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Analysis of coffee exports in Mexico from 1981 to 2022

Análisis de las exportaciones de café en México de 1981-2022

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ABSTRACT

Coffee exports are an income-generating activity for small producers, their communities, and a source of foreign exchange for the country. However, coffee cultivation faces major challenges, such as climate change. Understanding production and marketing statistics helps identify potential growth opportunities. This study aimed to analyze coffee exports in Mexico from 1981 to 2022 using a multiple linear regression model based on the ordinary least squares method to understand their historical behavior and propose solutions to the sector's challenges. The results indicate that national coffee production, coffee prices, and U.S. imports have positive effects of 1.1 %, 0.2 %, and 0.9 %, respectively, on Mexican coffee exports, while Mexico's per capita income has a negative effect of 0.2 %. Coffee production in Mexico has declined in recent years, while global demand continues to rise, making it essential to support producers to foster the development of coffee cultivation in the country.

KEY WORDS: Coffee growers, small farmers, price, regression, time series.

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RESUMEN

La exportación de café es una actividad que genera ingresos para los pequeños productores, en las comunidades y divisas para el país. Sin embargo, la cafeticultura presenta grandes problemas y desafíos como el cambio climático. Conocer las estadísticas de la producción y comercialización nos ayudan a entender posibles oportunidades de crecimiento. El objetivo fue analizar las exportaciones de café en México para el periodo 1981-2022, mediante un modelo de regresión lineal múltiple con el método de mínimos cuadrados ordinarios; con el fin de entender su comportamiento histórico y proponer soluciones a los desafíos del sector. Los resultados indican que la producción nacional de café, el precio del café y las importaciones de Estados Unidos tienen efectos positivos de 1.1, 0.2 y 0.9 %, respectivamente, sobre las exportaciones de café mexicano; mientras que, el ingreso per cápita de México tiene efectos negativos de 0.2 %. La producción de México se redujo en los últimos años y la demanda mundial de café está en aumento, por lo que incentivar a los productores es esencial para el desarrollo de la cafeticultura en México.

PALABRAS CLAVE: Cafeticultores, pequeños productores, precio, regresión, series de tiempo.

Introduction

Coffee production is concentrated in the Southern Hemisphere, while consumer markets are located in the global North (Sporchia *et al.,* 2023). In other words, the main suppliers are in developing countries, while the principal clients are in developed nations (Vegro & Almeida, 2020).

Global coffee production is primarily composed of two species: robusta coffee (*Coffea canephora*), which accounts for 30 % of global output, and arabica coffee (*Coffea arabica*), which makes up the remaining 70 % (Bunn *et al.,* 2015). In Mexico, coffee is produced in 12 states, 365 municipalities, and 3,090 communities, directly supporting the livelihoods of approximately 3.5 million people, around 10 % of the rural population (Leyva-Mir & Villaseñor-Luque, 2009). Coffee exports play a significant role in economic growth and in the gross domestic product of producing countries, particularly in developing and least-developed nations (Al-Abdulkader *et al.,* 2018).

The COVID-19 crisis affected both export and import sectors. In the case of coffee, the sector is recovering, and global demand is increasing; however, its full potential to boost producers’ incomes and reduce poverty remains underutilized. Without factoring in current issues such as aging producers, price volatility, and climate change (OIC, 2021).

The generational shift in coffee cultivation poses a serious concern for the future, since many producers are 55 years or older, and there is limited participation from younger generations; the children of coffee growers are increasingly disengaged from production, processing, and commercialization, which hinders the intergenerational transmission of knowledge (Escamilla-Prado *et al.,* 2018).

Mexican coffee farming is marked by marginalization and social backwardness (Pérez-Akaki, 2011). A large portion of Mexico's Indigenous population depends on coffee cultivation and harvesting, which represents an opportunity to improve their living conditions. For example, some Indigenous producers in Oaxaca and Chiapas sell directly to several European countries (Najera, 2002).

Currently, 65 % of coffee plantations require rejuvenation, meaning that old plants must be replaced with new ones. Additionally, 50 % of the coffee-growing area consists of plots yielding only 5 to 10 quintals per hectare, even though they could potentially produce 30 to 40 quintals (Leyva-Mir & Villaseñor-Luque, 2009).

Coffee productivity is negatively impacted by climate change (Ocampo-López & Álvarez-Herrera, 2017). Climate change reduces favorable bioclimatic conditions for coffee, alters optimal growing zones, and causes temperature shifts (Davis *et al.,* 2012). Hence, the global area suitable for coffee cultivation could decrease by approximately 50 %, particularly in regions such as Brazil and Vietnam (Bunn *et al.,* 2015).

Coffee collection and commercialization in Mexico is controlled by five foreign companies: AMSA, Jacobs, Expogranos, Becafisa-Volcafé, and Nestlé. These companies often determine the price paid to producers; manage dry processing, classify coffee beans, and use financial instruments such as futures and options. In response, some producers have turned to alternative markets such as organic coffee and fair trade to eliminate intermediaries in the agri-food chain (Pérez-Akaki, 2019).

Producers are the weakest link in the chain and are the most affected by price drops and market volatility (Pérez-Akaki & Huacuja, 2006). Decreases in prices may compel farmers to reduce coffee production (Ceballos *et al.,* 2004; Fousekis & Grigoriadis, 2022). Oligopolistic structures dominate the coffee market, as a few multinational companies purchase green coffee and supply processed coffee. These companies are considered directly or indirectly responsible for maintaining low prices for producers while keeping consumer prices high (Durevall, 2007).

Approximately 80 % of global coffee production is destined for export, with green coffee beans (arabica and robusta) making up 75 % of this total, followed by instant and ground coffee. European Union countries import green coffee to process it into roasted, ground, soluble, or

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capsule coffee products; which are then re-exported with added value to both producer and non-producer countries (Vegro & Almeida, 2020).

Key challenges for the coffee sector include: 1) meeting quality standards to avoid export rejections, 2) the lack of food safety regulations, and 3) limited government support for trade (Nugroho, 2014). Understanding coffee supply and demand is essential, as demographic trends such as population growth, population aging (older adults are the main consumers of coffee), and increasing per capita income since it can drive higher consumption. This information is useful for promoting exports and identifying potential coffee-importing countries (Torga & Spers, 2020).

The general objective of this study was to analyze coffee exports in Mexico through a multiple linear regression model for the 1981-2022 period. The specific objectives were: 1) to describe the behavior of coffee production, imports, and exports; 2) to estimate a model of the determinants of coffee export volume; and 3) to estimate a model of the determinants of coffee export value. The purpose was to understand the historical behavior of coffee exports and propose solutions to the sector's challenges by quantifying how variables such as prices and global demand affect exports. The study provides evidence to inform public policies and strategies aimed at strengthening small-scale producers.

Material and Methods

The analysis in this study is structured in two parts. First, an overview of Mexico's current situation regarding coffee production, exports, and imports is presented, using data from databases (FAOSTAT, 2024; SIAP, 2024). Second, a multiple linear regression model is applied to identify the main determinants of coffee exports in Mexico.

The model was built based on the relationship between Mexican coffee exports and the following variables: production, U.S. coffee imports, average rural coffee price in Mexico, and Mexico's per capita gross domestic product. The models were specified as follows:

$$VolExpMex_t = ProdMex_t + VolImpUSA_t + ARPMex_t - GDPpcMex_t + u_1 \quad (1)$$

$$ValExpMex_t = ProdMex_t + ValImpUSA_t + ARPMex_t - GDPpcMex_t + u_2 \quad (2)$$

Where:

$VolExpMex_t$ is the volume of Mexico's coffee exports, expressed in metric tons (FAOSTAT, 2024).

$ValExpMex_t$ is the value of Mexico's coffee exports, expressed in thousands of U.S. dollars at constant 2015 prices (FAOSTAT, 2024).

$VolImpUSA_t$ is the volume of U.S. coffee imports, expressed in metric tons (FAOSTAT, 2024).

$ValImpUSA_t$ is the value of U.S. coffee imports, expressed in thousands of U.S. dollars at constant 2015 prices (FAOSTAT, 2024).

$ARPMex_t$ is the average rural price of coffee in Mexico, expressed in U.S. dollars at constant 2015 prices. The exchange rate was obtained from the World Bank (BM, 2024), and the rural average price from SIAP (2024).

$ProdMex_t$ is Mexico's coffee production, expressed in metric tons (SIAP, 2024).

$GDPpcMex_t$ is Mexico's gross domestic product per capita, expressed in U.S. dollars at constant 2015 prices.

u_1 and u_2 are the error terms of the models.

All variables were analyzed at an aggregate national level for the period 1981-2022. They were transformed into logarithmic form and first differences (**Annex 1**), to apply unit root tests and use stationary series in the regression.

Estimation was performed using a multiple linear regression model via the ordinary least squares method. Gujarati & Porter (2010) recommend this method due to its clear coefficient interpretation, alignment with economic theories assuming linear relationships, and optimal statistical properties under Gauss-Markov assumptions.

The statistical software used was Stata 16, chosen for its balance of power, user-friendliness, and reliability, as well as its specific design for econometric analysis (Pérez-López, 2022). After running the model, autocorrelation and normality tests were conducted.

Results and Discussion

Coffee production in Mexico

Coffee was introduced to Mexico via Veracruz from Cuba at the end of the 18th century and was first planted in the region near Coatepec. During the 19th century, it spread throughout the national territory, especially in what are now the main coffee-growing regions: Chiapas and Oaxaca; and later in Colima and Michoacán (Pérez-Akaki, 2011).

In 2022, Mexico ranked 13th in global coffee production, accounting for 1.7 % of total world output. Since 1991, production has followed a downward trend; decreasing from 440,000 tons in 1990 to 181,700 tons in 2022. This decline is attributed to the reduction in cultivated areas, decreased investment in improving production, the impact of coffee leaf rust, and the migration of producers (Pérez-Akaki, 2019).

Coffee leaf rust, caused by the fungus *Hemileia vastatrix*, is the most devastating disease affecting coffee plants. It infects the leaves of all commercial coffee varieties, causing defoliation of more than 60 %. In extreme cases, damage can be so severe that it leads to the death of the plants (Pérez-Constantino *et al.,* 2023).

In 2022, cherry coffee production in Mexico was approximately one million tons, with around 650,000 hectares harvested (SIAP, 2024). A total of 96.6 % of national production is concentrated in six states: Chiapas, Veracruz, Puebla, Oaxaca, Guerrero, and Hidalgo. The remaining 3.4 % comes from the states of Nayarit, San Luis Potosí, Jalisco, Colima, Estado de México, Tabasco, Morelos, and Querétaro. The leading producing states have shown a declining trend from 2003 to 2022. For instance, Chiapas' production dropped from around 600,000 to approximately 400,000 tons.

In 2022, coffee production in Chiapas was 385,703 tons, with 239,737.7 hectares harvested. A total of 69.4 % of the state's production was concentrated in 20 municipalities, with the top five being: Motozintla, Tapachula, Siltepec, Chilón, and Amatenango de la Frontera, with 9.1 %, 9.0 %, 5.5 %, 4.5 % and 3.8 % of state-owned production, respectively.

In Veracruz, production reached 242804.7 tons with 127804.2 hectares harvested. A total of 69.1 % of the state's coffee output was concentrated in 20 municipalities. The top five producing municipalities were: Tezonapa (8.3 %), Atzalan (6.0 %), Coatepec (5.9 %), Huatusco (5.5 %), and Ixhuatlán del Café (4.4 %).

Most producers cultivate coffee out of tradition, as it is the predominant crop in their region, and because of the ease of management and accumulated experience (Vázquez-López *et al.,* 2017).

About 60 % of producers belong to ejidos and Indigenous communities representing 28 national ethnic groups. In recent years, many have shifted toward organic production, which now represents 4 % of the coffee-growing area in Mexico. These production systems contribute to biodiversity conservation and environmental services, such as carbon sequestration and groundwater recharge (Aguirre-Cadena *et al.,* 2012), as well as providing refuge and preservation for orchids within coffee agroecosystems (García-Franco & Toledo-Aceves, 2017).

Coffee exports

Between 1980-2022, the main coffee-exporting countries were Brazil, Vietnam, Colombia, Indonesia, and Guatemala, accounting for 23.7 %, 12.5 %, 11.0 %, 6.2 %, and 3.6 % of global exports, respectively.

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Brazil and Vietnam experienced the most significant growth. Vietnam was not considered a major exporter in the 1980s; however, in recent years it has stood out, even surpassing Brazil's exports in 2012. Colombia, by contrast, has seen a slight decline in its exports due to production challenges.

In Mexico, the first coffee exports date back to 1802 (Leyva-Mir & Villaseñor-Luque, 2009). During the 1980-2022 period, Mexico ranked 9th among coffee-exporting countries, with a 2.8 % share of total exports. By 2022, however, it had fallen to 14th place, with 116563.8 tons exported. Since 2000, Mexico's coffee exports have exhibited a downward trend.

Between 1986 and 2022, 71.4 % of Mexico's coffee exports were destined for the United States, followed by Switzerland, Belgium, Germany, and Japan with 3.9 %, 3.8 %, 3.7 % and 2.4 %, respectively. However, exports to the United States declined during this period, decreasing from 134136 to 81873.8 tons.

Coffee imports

From 1980-2022, the leading coffee-importing countries were the United States, Germany, Italy, Japan, and France, accounting for 22.4 %, 15.9 %, 7.1 %, 6.2 %, and 4.9 % of global imports, respectively.

Population growth in importing countries may be related to increasing demand for coffee imports. However, France has shown a declining trend.

Importing coffee for local processing has greater environmental impacts and higher associated costs, instant coffee, for example, requires twice the amount of green coffee beans and 7 to 11 times more energy (Gosalvitr *et al.,* 2023).

Mexico began importing coffee in 1989. Since then, imports have shown a positive trend, reaching 21447.5 tons in 2022. Between 1990-2022, imports mainly came from Brazil (40.1 %), Vietnam (20.3 %), the United States (14.8 %), Honduras (9.0 %), Colombia (3.9 %), and Ecuador (2.6 %). Combined, these countries represented 70.9 % of Mexico's total coffee imports during this period.

Model estimation

A fundamental requirement for time series modeling is stationarity. This means that the mean, variance, and autocovariance of the series must remain constant over time (Gujarati & Porter, 2010).

The variables in levels and logarithms do not pass the test; in other words, the null hypothesis that the coefficient $\rho = 0$ cannot be rejected. Thus, the series has a unit root and is non-stationary. In contrast, the logarithmic first differences are stationary; the null hypothesis that $\rho = 0$ is rejected in favor of the alternative hypothesis that $\rho \neq 0$.

The results of the augmented Dickey-Fuller unit root tests for the variables in levels, logarithms, and first-difference logarithms are presented in Table 1.

The regression coefficients from both models applied to the main variables determining coffee exports in Mexico for the period 1981-2022 are summarized in Table 2.

Thus, based on the obtained results, the models are as follows:

$$VolExpMex_t = 1.382 * ProdMex_t + 0.517 * VolImpUSA_t + 0.218 * ARPMex_t - 0.063 * GDPpcMex_t + u_1 \quad (3)$$

$$ValExpMex_t = 1.159 * ProdMex_t + 0.981 * ValImpUSA_t + 0.234 * ARPMex_t - 0.296 * GDPpcMex_t + u_2 \quad (4)$$

Both models pass the individual hypothesis tests for the null hypothesis that the variable coefficients are equal to zero. Given that $p < 0.05$, the null hypothesis is rejected in favor of the alternative hypothesis, indicating that at least one coefficient is significantly different from zero.

Table 1. Augmented Dickey-Fuller Unit Root Test.

		Levels		Logarithms		First differences log	
Variable	Test Statistic	Z(t)	*p-value*	Z(t)	*p-value*	Z(t)	*p-value*
VolExpMex	with constant	-2.42	0.136	-2.124	0.235	-8.63	0.000
	no constant	-0.859		-0.241		-8.726	
	with trend	-3.847	0.014	-3.67	0.024	-8.552	0.000
	with drift	-2.42	0.010	-2.124	0.020	-8.63	0.000
ValExpMex	with constant	-2.415	0.138	-2.089	0.249	-5.901	0.000
	no constant	-1.215		-0.248		-5.986	
	with trend	-3.049	0.119	-2.46	0.348	-5.836	0.000
	with drift	-2.415	0.010	-2.089	0.022	-5.901	0.000
VolImpUSA	with constant	-1.741	0.410	-1.987	0.293	-8.126	0.000
	no constant	0.579		0.733		-8.1	
	with trend	-3.988	0.009	-4.197	0.005	-8.018	0.000
	with drift	-1.741	0.045	-1.987	0.027	-8.126	0.000
ValImpUSA	with constant	-2.275	0.180	-1.949	0.309	-6.079	0.000
	no constant	-0.603		0.019		-6.182	
	with trend	-2.181	0.501	-1.908	0.651	-6.139	0.000
	with drift	-2.275	0.014	-1.949	0.029	-6.079	0.000

Continuation

Table 1. Augmented Dickey-Fuller Unit Root Test.

		Levels		Logarithms		First differences log	
Variable	Test Statistic	Z(t)	*p-value*	Z(t)	*p-value*	Z(t)	*p-value*
ProdMex	with constant	-1.138	0.700	-0.837	0.808	-6.412	0.000
	no constant	-0.475		-0.338		-6.477	
	with trend	-3.073	0.113	-2.823	0.189	-6.691	0.000
	with drift	-1.138	0.131	-0.837	0.204	-6.412	0.000
ARPMex	with constant	-4.197	0.001	-3.126	0.025	-5.52	0.000
	no constant	-2.031		-0.841		-5.539	
	with trend	-4.617	0.001	-3.394	0.052	-5.477	0.000
	with drift	-4.197	0.000	-3.126	0.002	-5.52	0.000
GDPpcMex	with constant	-1.437	0.565	-1.399	0.583	-5.85	0.000
	no constant	-0.298		0.035		-5.924	
	with trend	-2.602	0.279	-2.694	0.239	-5.794	0.000
	with drift	-1.437	0.079	-1.399	0.085	-5.85	0.000

Source: Own elaboration

The joint F-test for the null hypothesis that the model does not fit the data also yields $p < 0.05$. Therefore, the null hypothesis is rejected, confirming that the model fits the data at a significance level of $p < 0.01$. The goodness of fit or degree of fit of the data to the model is observed with the R-squared. In this case, Model (2) shows a better fit (79.11 %) than Model (1) (49.28 %).

The Breusch-Godfrey LM test for autocorrelation assumes no serial correlation under the null hypothesis. Since the chi-square probabilities are 0.408 (1) and 0.1816 (2), which are greater than 0.05, the null hypothesis is not rejected. This result is further supported by the Durbin-Watson statistic, which is close to 2. In the Jarque-Bera normality test, the null hypothesis assumes a normal distribution. The chi-square probabilities are 0.5090 (1) and 0.4915 (2); $p > 0.05$, so the null hypothesis is not rejected.

Model (1) considers the volume of coffee exports from Mexico, while Model (2) considers the value of those exports. The interpretation indicates that a 1 % increase in coffee production in Mexico results in a 1.382 % increase in export volume and a 1.159 % increase in export value. This underscores the urgency of renewing aging coffee plantations.

Table 2. Regression results for models (1) and (2).

ExpMEX	(1)	(2)
ProdMex	1.382*** (0.283)	1.159*** (0.259)
ImpUSA	0.517* (0.298)	0.981*** (0.117)
ARPMex	0.218** (0.093)	0.234** (0.096)
GDPpcMex	-0.063 (0.169)	- 0.296* (0.167)
Observations	42	42
F(4.38)	9.23***	35.98***
R-square	0.4928	0.7911
Adjusted R square	0.4394	0.7691
Durbin-Watson	2.2378	2.3642
Breusch-Godfrey LM	0.408	0.1816
Jarque-Bera normality	0.5093	0.4915

Note: statistical significance of the coefficients: $*p < 0.1$, $**p < 0.05$, $***p < 0.01$. Standard error in parentheses.
Source: Own elaboration

A 1 % increase in the volume or value of U.S. coffee imports leads to a 0.517 % and 0.981 % increase in the volume and value, respectively, of Mexican coffee exports. The United States is the main destination for Mexican coffee exports, accounting for 71.4% of the total. Thus, Mexican coffee exports are strongly dependent on U.S. import demand. However, strategies to consolidate this market and diversify export destinations are still lacking.

A 1 % increase in the real average rural price (in USD) of coffee in Mexico stimulates exports by 0.218 % in volume and 0.234 % in value. These results are consistent with findings from Figueroa-Hernández *et al.* (2019) and Amaya & Lanuza (2014). In other words, better prices for producers encourage them to expand planted areas and improve quality standards to enter the coffee export sector. However, the market remains distorted by intermediaries and a few companies that dominate the sector.

Coffee prices are a key determinant of exports, but their impact varies according to each country's production structure. While Figueroa-Hernández *et al.* (2019) emphasize adaptation to differentiated markets, Amaya & Lanuza (2014) highlight the vulnerability of less diversified economies. A comprehensive policy should combine price stability, productivity improvements, and access to differentiated markets.

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Small-scale producers are less integrated into the supply chain and are increasingly exposed to intermediaries who reduce the price paid to producers while raising the price for final consumers. Therefore, the government could provide financing to help producers acquire equipment for hulling and roasting coffee (Gálvez-Soriano & Cortés, 2021).

The problem of price instability in the coffee market gave rise to the production of differentiated and specialty coffee through agroecological cultivation on small plots. Fortuitously, demand continues to grow, generating significant expectations among producers (Flores-Anaya *et al.,* 2022; Jáuregui-Arenas *et al.,* 2017). These new coffee markets serve as incentives to enhance the capacity and innovation of small-scale producers, particularly among impoverished and Indigenous communities, to promote national exports, increase household income, and reduce poverty (Flores-Anaya *et al.,* 2022).

Smallholder coffee producers seek alternatives to diversify their income and mitigate risks associated with price drops. For instance, they often combine coffee farming with the cultivation of maize, beans, fruit trees, timber species, or beekeeping (Anderzén *et al.,* 2020). It is recommended that training and technical assistance be provided, subsidized by the government, since these producers are smallholders who cannot afford the costs; the objective is to increase productivity among small producers (Vázquez-López *et al.,* 2022). Diversification, along with training, strengthens the resilience of small producers and helps prevent them from abandoning coffee cultivation. This indirectly stabilizes and enhances Mexico's coffee export capacity.

The variable *GDPpcMex* was significant in Model (2); it indicates that a 1 % increase in Mexico's per capita income leads to a 0.296 % decrease in the value of exports. This suggests that, as per capita income rises, Mexican consumers allocate a greater share of their income to the domestic consumption of high-quality, locally produced coffee, thereby reducing the supply available for export. In other words, increased purchasing power stimulates domestic demand, displacing part of the supply previously destined for foreign markets.

Another variable that may affect coffee exports is climate. Climate variability has indirect effects on exports and direct impacts on coffee production, such as droughts or excessive rainfall (Azalia *et al.,* 2023). Moreover, rising global temperatures may reduce the yield of Arabica coffee and favor the emergence of coffee pests and diseases (Ayal *et al.,* 2023), such as rust and leaf miner infestations (Dias *et al.,* 2024). All these factors should be taken into consideration when aiming to produce higher-quality coffee for the international market.

Conclusions

Globally, coffee is primarily produced in Brazil, Vietnam, Colombia, Indonesia, and Mexico. In the case of Mexico, production is concentrated in the states of Chiapas, Veracruz, Puebla, Oaxaca, Guerrero, and Hidalgo, where agroclimatic conditions are favorable for cultivating high-quality varieties.

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The global coffee trade is dominated by major exporting countries such as Brazil, Vietnam, Colombia, Indonesia, and Guatemala, and leading importers such as the United States, Germany, Italy, Japan, and France. Mexican coffee exports are mostly directed to the United States, meaning this market largely determines the country's export dynamics. However, growing global demand for coffee could serve as an incentive for Mexican producers to expand exports to other regions, particularly the European Union and Asia.

Mexican coffee exports critically depend on three factors: domestic production, U.S. demand, and producer prices, yet they face structural challenges that limit their potential. Market concentration in five multinational companies, aging coffee plantations, and low productivity continue to perpetuate inequality within the value chain. While specialty coffee (organic, fair trade) offers promising opportunities for Indigenous smallholders, access to these markets remains limited due to a lack of financing and training.

Furthermore, climate change and generational turnover (aging producers without successors) pose additional threats to the sustainability of the sector. To address these challenges, comprehensive public policies are needed, combining: (1) subsidies for plantation renewal and machinery acquisition, (2) support for direct marketing and cooperative development, and (3) climate adaptation through agroforestry systems. Only then can Mexico strengthen its position in the global coffee market and reduce the vulnerability of its coffee growers.

Author Contributions

Work conceptualization, JCMG and JHP; Methodology development, JHP, JHO, and FSR; Software handling, JHP; Experimental validation, JCMG; Data analysis, JHP and JHO; Data curation, JHP and FSR; Manuscript drafting and preparation, JHP and JCMG; Writing, review, and editing, JHO and FSR.

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Conflict of Interest

The authors declare no conflict of interest.

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Annex 1

Year	d1lVolExpMex	d1lValExpMex	d1lProdMex	d1lVolImpUSA	d1lValImpUSA	d1lARPMex	d1lGDPpcMex
1981	-0.016993	-0.139780	0.027805	-0.039983	-0.208480	-0.023329	0.059337
1982	0.002341	0.037921	0.044020	0.024125	-0.008651	-0.343002	-0.189905
1983	0.075311	-0.099509	0.007749	-0.026523	-0.016542	-0.064048	-0.097997
1984	-0.055593	0.107074	0.008526	0.032834	0.055440	0.064082	0.047971
1985	0.122543	0.066966	0.054216	0.023038	-0.004317	0.412472	0.003594
1986	-0.030440	0.198421	0.024916	0.017884	0.121618	-0.257252	-0.178102
1987	0.031675	-0.234750	0.020341	0.008506	-0.202948	-0.157150	0.021898
1988	-0.119466	-0.049372	0.014564	-0.112765	-0.088393	-0.027729	0.067738
1989	0.217349	0.079985	0.058738	0.101232	-0.017509	0.087667	0.062017
1990	-0.144695	-0.247265	-0.112157	0.004215	-0.114827	0.050490	0.047945
1991	0.038708	0.041057	0.044007	-0.015206	-0.025031	-0.031491	0.055648
1992	-0.049310	-0.163419	0.022446	0.059621	-0.050454	-0.210496	0.046101
1993	-0.005244	-0.013360	-0.029217	-0.080090	-0.069288	-0.004394	0.145761
1994	0.010310	0.167725	-0.014650	-0.083447	0.190490	0.082622	0.001356
1995	-0.002280	0.277564	-0.000053	0.028622	0.107133	0.152131	-0.180323
1996	0.146778	-0.020931	0.058663	0.052713	-0.084074	0.059247	0.040063
1997	-0.034766	0.081957	-0.028479	0.021548	0.145834	0.071034	0.068302
1998	-0.106298	-0.120366	-0.089554	0.003447	-0.070636	-0.027542	0.015158
1999	0.098887	-0.056984	0.037115	0.034323	-0.084741	-0.026580	0.040784
2000	0.070410	0.009938	0.048957	0.021923	-0.040468	-0.167616	0.053628
2001	-0.237346	-0.440364	-0.047699	-0.049565	-0.236325	-0.196045	0.014136
2002	-0.044371	-0.119327	0.014146	0.002054	-0.032093	-0.080888	-0.005426
2003	-0.064641	-0.029056	-0.020495	0.020665	0.088064	-0.002671	-0.039816
2004	-0.034095	0.030903	0.019642	0.006835	0.051753	-0.065955	0.011667
2005	-0.127316	0.035363	-0.025844	-0.009012	0.110312	0.128354	0.029495
2006	0.155100	0.136748	-0.022294	0.021828	0.037814	0.058776	0.026966
2007	0.034943	0.046002	-0.017541	0.012317	0.043661	0.084175	0.016311
2008	-0.090414	-0.022118	-0.013342	-0.000558	0.059556	0.053729	0.008962
2009	0.070625	0.016130	0.006669	-0.018824	-0.054046	-0.109367	-0.098472
2010	-0.098582	-0.001085	-0.032734	0.008460	0.072402	0.086591	0.057866
2011	0.039816	0.256802	-0.014795	0.031503	0.220717	0.088791	0.030897
2012	0.155241	0.026857	0.016298	-0.001670	-0.094052	0.053696	-0.004989
2013	-0.059801	-0.197593	-0.026418	0.016309	-0.090361	-0.122210	0.011073
2014	-0.135908	-0.068746	-0.032967	0.010036	0.029018	-0.027203	-0.001475
2015	-0.046721	-0.054772	-0.055454	0.001627	-0.003548	-0.045362	-0.060402
2016	-0.061144	-0.083255	-0.095284	0.016191	-0.033433	-0.052163	-0.047023
2017	0.150399	0.116184	0.005914	0.003758	0.025747	0.015033	0.016749
2018	0.001404	-0.041911	0.012610	-0.010878	-0.055324	-0.022217	0.008833
2019	-0.062826	-0.091397	0.019852	0.027823	-0.010727	-0.052185	0.005130
2020	0.011526	0.057766	0.025058	-0.047329	-0.024250	-0.041949	-0.074965
2021	-0.024788	-0.009356	-0.003012	0.012711	0.050550	0.015445	0.047097
2022	0.088213	0.221678	0.034346	0.012401	0.140470	0.037554	0.015693