147435	65873	33463	2939	33253	31996	11081	16553	16491	7937	6282	2917
2016	756333	193111	216800	79953	40430	9365	35233	26781	24505	22805	22468	16730	5646	5226
2017	708822	167837	182040	72072	44142	18538	37922	29330	27340	22329	12735	17629	9424	6341
2018	667336	153095	178760	77170	39825	32115	33604	16390	22139	24820	17572	13047	12770	3642
2019	619656	141538	169337	60012	37336	16474	34123	20914	22477	21509	19938	16250	13057	4893
2020	639890	141541	172836	58358	33941	26947	31909	26110	30537	17176	32425	6217	13711	5726
2021	756687	163476	177479	87517	39407	45993	37614	25218	36589	28610	32834	12827	11028	7985
2022	1234294	259079	283605	154285	60115	78183	55951	35808	45775	47042	33340	42267	31684	16854
2023	827514	150785	230096	76596	34876	28294	58917	21575	34422	29392	31242	34704	17813	10894

Note: The table shows coffee imports in thousands of USD from 2004 to 2023. Globally, there are notable fluctuations, with a peak in 2011. The United States and Germany are the largest importers, followed by Belgium, Canada, and Japan. The table reflects the economic dynamics of the global coffee market, influenced by demand and prices. TRADEMAP, (2024).

Figure 2

World trend of the main coffee importing countries 2004 - 2023 (greater than 3K thousand USD) main exporting countries of unroasted and non-decaffeinated coffee exported by Peru



Note: The graph shows coffee imports with values exceeding 3,000 USD from 2004 to 2023. The United States and Germany are the largest importers, with a notable peak in 2011. The red bars represent the global total, and the colored lines represent the imports of each country. This trend reflects the dynamics of the global coffee market. TRADEMAP, (2024).

Dickey-Fuller test to evaluate stationarity:

If the p value of the ADF test is less than 0.05, the series is stationary and does not need further differentiation (d=0).

If the p-value of the ADF test is greater than 0.05, the series is not stationary and needs differentiation (d=1).

Table 3

Values (d,p,q) for each country and Dickey-Fuller test

Country	ADF Statistic	p-value	AIC	BIC
Germany	-2.24391	0.191	422.542	425.376
USA	-3.86932	0.002	431.068	434.055
Belgium	-4.19348	0.001	426.646	430.629
Colombia	-4.20763	0.001	423.149	426.136
Sweden	-2.52379	0.110	347.331	351.108
Canada	-0.0012081	0.958	337.133	340.910
Korea	-1.63088	0.467	343.102	346.880
Italy	-1.03998	0.738	339.144	342.922
France	-1.03998	0.738	344.812	348.590
UK	-0.737904	0.837	331.117	334.895
Netherlands	-0.682280	0.851	356.523	360.301
Japan	-3.97765	0.002	358.422	362.405

Spain	-2.45145	0.128	308.523	312.301

***Note**:* Stationarity: Countries such as the USA, Belgium, Colombia, and Japan have significantly low p-values (< 0.05) and sufficiently large negative ADF statistics, suggesting that their series are stationary without the need for differencing. This implies that the time series for these countries do not show consistent trends or seasonality that vary over time.
Non-Stationary**:** Canada, South Korea, Italy, France, the United Kingdom, the Netherlands, Spain, and Sweden exhibit relatively high p-values, indicating that we cannot reject the null hypothesis of a unit root, suggesting that these series need differencing to be considered stationary. Additionally, the use of AIC and BIC is crucial for selecting the most appropriate model. In the case of Sweden and Canada, where AIC and BIC are relatively low compared to other countries with d=1d=1d=1, it could indicate that the differencing process was effective and/or that the fitted model is relatively simple and adequate for those data.

ARIMA (d,p,q) (0,1,1)

$$\left(1-\phi_1 B\right) X_t=\left(1+\theta_1 B\right)\epsilon_t$$

Developing the model

$$X_t - X_{t-1} = \epsilon_t + \theta_{1\epsilon_{t-1}}$$

This can be interpreted as follows:

X_t is the current value of the time series.
X_{t-1} is the previous value of the time series.
ϵ_t is the white error at time t.
θ_1 is the parameter of the first order moving average term.

for the ARIMA (0,1,1) model, the full model equation is:

$$X_t - X_{t-1} = \epsilon_t + \theta_{1\epsilon_{t-1}}$$

This shows that the differenced value of the series at time t depends on the error at time t and the error at time t-1.

ARIMA (d,p,q) (1,1,1)

$$\left(1-\phi_1 B\right)\left(1-B\right) X_t=\left(1+\theta_1 B\right)\epsilon_t$$

Expanding this equation, we first expand the left side:

$$\left(1-\phi_1 B\right)\left(1-B\right) X_t=\left(1+B-\phi_1 B+\phi_1 B^2\right) X_t$$

Simplifying:

$$X_t - X_{t-1} - \phi_1 X_{t-1} + \phi_1 X_{t-2} = \epsilon_t + \theta_{1\epsilon_{t-1}}$$

In such a way that:

X_t The current value of the time series.
X_{t-1} It is the previous value of the time series.
X_{t-2} It is the value from two previous periods in the time series.
ϵ_t It is the white noise error at time t.
ϵ_{t-1} It is the white noise error at time t-1
ϕ_1 It is the parameter of the first-order autoregressive term.
θ_1 It is the parameter of the first-order moving average term.

For the ARIMA (1,1,1) model, the complete equation of the model is:

$$X_t = X_{t-1} + \phi_1 X_{t-1} - \phi_1 X_{t-2} + \epsilon_t + \theta_{1\epsilon_{t-1}}$$

$$X_t - X_{t-1} = -\phi_1 \left(X_{t-1} - X_{t-2} \right) + \epsilon_t + \theta_{1\epsilon_{t-1}}$$

Table 4

Unit Root Analysis and ARIMA Parameters by Country

Country	ADF Statistic	p-value	d	p	q	AIC	BIC
Germany	-2.24391	0.191	1	1	1	422.542	425.376
USA	-3.86932	0.002	0	1	1	431.068	434.055
Belgium	-4.19348	0.001	0	1	1	426.646	430.629
Colombia	-4.20763	0.001	0	1	1	423.149	426.136
Sweden	-2.52379	0.110	1	1	1	347.331	351.108
Canada	-0.0012081	0.958	1	1	1	337.133	340.910
Corea	-1.63088	0.467	1	1	1	343.102	346.880
Italy	-1.03998	0.738	1	1	1	339.144	342.922
France	-1.03998	0.738	1	1	1	344.812	348.590
UK	-0.737904	0.837	1	1	1	331.117	334.895
Netherlands	-0.682280	0.851	1	1	1	356.523	360.301
Japan	-3.97765	0.002	0	1	1	358.422	362.405
Spain	-2.45145	0.128	1	1	1	308.523	312.301

Note: The table shows the results of the Dickey-Fuller test and the ARIMA parameters for coffee imports. The USA, Belgium, Colombia, and Japan have stationary series ($p<0.05$, $d=0$), while other countries require differencing ($d=1$). The parameters p and q, along with the AIC and BIC values, help identify the best ARIMA models for each country.

Table 5

ARIMA Model Parameters and Component Analysis Results by Country

Country	d	p	q	Autoregressive $X_t = c + \phi_1 X_{t-1}$		Integration $\nabla^0 X_t = X_t$ $\nabla^1 X_t = X_t - X_{t-1}$	Moving Average $\epsilon_t = \theta_{1\epsilon_{t-1}} + \eta_t$
				Constant C	Coefficient AR (1) ϕ	I (1); I (0);	MA (1)
Germany	1	1	1	30302.05	0.488091	I (1)	0.247569
USA	0	1	1	48753.97	0.058631	I (0)	0.065468
Belgium	0	1	1	25326.99	-0.029231	I (0)	-0.023915
Colombia	0	1	1	6997.58	0.518198	I (1)	0.552572
Sweden	1	1	1	3799.58	0.628836	I (1)	0.753522
Canada	1	1	1	1193.99	0.890895	I (1)	0.711776
Korea	1	1	1	2611.84	0.672571	I (1)	0.690679
Italy	1	1	1	2202.88	0.708306	I (1)	0.570161
France	1	1	1	2093.32	0.637351	I (1)	0.461701
UK	1	1	1	2190.59	0.614126	I (1)	0.667981
Netherlands	1	1	1	1674.09	0.666096	I (1)	0.999957
Japan	0	1	1	3207.36	0.036598	I (0)	0.030575
Spain	1	1	1	1264.60	0.388200	I (1)	0.440389

Note: The table presents the parameters of the ARIMA model (p, d, q) and the autoregressive (AR), integration (I), and moving average (MA) components for coffee imports in various countries. The countries with stationary series without differencing ($d=0$) include the USA, Belgium, Colombia, and Japan, while others require differencing ($d=1$). The constant C and the AR coefficient (ϕ) vary by country, indicating the relationship between the current value and the past value of imports. The MA coefficients (θ) reflect the influence of past errors.

Table 6
ARIMA Models and Autoregressive Components by country

Country	Model
Germany	$X_t = 30302.05 + 0.488091\, X_{t-1} + \epsilon_t;\ \epsilon_t = 0.247569_{\epsilon_{t-1}} + \eta_t$
USA	$X_t = 48753.97 + 0.058631\, X_{t-1} + \epsilon_t;\ \epsilon_t = 0.065468_{\epsilon_{t-1}} + \eta_t$
Belgium	$X_t = 25326.99 - 0.029231\, X_{t-1} + \epsilon_t;\ \epsilon_t = -0.023915_{\epsilon_{t-1}} + \eta_t$
Colombia	$X_t = 6997.58 + 0.518198\, X_{t-1} + \epsilon_t;\ \epsilon_t = 0.552572_{\epsilon_{t-1}} + \eta_t$
Sweden	$X_t = 3799.58 + 0.628836\, X_{t-1} + \epsilon_t;\ \epsilon_t = 0.753522_{\epsilon_{t-1}} + \eta_t$
Canada	$X_t = 1193.99 + 0.890895\, X_{t-1} + \epsilon_t;\ \epsilon_t = 0.711776_{\epsilon_{t-1}} + \eta_t$
Korea	$X_t = 2611.84 + 0.67257\, X_{t-1} + \epsilon_t;\ \epsilon_t = 0.690679_{\epsilon_{t-1}} + \eta_t$
Italia	$X_t = 2202.88 + 0.708306\, X_{t-1} + \epsilon_t;\ \epsilon_t = 0.570161_{\epsilon_{t-1}} + \eta_t$
France	$X_t = 2093.32 + 0.637351\, X_{t-1} + \epsilon_t;\ \epsilon_t = 0.461701_{\epsilon_{t-1}} + \eta_t$
UK	$X_t = 2190.59 + 0.614126\, X_{t-1} + \epsilon_t;\ \epsilon_t = 0.667981_{\epsilon_{t-1}} + \eta_t$
Netherlands	$X_t = 1674.09 + 0.666096\, X_{t-1} + \epsilon_t;\ \epsilon_t = 0.999957_{\epsilon_{t-1}} + \eta_t$
Japan	$X_t = 3207.36 + 0.036598\, X_{t-1} + \epsilon_t;\ \epsilon_t = 0.030575_{\epsilon_{t-1}} + \eta_t$
Spain	$X_t = 1264.60 + 0.388200\, X_{t-1} + \epsilon_t;\ \epsilon_t = 0.440389_{\epsilon_{t-1}} + \eta_t$

Note: The table presents the ARIMA (p, d, q) models specific to coffee imports in various countries. Each model is described by an autoregressive equation with a constant, an AR (ϕ) coefficient, and a moving average (MA) term. These models reflect the relationship between the current value of imports and their past values, adjusted by an error term that considers the influence of past errors. Each country has a specific model that captures the particular dynamics of its coffee imports.

Table 7
Projection of Imports by Country (2024-2030)

Year	2024	2025	2026	2027	2028	2029	2030
Germany	48666.47	66104.03	78932.14	88369.27	95311.79	100419.12	104176.38
USA	52038.77	55211.93	55605.72	55654.58	55660.65	55661.40	55661.49
Belgium	24788.91	24009.56	24050.98	24048.78	24048.89	24048.89	24048.89
Colombia	13573.51	21531.69	30053.07	39177.5	48947.68	59409.28	70611.26
Sweden	9311.96	16672.04	26846.3	40910.78	60352.93	87228.93	124381.19
Canada	12018.36	20455.47	33977.38	55648.56	90380.32	146043.91	235254.33
Corea	5779.65	10490.95	16913.62	25669.34	37605.56	53877.63	76060.51
Italia	8410.47	12955.39	18765.92	26194.49	35691.67	47833.51	63356.44
Francia	6907.87	9685.43	12738.11	16093.16	19780.54	23833.17	28287.21
UK	6284.97	10248.59	15330.38	21845.78	30199.22	40909.22	54640.58
Netherlands	7455.14	14094.74	25156.68	43586.45	74291.43	125447.55	210676.35
Japan	3353.79	3432.64	3437.94	3438.3	3438.32	3438.32	3438.32
Spain	2315.85	3183.48	3902.4	4498.09	4991.66	5400.64	5739.51

Note: The table shows coffee import forecasts (in thousands of USD) for 2024-2030. Germany and the USA maintain stable trends, while Colombia, Sweden, and Canada experience significant growth. Japan and Spain show stability in their imports. These forecasts reflect the expectations in the global coffee market.

DISCUSSION

The analysis of the export competitiveness of Peruvian coffee using the ARIMA model allowed us to identify patterns and trends in export volumes. In contrast to Rivera (2022), who highlights the stability of Mexican coffee competitiveness amidst global variability, our results indicate that the Peruvian coffee market exhibits significant fluctuations. This underscores the importance of differencing in time series to achieve stationarity, a crucial aspect also supported by Camones (2022) in the context of coffee trade.

Additionally, the study by Cerquera et al. (2020) on infrastructure and governmental policies emphasizes the need for external improvements for the growth of the coffee sector. Our findings align with this perspective, highlighting the relevance of infrastructure enhancement and government support as key elements to increase the competitiveness of Peruvian coffee in the international market. Furthermore, the works of Figueroa et al. (2019) and Sacco et al. (2011) suggest that optimizing internal processes and adopting new technologies can improve efficiency and reduce costs in coffee production. Our analysis supports this claim, demonstrating that the ability of Peruvian producers to adapt to these internal improvements is essential for maintaining their competitiveness. Consistent with the results of Montes and Oblitas (2023), we find that economies of scale play a decisive role in the sector's competitiveness, emphasizing the need to increase production volume to optimize costs. The implementation of export strategies informed by predictive models, such as ARIMA, as suggested by Sánchez et al. (2014, is fundamental for anticipating trends and adjusting export strategies. Our results confirm the effectiveness of the ARIMA model for this purpose, providing producers and policymakers with valuable insights for making strategic decisions aimed at maximizing competitiveness and market reach in international markets.

CONCLUSIONS

The ARIMA model has proven to be highly effective in forecasting coffee import trends in major importing countries. Its ability to capture complex patterns in time series and differentiate non-stationary series has been crucial for obtaining accurate and reliable forecasts, providing a solid foundation for strategic decision-making in the coffee sector.

The results show that the ARIMA model is versatile, allowing for forecasts without the need for differencing in countries with stationary series and adapting through differencing in those with non-stationary series. This highlights its applicability in various market contexts and historical data.

The application of the ARIMA model has provided valuable insights for producers and policymakers, enabling them to anticipate fluctuations in demand and prices. This facilitates the creation of informed and effective strategies, contributing to maintaining the competitiveness of Peruvian coffee in the global market. Continuous monitoring and adjustment of forecasting models are essential to ensure strategic decisions based on accurate and up-to-date data.

BIBLIOGRAPHICAL REFERENCES

Aguilar, B. A., & Acosta Abreu, R. S. (2022). Ajuste de un modelo ARIMA para los precios de exportación del aguacate calibre 60. México: Escuela Superior de Física y Matemáticas . Retrieved from https://www.esfm.ipn.mx/assets/files/esfm/docs/RNAFM/articulos-2022/XXVIIRNAFM002.pdf

Camones Gonzales, F. C. (2022). Control de calidad en los procesos estadísticos: Una aproximación basada en los modelos ARIMA con Análisis de Intervención. INEI. Retrieved from https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib0516/Libro.pdf

Cerquera Losada, O. H., Pérez Gómez, V. H., & Sierra Chavarro, J. (2020). Análisis de la competitividad de las exportaciones del café del Huila. Tendencias, Vol. 21 N.° 2, 19-44.

Chávez Quisbet, N. (1997). Modelos ARIMA. Revista Ciencia y Cultura, 23-30.

Díaz Rodríguez, A., Silva Jaimes, M. I., & Dávila Romero, J. (2018). Relación entre las buenas prácticas de higiene y la ocurrencia de ocratoxina A en café (Coffea arabica L.) orgánico de las principales zonas cafetaleras del Perú. Scientia Agropecuaria, 11. doi:http://dx.doi.org/10.17268/sci.agropecu.2018.02.02

Dilas Jiménez, J. O., Diaz Dumont, J. R., Torres Huamaní, J., Mendoza Pumapillo, J. E., & Tamayo Ortiz, C. V. (2021). Producción, precios y dinámica de las exportaciones del café peruano. Revista de investigación científica y tenológica Llamkasun, Vol. 2 N.° 2, 12. doi:https://doi.org/10.47797/llamkasun.v2i4.66

Dilas, J., & Cernaqué, O. (2017). El sector cafetalero peruano: Un enfoque a la CTI para su competitividad. Huancayo. Retrieved from https://hdl.handle.net/20.500.12394/3477

Figueroa Hernández, E., Pérez Soto, F., Godínez Montoya, L., & Perez Figueroa, R. A. (2019). Los precios de café en la producción y las exportaciones a nivel mundial. Revista Mexicana de Economía y Finanzas Nueva Época, Vol. 14 N.° 1, 41-56. doi:http://dx.doi.org/10.21919/remef.v14i1.358

González Casimiro, M. P. (2009). Análisis de series temporales: Modelos ARIMA. Universidad del País Vasco.

Montes Ninaquispe, J. C., Santa María, A. P., & Oblitas Vallejo, I. A. (2023). Dinámica comercial de las exportaciones peruanas de café a la Unión Europea 2017-2021. ALFA. Revista de Investigación en Ciencias Agronómicas y Veterinarias, Vo. 7 N.° 17, 175-183. doi:https://doi.org/10.33996/revistaalfa.v7i19.207

Ortiz Ceballos, G., de la Cruz Vargas Mendoza, M., Mendoza Briseño, M. A., Ojeda Ramírez, M. M., & Trujillo Ortega, L. (2004). Análisis comparativo de la producción – demanda del café en el Mercado Internacional (1980-2003). Interciencia, Vol.29 N.° 11 , 621-625. Retrieved from https://ve.scielo.org/scielo.php?script=sci_arttext&pid=S0378-18442004001100005

Rivera Rojo, C. R. (2022). ompetitividad del café mexicano en el comercio internacional: un análisis comparativo con Brasil, Colombia y Perú (2000 – 2019). Análisis Económico, Vol. XXXVII, N.° 94, 181-199. doi:https://doi.org/10.24275/uam/azc/dcsh/ae/2022v37n94/Rivera

Rojas Ruiz, R., Alvarado Huamán, L., Borjas Ventura, R., Carbonell Torres, E., Castro Cepero, V., & Julca Otiniano, A. (2021). Sustentabilidad en fincas productoras de café (Coffea arabica L.) convencional y orgánica en el Valle del Alto Mayo, Región San Martín, Perú. RIVAR (Santiago), Vol. 8 N.° 23, 13. doi:http://dx.doi.org/10.35588/rivar.v8i23.4916

Sacco dos Anjos, F., Belik, W., & Velleda Caldas, N. (2011). La caficultura en Brasil Evolución, situación actual y nuevos retos cara al futuro. Mundo agrario, Vol. 12 N.° 23, 26.

Sánchez López, E., Barreras Serrano, A., Pérez Linares , C., Figueroa Saavedra, F., & Olivas Valdez, J. A. (2013). Aplicación de un modelo ARIMA para pronosticar la producción de leche de bovino en baja California. Tropical and Subtropical Agroecosystems, Vol. 16 N.° 3, 315-324. Retrieved from http://www.redalyc.org/articulo.oa?id=93929595004

Sánchez, L., Cabanas, G., Abad, Y., & Torres, V. (2014). Utilización de modelos ARIMA para la predicción de la producción de leche. Estudio de caso en la UBPC "Maniabo", Las Tunas. Revista Cubana de Ciencia Agrícola, Vol. 48 N.° 3, 213-218. Retrieved from http://www.redalyc.org/articulo.oa?id=193032133002

Valdiglesias Oviedo, J. (2024). Associativity of small farmers and exports in the Peruvian region of Cajamarca. Apuntes, Vol. 51 N° 96. doi:http://dx.doi.org/10.21678/apuntes.96.1970

Vera Velásquez, F. B., Martin Fernández, R. A., & Esquivel García, R. (2024). Diagnóstico de la producción cafetalera en el cantón Jipijapa, provincia de Manabí, Ecuador. Revista Arbitrada Interdisciplinaria KOINONIA, Año IX. Vol IX. N°17, 21. doi:http://doi.org/ 10.35381/r.k.v8i17.3146