Factors Influencing the Competitiveness of Coffee Growers in Puebla, Mexico, to Export to the United States

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Received: March 17, 2024 Accepted: May 1, 2024 Online Published: May 17, 2024

doi:10.5430/ijba.v15n2p42 URL: https://doi.org/10.5430/ijba.v15n2p42

Abstract

This research aims to examine whether price, productivity, quality, innovation and technology transfer (TT), exchange rate, and financing are key factors that influence the export competitiveness of the coffee industry in the state of Puebla, Mexico. Previous studies on competitiveness have explored classical and neoclassical theories and new theories of international trade. We collected information by conducting an online survey using Google Forms, which included indicators for each of the variables studied. The multivariate regression model was employed to analyze the relationship between the dependent and independent variables, and we used the Statistical Package for the Social Sciences to process the data. The results indicated that the studied variables significantly affected coffee producers' export competitiveness in Puebla. Specifically, the model's exchange rate, quality, and productivity variables demonstrated considerable explanatory power. This underscored the importance of product quality, production volume, and factors related to the producer's income in the decision to export coffee rather than sell it in the domestic market. Despite the emphasis placed on variables such as innovation and TT in the literature, they had limited relevance in the used model. However, we discussed several potential explanations for this outcome.

Keywords: coffee, Puebla, competitiveness, multivariate analysis

1. Introduction

According to Figueroa et al. (2015), around 120 million individuals worldwide depend on coffee cultivation and processing, making it the second most traded commodity globally following oil, with significant transactions in the financial market. Mexico currently ranks as the eleventh largest coffee producer globally, contributing 2.4% to the total production share. This accounts for 0.66% of the national agricultural gross domestic product and 1.34% of agro-industrial production (Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación [SAGARPA], 2017). Among the states in Mexico, Puebla holds the position of the third most important for coffee production.

According to the United States Department of Agriculture (USDA, 2019), coffee is produced in 15 states in Mexico, with Chiapas leading at 40% of production, Veracruz at 25%, and Puebla at 16%. The coffee harvesting season typically spans from September to March. Over the years, Mexico has witnessed a decline in coffee production and a decrease in the number of planted and harvested hectares. Factors contributing to this trend include adverse weather conditions, unusual rainfall patterns, and the presence of coffee rust.

Coffee is a significant industry in Mexico, particularly in poor states. In 2014, it was estimated that 511,669 coffee producers were employed across 12 states and 391 municipalities, working on an average of 690,000 hectares. The coffee industry generates approximately $900 million in annual exports, directly and indirectly affecting three million people and boasting a market value of around 20 billion pesos annually (Centro de Estudios para el Desarrollo Rural Sustentable y la Soberanía Alimentaria [CEDRSSA], 2018).

In the state of Puebla, coffee production is concentrated primarily in the Sierra Norte region, specifically in the municipalities of Hueytamalco, Huauchinango, Xicotepec de Juárez, Cuetzalan, and Teziutlán. Coffee was introduced to the Sierra Norte de Puebla in 1870, 150 years after its introduction to Mexico (Sola, 2016). Coffee production in Puebla holds significant economic and social importance. In today's global and highly competitive environment, understanding the variables influencing the coffee sector's competitiveness is essential. This

understanding is crucial for promoting sustainable development in coffee production and strengthening Puebla's position in national and international markets.

Presently, Puebla ranks as the third most important coffee-producing state, accounting for approximately 18% of national production. The sector continues to grow each year, as Figure 1 shows. Coffee represents the second most economically significant crop in Puebla; however, coffee producers in Puebla face many challenges because most of them are small and medium-sized producers. Many belong to Indigenous ethnic groups, rendering them even more vulnerable. Puebla dedicates over 66,000 hectares to coffee production across 54 municipalities, making it the second most important crop after corn (SAGARPA, 2017). According to the Puebla government (2023), the state's coffee production witnessed a growth of 72.6% for the 2021/2022 cycle.

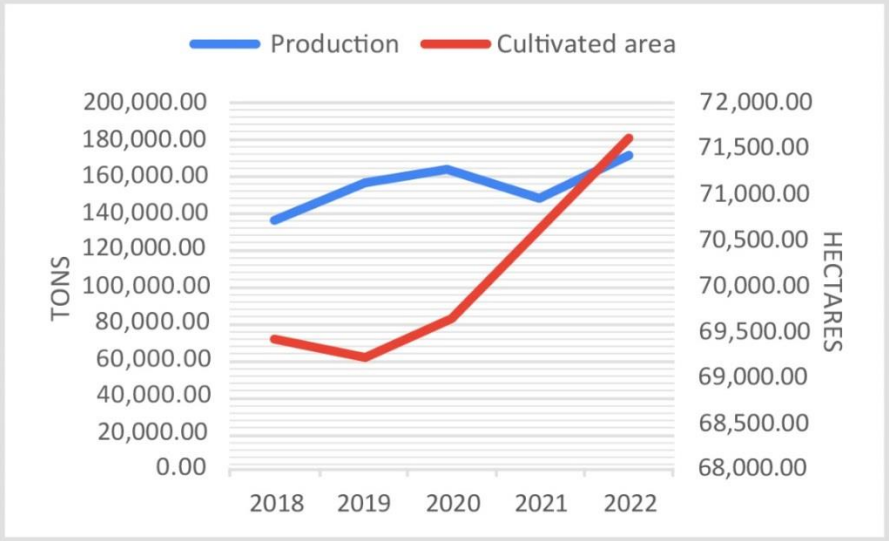

Figure 1. Coffee production growth in Puebla from 2018 to 2022 (Authors)

2. Materials and Methods

We adopted a cross-sectional design with a period spanning from 2022 to 2023, encompassing the agricultural coffee year, including the production and harvest periods. Data collection took place in Puebla, Mexico, specifically targeting coffee producers in Puebla involved in export activities. According to the Puebla government (2021), the number of coffee producers meeting the export criteria is approximately 17,000, accounting for approximately 36% of the total coffee producers in the state.

We developed a survey consisting of six sections to analyze the variables' impact on export competitiveness. We formulated the survey based on a literature review of the main indicators associated with the selected variables, including the financing variable resulting from a pilot test conducted from December 2022 to January 2023.

The sample size for this research was determined using the formula Nieves and Dom ńguez (2010) recommended when the population size "N" is known.

$$n = \frac{(Z^2)*(p)(q)*N}{(EE^2)*(N-1)+(Z^2)(p)(q)} \quad (1)$$

Table 1. Sample calculation (Authors)

Z	N	p	q	EE	n
Confidence coefficient level	Size of total population	Probability in favor	Probability against	Estimated error margin	Sample size to be determined
1.96	17,000	0.5	0.5	0.05	?

The substitution of the equation mentioned above can be expressed as follows:

$$n = \frac{(1.96^2)*(0.5)(0.5)*17{,}000}{(0.05^2)*(17{,}000-1)+(1.96^2)(0.5)(0.5)} = 376 \quad (2)$$

Based on the equation, the calculated sample size was 376.

To validate the survey, we calculated Cronbach's coefficient, which, according to González and Pazmiño (2015), is a reliable method to assess a scale's construct validity. Cohen and Swerdlik (2001, as cited in Quero, 2010) also stated that Cronbach's coefficient allows researchers to estimate an instrument's internal consistency or reliability using a Likert-type or multiple-choice scale. We performed the calculation using the Statistical Package for the Social Sciences. Table 2 presents the results.

Table 2. Statistics of reliability (Authors)

Statistics of reliability		
Cronbach's alpha	Cronbach's alpha based on standardized items	Number of elements
.895	.891	29

Table 2 displays Cronbach's alpha coefficient, indicating a value of 0.895. This value fell within the range of 0.7 to 0.9, which is considered good internal consistency. As González and Pazmiño (2015) stated, this range is widely accepted as optimal for assessing reliability using Cronbach's coefficient. Therefore, we concluded that the survey was valid for this study.

We selected for this specific research a multivariate regression model, also known as multivariate linear regression. This model allows for simultaneously examining the relationship between one dependent variable and several independent variables. Bunge (2004) suggested that the identification of specific characteristics can be achieved directly or indirectly. In the case of tangible objects, quantitative observations are necessary because they possess measurable properties. Quantifying observations involves assigning numerical values to the identified characteristics. When determining the appropriate measurement type for each case, it is crucial to analyze the concept representing the corresponding property and comprehend the essence of quantification.

Table 3. Operationalization of variables (Authors)

Dependent variable	Dimension	Indicator	Item no.
Export competitiveness	Production volume	Quantity of coffee produced per season	9
	Production volume	Percentage of production exported	17
	Distribution channels	Efficiency of distribution channels	38, 39
Independent variables	Dimension	Indicator	Item no.
Innovation and technology transfer	Product innovation	Creation of new products or improvement of existing ones	19, 26, 30
	Process innovation	Improvement or redesign of existing processes	20, 22, 23, 27, 28
	Technological factors	Use of technologies that make production efficient	18, 21, 24, 25
Price	Sales price	Revenues	31, 32
	Perception of importance	Importance of price in marketing	33, 34
	Nominal exchange rate	Revenues	37

Exchange rate	Perception of importance	Importance of the exchange rate in marketing	34, 36
Productivity	Labor productivity	Crop yields and technical efficiency	13, 14, 15, 16, 17
Quality	Perceived quality	Certifications	3, 4, 5, 6
	Tangible quality	Cultivated varieties and quality control	1, 2, 7, 8
Financing	Financing sources	Financing options	44, 45
	Accessibility to financing	Accessibility to the financial system	42, 43
	Importance of financing	Perception of the need for financing	40, 41

Table 3 presents the operationalization of variables in the study, including the dimensions analyzed for each variable, the corresponding indicators for these dimensions, and the item number in the applied survey.

Furthermore, we selected a noncomparative scale, with the Likert-type scale being one of the most significant, as Ursini et al. (2004) indicated. According to Bertram (2008), Likert-type scales are psychometric instruments that require respondents to indicate their level of agreement or disagreement with a statement, item, or prompt using an ordered and unidimensional scale. In this study, a five-point scale was employed, where "strongly disagree" represented the lowest rating, indicating a complete lack of competitiveness, and "strongly agree" represented the highest rating, indicating a prominent level of competitiveness. Table 4 illustrates the equivalent values for the possible responses.

Table 4. Equivalent values to the Likert-type scale and the variables to be measured (Authors)

Likert variable/value	Strongly disagree	Disagree	Neutral	Agree	Totally agree
Quality	Uncompetitive	Rarely competitive	Fairly competitive	Competitive	Very competitive
Productivity	Uncompetitive	Rarely competitive	Fairly competitive	Competitive	Very competitive
Innovation	Uncompetitive	Rarely competitive	Fairly competitive	Competitive	Very competitive
Technology transfer	Uncompetitive	Rarely competitive	Fairly competitive	Competitive	Very competitive
Price	Uncompetitive	Rarely competitive	Fairly competitive	Competitive	Very competitive
Exchange rate	Uncompetitive	Rarely competitive	Fairly competitive	Competitive	Very competitive
Financing	Uncompetitive	Rarely competitive	Fairly competitive	Competitive	Very competitive

Multivariate or multivariable statistical techniques analyze multiple characteristics measured within the same individual or subject under investigation. Such techniques are used because these characteristics are correlated, and it is more effective to measure their combined effect rather than considering them in isolation (Sagar ó & Zamora, 2020). According to Gujarati and Porter (2010), multiple regression analysis's functional expression is as follows:

$$y = F(X_1, X_2, \dots, X_n + \mu_i) \quad (3)$$

By substituting the equation, the application of this model was expressed using the following equation:

$$Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + \mu_i \quad (4)$$

Where

Y = Dependent variable

X2 = Productivity

X3 = Quality

X4 = Price

X5 = Exchange rate

X6 = Financing

X7 = Innovation and technology transfer (TT)

$\mu =$ The stochastic disturbance term.

As Gujarati and Porter (2010) stated, β1 represents the intercept term, which indicates the average effect on Y when the independent variables X2, X3, . . . X7 are all set to zero. It can be interpreted as the average value of Y under such conditions. The β coefficients are known as partial regression coefficients.

3. Results and Discussion

According to Vilà et al. (2019), the multivariate regression model was based on certain assumptions that need to be examined to ensure the model's correct specification and to provide explanations for the variables' behavior.

3.1 Durbin-Watson (D-W) Test

The independence of error measurements for the explanatory or regressing variables, also known as autocorrelation, is an assumption of the classical model. Gujarati and Porter (2010) explained that this assumption implies that the disturbance term associated with any observation is not influenced by the disturbance term associated with any other observation. According to Catalán (2021), the metric for interpreting the D-W statistic ranges between 1.5 and 2.5; values within this range suggest no autocorrelation.

The results shown in Table 5, which presents the D-W statistic, fell within the range Catalán described, indicating no autocorrelation. Therefore, it was concluded that there was statistical evidence supporting the independence of errors.

Table 5. Durbin-Watson statistic (Authors)

Summary of the Durbin-Watson model
2.044

3.2 Levene's Test

According to Correa et al. (2006), one of the essential assumptions in statistical applications of multiple regression analysis, such as in this paper, is the homogeneity of variances (homoscedasticity). This assumption provides a robust alternative to Bartlett's procedure because it is less sensitive to deviations from normality. Thus, it is less likely to erroneously reject the hypothesis of equal variances due to non-normal distributions in the sampled populations. Ensuring this assumption is crucial for maintaining the quality of statistical procedures used in hypothesis testing and constructing confidence intervals.

For these data, the hypothesis test was as follows:

Ho: Variances are equal ($s^2 = s^2$).

H1: Variances are not equal ($s^2 \; ? \; s^2$).

Table 6 displays the probability values (p-values) for the individual variables studied, which were compared against the significance level alpha (0.05). Because the p-values were higher than alpha, there was insufficient evidence to reject the null hypothesis. Therefore, statistical evidence supported the presence of homogeneous variances in the data.

Table 6. Levene's test (Authors)

Test for homogeneity of variance				
Export competitiveness				
Productivity	Levene's statistic	df1	df2	Sig.
	0.232	8	371	.640
Quality	Levene's statistic	df1	df2	Sig.
	0.245	5	374	.695
Price	Levene's statistic	df1	df2	Sig.
	.112	2	377	.745
Exchange rate	Levene's statistic	df1	df2	Sig.
	0.130	1	378	.833
Financing	Levene's statistic	df1	df2	Sig.
	0.144	5	374	.917
Innovation and technology transfer	Levene's statistic	df1	df2	Sig.
	0.176	11	368	.760

3.3 Kolmogorov-Smirnov Test (K-S)

We used the K-S test to assess the adherence of a dataset to a normal distribution. It shares similarities with the Shapiro-Wilk test, but the key distinction lies in the sample size; the K-S test is recommended when there are more than fifty observations, as in this study. Before conducting the K-S test, it is essential to establish the hypothesis to be assessed (Flores & Flores, 2021).

For these data, the hypothesis test was as follows:

Ho: The sample follows a normal distribution ($X = N\ (\mu, \sigma^2$).

H1: The sample does not follow a normal distribution ($X \neq N\ (\mu, \sigma^2$).

According to the information presented in Table 7, the obtained significance value of the K-S statistic was higher than the predetermined significance level of 0.05. This finding suggested that there was insufficient evidence to reject the null hypothesis. Therefore, the statistical evidence supported the notion that the residuals conformed to a normal distribution.

Table 7. Kolmogorov-Smirnov test for normality of data (Authors)

Normality tests			
	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Unstandardized residual	.767	380	.451

3.4 Variance Inflation Factor (VIF)

The assumption of noncollinearity posits that the independent variables are not correlated with each other. Multicollinearity occurs when there is a strong linear relationship between explanatory variables, extending beyond pairwise correlations. According to Vil à et al. (2019), it is crucial to test for collinearity between individual variables and between any variable and the remaining group of variables. One commonly used test for this assumption is VIF analysis, which provides coefficients to determine collinearity's presence or absence.

Table 8 presents the VIF coefficients, which help assess the level of correlation between the independent variables. Vil à et al. (2019) suggested that the VIF value should fall within a range greater than 0.10 and less than 10. An expected value close to 1 indicates the absence of collinearity issues, whereas a coefficient below 0.10 or above 10 suggests serious collinearity problems. By examining the VIF coefficients in Table 14, it became evident that the variables fell within the acceptable range. Thus, we concluded that the data did not exhibit collinearity problems, satisfying the multivariate regression model's final assumption.

Table 8. Variance inflation table (Authors)

	Unstandardized coefficients		Standardized coefficients			Collinearity statistics	
Model	B	Standard error	Beta	t	Sig.	Tolerance	Variance inflation factor
(Constant)	-96.919	33.935		-3.019	.003		
Productivity	1.408	.239	.358	5.883	.000	.545	1.236
Quality	1.540	.413	.261	3.730	.000	.411	1.332
Price	.906	.492	.090	1.841	.000	.848	1.180
Exchange rate	1.952	.311	.081	1.710	.009	.902	1.109
Financing	.144	.380	.001	.012	.006	.495	1.022
Innovation and TT	.104	.205	.051	.506	.020	.297	1.083

3.5 Coefficient of Determination R^2

The coefficient of determination r^2 (in the case of two variables) or R^2 (multiple regression) is a measure that indicates the level of adjustment of the sample regression line to the data (Gujarati & Porter, 2010). Rojo (2007) provided a classification for the values of R^2 as follows:

Table 9. Variance inflation table (Authors)

Less than 0.3	0.3–0.4	0.41–0.5	0.51–0.85	Greater than 0.85
Very bad	Bad	Fair	Good	Suspect

Table 10 presents the model's level of adjustment, as indicated by the statistic. The table displays the multiple correlation coefficients between the predictors and the dependent variable. It illustrates the incremental improvement in the model's explanatory power as we added each variable. Taking as a reference the sixth model, where we included all the explanatory variables, we concluded that they explained 79% of export competitiveness; the statistical significance F, which remained below 0.05, validated this conclusion.

Table 10. Coefficient of determination table (Authors)

Summary of the model[g]										
					Change statistics					
Model	R	R-squared	Adjusted R-squared	Standard error of the estimate	R-squared change	Change in F	df1	df2	Sig change in F	Durbin-Watson
1	.446[a]	.199	.197	7.015089	.199	64.004	1	378	.031	2.044
2	.513[b]	.473	.459	6.874331	.213	26.638	1	377	.000	
3	.591[c]	.502	.471	6.848737	.228	17.823	1	376	.000	
4	.684[d]	.616	.578	6.833842	.215	12.641	1	375	.010	
5	.736[e]	.685	.635	6.841224	.285	10.191	1	374	.004	
6	.845[f]	.792	.755	6.848040	.252	10.256	1	373	.006	

a. Predictors: (Constant), Productivity

b. Predictors: (Constant), Productivity, Quality

c. Predictors: (Constant), Productivity, Quality, Price

d. Predictors: (Constant), Productivity, Quality, Price, Exchange rate

e. Predictors: (Constant), Productivity, Quality, Price, Exchange rate, Financing

f. Predictors: (Constant), Productivity, Quality, Price, Exchange rate, Financing, Innovation and TT

g. Dependent variable: Export competitiveness

3.6 Partial Regression Coefficients

The ß coefficients, or partial regression coefficients, represent the coefficients used to establish the regression equation after standardizing the variables. This standardization involves assigning values and converting the variables into numerical form for further analysis.

When conducting multiple regressions, the regression coefficients allow for assessing the significance of each independent variable in the equation.

Table 11 shows the ß coefficients. Based on empirical data, the variables "exchange rate," "quality," and "productivity" exhibited greater importance compared to other explanatory variables within the model. These variables contributed significantly to explaining the phenomenon under study, surpassing the perceived importance of variables suggested by the existing literature, such as "innovation and TT" or access to financial services.

Table 11. Table of beta coefficients (Authors)

Coefficients[a]				
	Unstandardized coefficients		Standardized coefficients	
Model	B	Standard error	Beta	Sig
(Constant)	-96.919	33.935		.003
Productivity	1.408	.239	.358	.000
Quality	1.540	.413	.261	.000
Price	.906	.492	.090	.000
Exchange rate	1.952	.311	.081	.009
Financing	.144	.380	.001	.006
Innovation and TT	.104	.205	.051	.020

On the one hand, the low coefficients observed for the variables "innovation and TT" and financing suggested that coffee growers in various regions of Puebla, particularly those that are geographically challenging to access, place less emphasis on these aspects because of the difficulties they face in obtaining financial services. Given the relative difficulty in accessing external resources and investing in equipment and technological advancements to enhance production, coffee growers may assign lower importance to these factors than to others that are more within their control. The latter factors could include focusing on quality during the production process, work performance, and exportation.

3.7 Empirical Analysis

After examining the various statistics comprising the multiple regression model and confirming the statistical significance of the independent variables in explaining the dependent variable, another way to enhance the results was to analyze the data obtained through the survey conducted to characterize the production system.

Table 12. Crop information of exporting production units (Authors)

Municipality	Up number	% of surveys by municipality	Average cultivated area	% of average exports to the United States
Atlequizayan	10	2.63%	2.57 ha	41%–60%
Ayotoxco de Guerrero	12	3.16%	3.92 ha	91% or greater
Camocuautla	10	2.63%	3.3 ha	61%–80%
Coatepec	57	15.00%	2.39 ha	61%–80%
Cuetzalan del Progreso	61	16.05%	3.42 ha	61%–80%
Huauchinango	39	10.26%	2.64 ha	61%–80%
Huehuetla	13	3.42%	3.62 ha	91% or greater
Hueyapan	10	2.63%	2.7 ha	61%–80%
Hueytamalco	38	10.00%	3.37 ha	61%–80%
Ixtepec	10	2.63%	1.5 ha	61%–80%
Jalpan	17	4.47%	2.5 ha	70%–90%
Jopala	22	5.79%	2.75 ha	61%–80%
San Felipe Tepatlán	11	2.89%	2.45 ha	61%–80%
Teziutlán	10	2.63%	4.00 ha	61%–80%
Xicotepec	41	10.79%	2.88 ha	61%–80%
Zihuateutla	19	5.00%	3.00 ha	61%–80%

Table 12 provides the percentage distribution of participating producers who completed the survey via Google Forms. The data revealed that respondents were from 16 of the 54 municipalities involved in coffee production in Puebla, according to the Puebla government (2023). They accounted for approximately 29.6% of the registered producing municipalities in the Servicio de Información Agroalimentaria y Pesquera (SIAP, 2023). During the data collection stage, there was substantial participation from producers in various municipalities. Cuetzalan del Progreso had the highest participation rate at 16.05%, followed by Coatepec at 15%, Xicotepec at 10.79%, Huauchinango at 10.26%, and Hueytamalco at 10%. The cultivated area per producer varied across municipalities, but it was 2.9 hectares on average. Teziutlán had the largest average cultivated area at four hectares, whereas Ixtepec had the smallest at 1.5 hectares.

Figure 2 illustrates the grouped yields in tons per hectare (ton/ha) for coffee producers in Puebla. The average yield was 2.93 tons/ha, which aligned with the official data from SAGARPA (Multimedios Líder, 2016). SAGARPA reported an average yield of 3.1 tons/ha. This average yield was significantly higher than the national average of 1.47 tons/ha, indicating a difference twice as large as the national average. Consequently, in 2018 Puebla emerged as the

third most important state in coffee cultivation. According to the Puebla government (Urbeconómica, 2023), Puebla is now becoming the second most significant state in coffee production in Mexico.

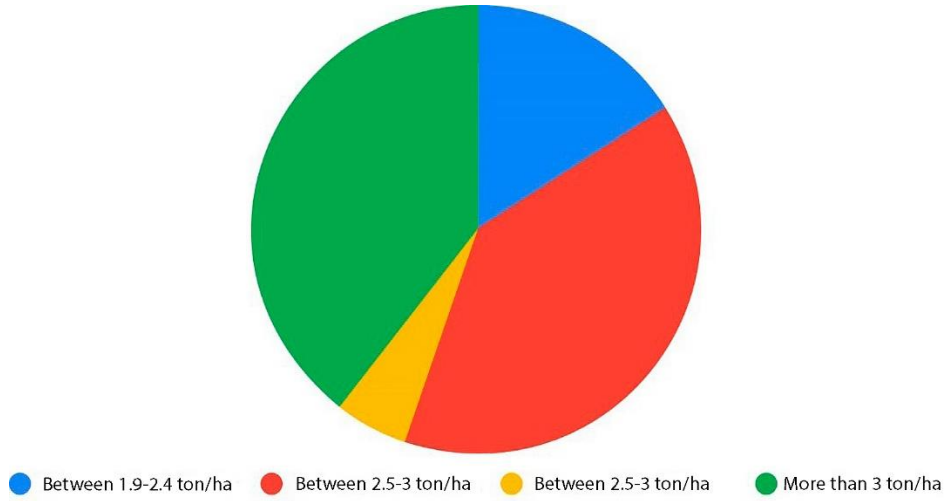

Figure 2. Yields ton/ha (Authors)

The significance of quality in the regression model stood out as one of the most prominent indicators when analyzing the ß coefficients, ranking as the second most important explanatory factor. Coffee producers in Puebla, particularly those exporting to the U.S. market, often rely on a key reference point: the evaluation the Specialty Coffee Association conducts (SCA, 2023). This international organization regulates specialty coffee's classification in different regions worldwide. The SCA score uses a scale ranging from 0 to 100, where only coffees scoring above 80 points are deemed specialty-grade, as illustrated below.

Table 13. SCA protocol classification scores (Authors)

SCA score	Ranking
90–100	Exquisite
85–89.9	Excellent
80–84.9	Very good

According to Figure 3, over 40% of producers already cultivate coffee that qualifies as specialty-grade coffee of excellent quality. Additionally, more than 5% of producers produce exquisite coffee, representing the highest quality level within the specialty coffee category. The remaining portion of the production either falls under the specialty coffee classification or is nearing the criteria this classification requires.

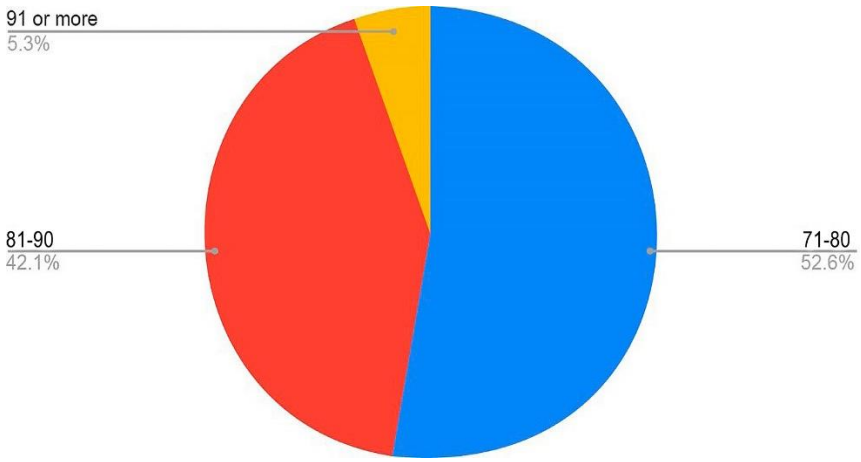

Figure 3. SCA protocol score of surveyed Puebla coffee producers (Authors)

However, the sample used for this research exclusively consisted of producers engaged in export activities. Therefore, the specialty coffee production index may need to reflect the overall average for the entire state accurately.

Another key factor to consider is the percentage of exports relative to production, which has been steadily increasing each year, as indicated by information from the Puebla government. Figure 4 illustrates this relationship, presenting the percentage of total exported production. It emphasizes the significance of the exchange rate within the regression model because the desired relationship between the exchange rate and the currencies in which coffee is traded influences international trade.

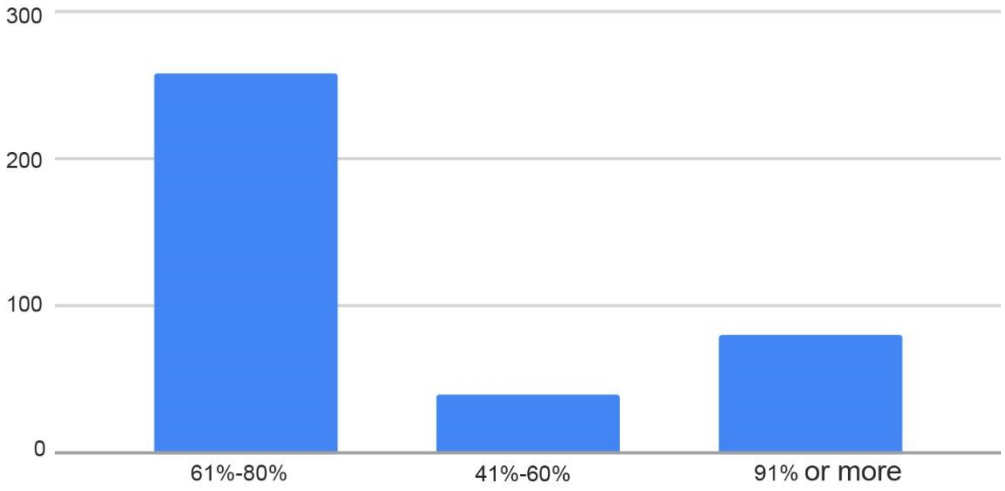

Figure 4. Percentage of exports with respect to production (Authors)

Another crucial aspect of the model was the exchange rate and prices, which, based on the survey results, demonstrated that producers attach significant importance to these factors when exporting their coffee. Figure 5 illustrates the perception of the price's importance in the decision to export coffee compared to domestic market commercialization. All coffee growers mentioned the considerable significance of price and exchange rate in the commercial exchange of coffee.

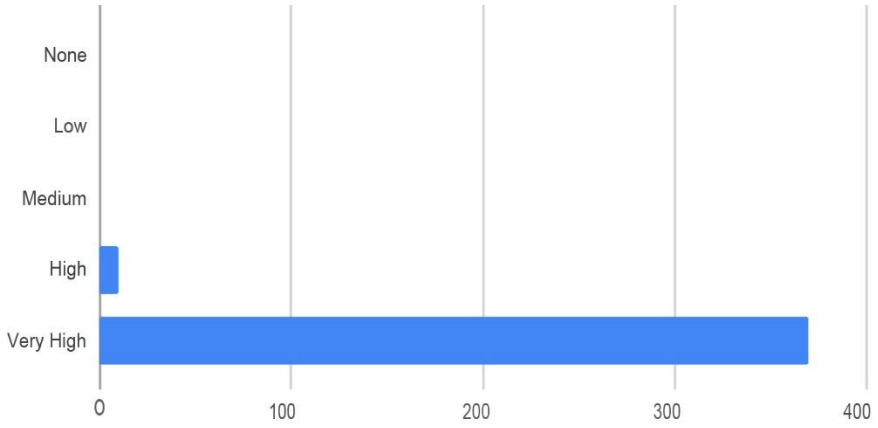

Figure 5. Importance of price in coffee exports to the United States (Authors)

The way producers sell coffee is a key factor that should be highlighted. This pattern appears consistent in the sale of coffee across various coffee-producing countries, and Puebla is no exception, particularly among small production units.

Figure 6 reveals that over 70% of coffee production continues to be marketed as raw material, which carries the lowest value as a marketable format. Less than 3% is marketed as the final consumer product, such as ground coffee. This indicated a notable disparity in marketing practices compared to other countries.

Regarding the significance of prices in international trade, the favorable exchange rate, combined with the high volatility of coffee in stock markets, has led to a gradual increase in new companies seeking to bypass intermediaries in trading their coffee.

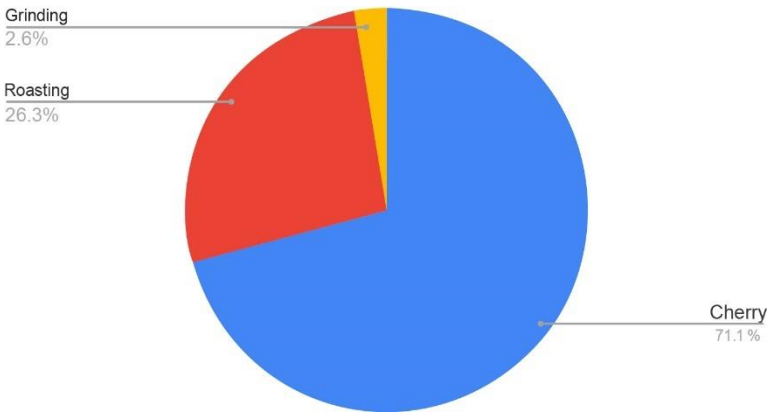

Figure 6. Methods of coffee sales (Authors)

Finally, Table 14 presents the overall results of the summed scores, indicating that the coffee sector's competitiveness in Puebla falls within the moderately competitive parameter. Related results have been obtained in other studies assessing competitiveness in the state. These results demonstrated that while the Puebla sector exhibits faster and more accelerated growth compared to other states, it still has to overcome a considerable gap to be considered an international reference.

Table 14. General results of the dependent variable export competitiveness (Authors)

Uncompetitive	Rarely competitive	Fairly competitive		Competitive	Very competitive
29	52	75.4	**97.34**	98.6	121	145

4. Conclusions

The Mexican coffee sector has experienced significant instability for over three decades. This instability can be attributed to numerous factors, including the termination of the International Coffee Agreement (ICA) in 1983, resulting in a high rate of price volatility. Additionally, climate change affected the sector, whereas the prevalence of diseases affected coffee plants in major coffee-producing states. In Puebla and other parts of the country, important levels of poverty and marginalization have characterized the communities historically engaged in coffee cultivation.

These challenges have prompted numerous studies to address the issues in the coffee sector. Various models have been developed to explore competitiveness within this context. These models have considered a wide range of variables as crucial elements for enhancing and expanding production, increasing household income, and improving the overall quality of life. Among these variables, innovation has been extensively studied. However, despite existing literature suggesting that innovation contributes to improved productivity and competitiveness, it did not appear to carry significant explanatory weight in the regression equation of the model in this study. This observation did not indicate a low contribution level; rather, it reflected the limited investment in the sector.

The challenge of accessing financial services is another variable intricately linked to the above problem. This difficulty may stem from the fact that the scores assigned to the indicators representing the impact of this variable in the Google Forms survey yielded the lowest values on the scale. Consequently, it highlights a complex and systemic issue that the Food and Agriculture Organization of the United Nations (2019), has already recognized: the most vulnerable groups affected by this problem are those on the poverty line, women, young people, the rural population, and individuals working in the informal economy. Enhanced financial inclusion can drive rural development and foster economic stability within the most disadvantaged and marginalized sectors.

Some of the variables with the most explanatory weight that resulted from the analysis of the ß coefficients were, as expected, due to the feedback from the pilot test. The exchange rate and the price reflect the need to have better income, which is expressed in the search for better sales prices than those that can be obtained in the national market. Furthermore, given that Mexico lacks the development index observed in other coffee-producing countries like Brazil, public policies in those countries have successfully fostered an annual increase in domestic consumption. This gradual progression may eventually empower them to exercise greater control over sales prices, based on domestic consumption patterns, in the long term. During this research, the issue of increasing domestic consumption was noticeably absent from discussions in specialized coffee forums within Mexico. This can be attributed to the prevailing focus on economic exchange and the significant levels of poverty and marginalization that define the Mexican coffee sector. Consequently, a lag persists in the production system in Mexico, which has struggled to recover and progress from the rust crisis experienced in the early 2010s compared other coffee-producing countries that have successfully recovered and progressed.

The method of coffee sales has been a persistent challenge plaguing the coffee production industry since its inception in the country. We highlighted the issue in Figure 6, where the importance of the exchange rate and financing, as revealed by the beta analysis, became evident in the decision to export. However, coffee continues to sell in its less valuable form, primarily as raw material. Importing countries like the United States or Italy add value to the coffee by transforming it into a final consumer product, thereby reaping greater benefits than producing countries such as Mexico.

The SCA score holds significant relevance, particularly for Puebla's coffee. It positions a huge portion of Puebla's coffee as specialty coffee, contributing to an increased economic value. These scores, granted by regulatory institutions, hold significant importance because they bestow intangible added value in perceived quality. It is highly sought after by consumers in countries with much higher coffee consumption rates than in Mexico. This emphasis on quality, spanning both the production and cultivation phases, represents a pivotal aspect. With proper monitoring and institutional support, it can serve as a differentiating factor amid fierce competition in the globalized coffee sector, even amid the saturation caused by overproducing nations like Brazil and Vietnam.

The findings presented in Table 12 indicate a medium level of competitiveness. This numerical representation reflects the abovementioned setbacks within the coffee sector of Puebla and across the country. These setbacks are closely intertwined with public policies that, over more than three decades, have failed to address the various socioeconomic challenges that primarily affect the vulnerable and often marginalized communities involved in coffee production. Many authors have recognized these communities as vulnerable populations who are subject to discrimination. Additionally, the sector faces the issues of low investment and uncertainty surrounding volatile sale prices. These factors collectively undermine competitiveness and productivity within the industry, impeding its ability to achieve the necessary scale of growth required in Puebla.

The findings of this study revealed that certain variables—namely, the exchange rate, quality, productivity, price, and, to a lesser extent, innovation and TT—significantly affect coffee producers' competitiveness in export activities in Puebla. The regression model results and empirical data demonstrated a positive relationship between these variables and export competitiveness. However, we obtained the data for this research from a sample of producers already involved in export activities, which may have introduced bias due to the homogeneity of the sample. Therefore, while these findings provided insights into the national coffee sector's challenges and realities, it is essential to validate the model and data collection instrument by conducting further analysis of populations exhibiting greater diversity, ensuring a more comprehensive understanding of both the model's behavior and the instrument's efficacy.

Acknowledgments

The project was supported by the Universidad Michoacana de San Nicolás de Hidalgo (UMSNH)

Authors' contributions

Prof. Alcaraz, Prof. Vanegas and Prof. Chávez were responsible for study design and revising. Dr. Alcaraz and Dr. Vanegas were responsible for data collection and analysis. Prof. Vanegas, Prof. Chávez drafted the manuscript and Prof. Alcaraz revised it. All authors read and approved the final manuscript.

Funding

Not applicable.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of Sciedu Press.

The journal and publisher adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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