Health and economic crises and the Mexican agricultural sector

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ABSTRACT

Objective: To determine if the 1994 and 2008 economic crises and the 2009 and 2020 health crises had an impact on the relationship between the price and the production of the main agricultural products in the main producer states of the Mexican agricultural sector.

Design/Methodology/Approach: Seventy structural stability tests with dichotomous variables were carried out in order to analyze the effect of these crises on the price-quantity relationship in the main producer states of the five regions in which the Mexican agricultural sector is divided. These states are the main producers of corn, sorghum, and bean grains in Mexico.

Results: There were some exceptions but, overall, neither the 1994 and 2008 economic crises, nor the 2009 and 2020 health crises had an impact on the price-production relationship of main products of the main producer states of the five regions of the Mexican agricultural sector.

Study Limitations/Implications: We did not evaluate all the products or all the Mexican states.

Findings/Conclusions: Overall, economic and health crises did not impact the price-production relationship of the analyzed producer states. The price-production relationship of these states is resilient to economic and health crises —*i.e.*, producers did not significatively alter their production as a consequence of the price changes brought about by the economic and health crises.

Keywords: economic crises, health crises, agricultural sector, structural analysis.

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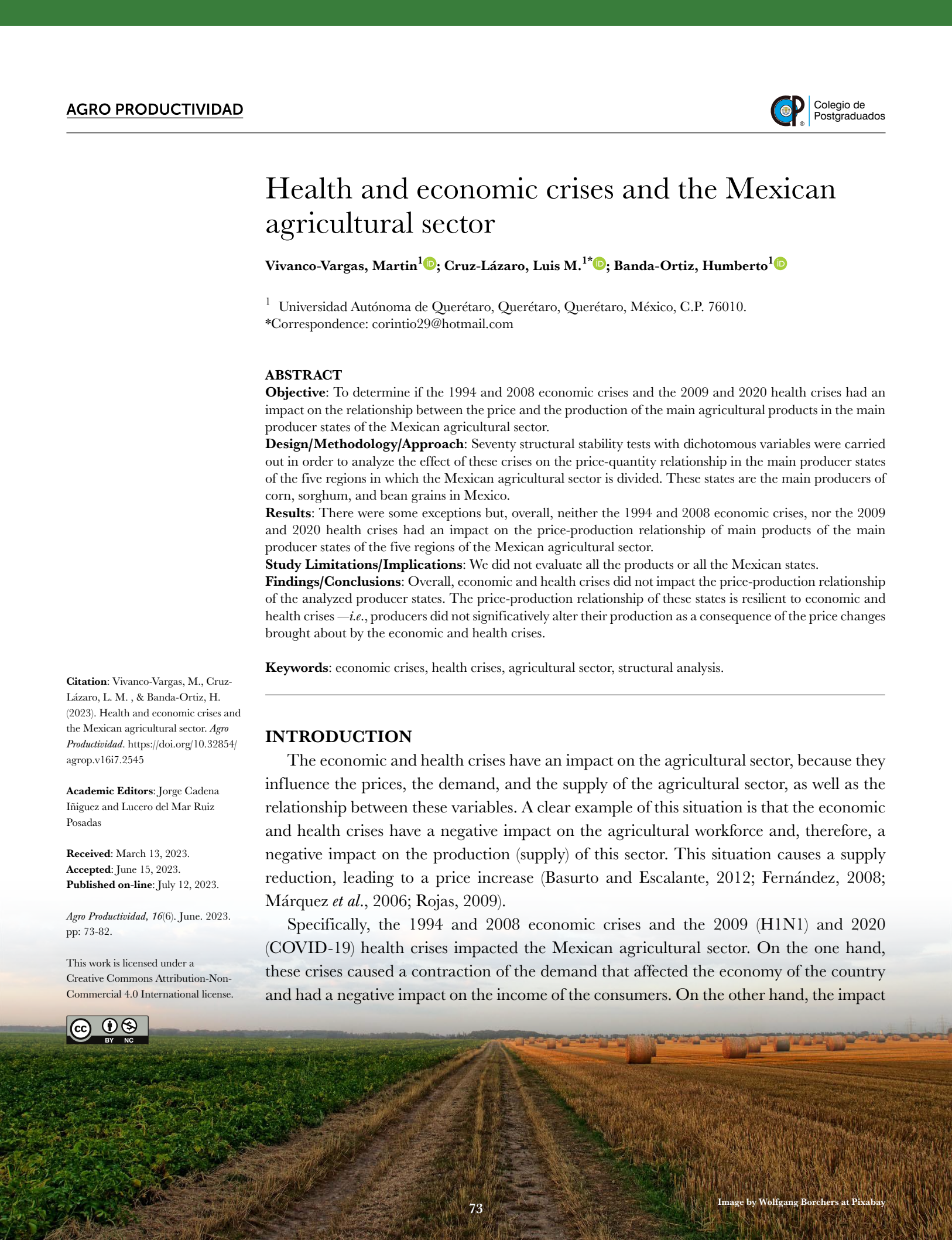
INTRODUCTION

The economic and health crises have an impact on the agricultural sector, because they influence the prices, the demand, and the supply of the agricultural sector, as well as the relationship between these variables. A clear example of this situation is that the economic and health crises have a negative impact on the agricultural workforce and, therefore, a negative impact on the production (supply) of this sector. This situation causes a supply reduction, leading to a price increase (Basurto and Escalante, 2012; Fernández, 2008; Márquez *et al.*, 2006; Rojas, 2009).

Specifically, the 1994 and 2008 economic crises and the 2009 (H1N1) and 2020 (COVID-19) health crises impacted the Mexican agricultural sector. On the one hand, these crises caused a contraction of the demand that affected the economy of the country and had a negative impact on the income of the consumers. On the other hand, the impact



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on the income of the consumers had an impact on the demand. Additionally, producers had less resources to invest and lacked access to credit. Meanwhile, health crises had an impact on the production and demand of agricultural products, as a result of the measures implemented by the governments to contain the epidemic, such closing borders and shutting down the productive sectors (CEPAL, 2020; Ríos, 2020; Ayala and Chapa, 2017; Becerril *et al.*, 2011; Reynoso, 2010; Ortega *et al.*, 2010).

Therefore, the objective of this research was to determine if the 1994 and 2008 economic crises and the 2009 and 2020 health crises had an impact on the price-production relationship of the main agricultural products, in the main producer states of the Mexican agricultural regions.

THEORETICAL FRAMEWORK

The 1994 and 2008 economic crises impacted the Mexican agricultural sector; the subsequent economic contraction had an impact on the income of the consumers, while the producers did not have resources to invest, because they did not have access to credits. These effects impacted the supply and demand of agricultural products, leading to a negative impact on their prices and production. This situation altered the price-production relationship in the agricultural sector. Additionally, the 2008 crisis caused a contraction of exports (Basurto and Escalante, 2012; Blanke, 2009; Becerril *et al.*, 2011; Gómez, 2008; Tonconi, 2015; Benítez, 2022).

Meanwhile, the 2009 (H1N1) and the 2020 (COVID-19) health crises affected the agricultural sector, as a consequence of the effect that the supply and the demand had on the prices of the products. In this regard, the demand contracted, due to the unemployment and the income contraction resulting from the crisis and the related social restriction measures. It also had a negative impact on the supply, as a result of the measures taken to control the health crisis, which affected the productive structure and lead to a price increase. In order to tackle the crisis, the government closed the borders and shut down the activity of productive sectors. However, the governments tried to minimize the impact of these policies on the agricultural sector and implemented measures aimed to maintain or to increase the agricultural production and to stabilize the prices (CEPAL, 2010, 2020; OCDE-FAO, 2011; Ríos, 2020; Ayala and Chapa, 2017; Obschatko, 2020; Brambila *et al.*, 2014).

Another element to be considered is that the agricultural sector is more resilient to the economic and health crises than other sectors, because the supply and the demand are inelastic. Consequently, the supply and the demand of this sector do not have a significant reaction to changes in the price of products (Basurto and Escalante, 2012; Vilaboa *et al.*, 2021; Cardona *et al.*, 2007; Roitbarg, 2021; Ortega *et al.*, 2010).

METHODOLOGY

The methodology applied seeks to determine if the 1994 and 2008 economic crises and the 2009 and 2020 health crises had an impact on the price-production relationship of the main agricultural products, in the main producer states of the Mexican agricultural regions. Consequently, seventy structural stability tests with dichotomous variables were

carried out. The 1980-2021 price and production annual data bases for the main producer states of the main products of the Mexican agricultural sector was obtained from the Secretaría de Desarrollo y Agricultura (SADER, 2022 a). The price data base was deflated, using the Mexican National Consumer Price (INPC) developed by the Instituto Nacional de Estadística y Geografía (INEGI, 2022 a). The five analyzed regions are the ones used by SADER (2022 b) to oversee the Mexican agricultural sector. The states in which the main products of the agricultural sector (corn, sorghum, and bean grains) are produced were chosen from these regions (SADER, 2022 a b). Table 1 shows the products and the analyzed states in each region.

A structural analysis was carried out to determine if the 1994 and 2008 economic crises and the 2009 and 2020 health crises had an impact on the relationship between price and the production of the main agricultural products in the main producer states of the five regions that make up the Mexican agricultural sector (SADER, 2022 a b). The theoretical basis of this analysis is described in the theoretical framework and the neo-classical economics theory, which has been used to study the Mexican agricultural sector (Cardona *et al.*, 2007; Roitbarg, 2021). Table 2 describes the economic and health crises.

Table 1. Products and analyzed states by region.

Region	Corn grain	Bean	Sorghum grain
Northwest	Sinaloa		
Northwest	Chihuahua	Zacatecas	Tamaulipas
Center-West	Jalisco	Guanajuato	Guanajuato
Center	State of Mexico	Puebla	Morelos
South-southeast	Veracruz	Chiapas	Campeche

Source: table developed by the authors using data from SADER (2022 a b).

Table 2. Description of the economic and health crises.

Year-Crisis	Type	Years before the crisis	Years after the crisis	Description of the crisis
1994 The Tequila Effect	Economic	1980-1994	1994-2021	In early 1994, the sudden interruption of the flow of foreign capital towards Mexico and the devaluation of the national currency caused an economic contraction.
2008 Subprime Mortage Crisis	Economic	1980-2007	2008-2021	The international 2008 financial crisis was mainly the consequence of a crisis caused by the low-quality mortgages derivatives in USA. This crisis had global repercussions.
2009 H1N1 Pandemic	Health	1980-2008	2009-2021	The H1N1 pandemic officially started on March 11, 2009, after the first case was confirmed in Mexico City. From April 2009, this pandemic had an impact on the 32 states of Mexico, leading to an economic crisis.
2020 COVID-19 Pandemic	Health	1980-2019	2020-2021	To avoid the spread of the COVID 19 disease, many countries closed their borders. Consequently, the exchange of goods and services was reduced in most of the economic sectors, leading to a GDP economic contraction in 2020.

Source: Table developed by the authors based on data from CEPAL, 2009; Camberos and Bracamontes (2015); De la Luz *et al.* (2015).

ANALYSIS OF THE STRUCTURAL CHANGE WITH DICHOTOMOUS VARIABLES

Seventy structural analysis tests with dichotomous variables were carried out to determine if there was a structural change in the slope, the ordinate intercept, or in both. Based on the procedure determined by Gujarati and Porter (2010), seventy multiple regressions with dichotomous variables were estimated. The result was Equation 1.

$$Y_t = \alpha_1 + \alpha_2 D_t + B_1 P + B_2 \left(D_t P\right) + B_3 X_1 + B_4 X_2 + u_1 \quad (1)$$

Where: Y = amounted produced variable (one of the three products) in one of the main producer states of the five regions; α_1 = is the intercept value; α_2 = is the differential intercept value; D_t = is the dichotomous variable, where: 0 is the observation from period 1 to the structural change and 1 is the observation from the structural change to the end of the series; B_1 = value of the actual price variable (one of the three products); P = actual price variable (one of the three products); B_2 = is the differential slope; D_tP = is the multiplication of the actual price variable times the dichotomous variable; X_1 = is the controlled variable of the harvesting area; X_2 = is the controlled variable of the economic activity

The cut in the tests will take place according to the dates shown in Table 2. Therefore, the dichotomous variable of the impact analysis before the 2009 (H1N1) health crisis was zero, while it increased to 1 after 2009. Regarding the COVID-19 health crises, the dichotomous variable before 2020 was zero, while after 2020 the dichotomous variable had a value of 1. Meanwhile, the dichotomous variable before the 1994 economic crisis was zero, while after 1994 the dichotomous variable was 1. Finally, before the 2008 economic crises, the dichotomous variable was zero, but it increased to 1 after 2008. Additionally, the following control variables were added to strengthen the analysis: harvested area (SADER, 2022 a) and the Global Indicator of Economy Activity (IGAE, two months average) (INEGI, 2022 b). The periodicity of both variables is the same than the periodicity of the analyzed variables and the deflated IGAE, using the INPC (INEGI, 2022 a).

Once the seventy multiple regressions were estimated (Equation 5), their R^2 values were analyzed in order to validate them. For this purpose, >50% values are used as reference. After the validity of the models was established, the p values of the differential intercept (α_2) and the differential slope (B_2) of each model were analyzed. Only <0.05 results were considered statistically significative. If the p value of the differential intercept (α_2) is <0.05, then the structural change took place in the ordinate intercept. However, if the p value of the differential slope (B_2) is <0.05, the structural change took place in the slope. Finally, if both are <0.05, the structural change took place in the ordinate intercept and the slope.

RESULTS AND DISCUSSION

Table 3 shows the results of the structural analysis evaluations used to determine if the 1994 and 2008 economic crises and 2009 and 2020 health crises caused a structural

Table 3. Results of the structural analysis evaluations with dichotomous variables.

Region	Model		1994		2008		2009		2020	
			Beta value	P-value	Beta value	P-value	Beta value	P-value	Beta value	P-value
Northwest	Real price of corn kernel in the state of Sinaloa	Differential intercept	-59439.31	0.5063	-283244.7	0.0047	-280387.3	0.0056	188659.6	0.811
		Differential slope	29.48359	0.0541	69.9895	0.0071	68.23946	0.0127	-75.24794	0.7594
		Coefficient of determination R^2	0.969521		0.961615		0.96165		0.955297	
	Real price of beans in the state of Sinaloa	Differential intercept	11413.9	0.5944	3039.708	0.9093	8383.427	0.7591	4014.682	0.9717
		Differential slope	-0.64402	0.6272	0.130477	0.933	-0.036013	0.9818	-0.38968	0.9537
		Coefficient of determination R^2	0.862518		0.862643		0.864312		0.861621	
	Real price of sorghum kernel in the state of Sinaloa	Differential intercept	128415.5	0.0222	-112198.8	0.1691	-94128.72	0.2157	159530.6	0.7838
		Differential slope	-8.407028	0.5329	6.482687	0.793	-1.947047	0.933	-64.93095	0.7462
		Coefficient of determination R^2	0.771865		0.701326		0.740756		0.624008	
Northeast	Real price of corn kernel in the state of Chihuahua	Differential intercept	259662.1	0.1204	5805.61	0.9652	33012.08	0.8019	189216.9	0.515
		Differential slope	-40.12901	0.1014	-20.65636	0.5402	-31.91615	0.3533	-60.20869	0.4398
		Coefficient of determination R^2	0.525507		0.520508		0.540048		0.502766	
	Real price of beans in the state of Zacatecas	Differential intercept	-98276.22	0.2962	78637.39	0.3527	87558.55	0.3045	-29129.37	0.912
		Differential slope	7.004287	0.1958	-9.615242	0.1623	-9.356099	0.1756	5.98185	0.7793
		Coefficient of determination R^2	0.816137		0.819495		0.817231		0.811483	
	Real price of sorghum kernel in the state of Tamaulipas	Differential intercept	215661.3	0.0758	-320043	0.1218	-312505.2	0.1258	-511860.3	0.4367
		Differential slope	-5.714089	0.8391	71.99688	0.2578	67.20681	0.2891	174.7614	0.4286
		Coefficient of determination R^2	0.727336		0.641589		0.646987		0.613503	
Center-West	Real price of corn kernel in the state of Jalisco	Differential intercept	128601.3	0.1328	-37297.35	0.7034	-31001.35	0.7516	127376.4	0.5568
		Differential slope	-10.0009	0.5057	4.787082	0.8463	5.761058	0.8165	-34.11174	0.5572
		Coefficient of determination R^2	0.827216		0.79518		0.793549		0.794665	
	Real price of beans in the state of Guanajuato	Differential intercept	-8640.629	0.6576	-5710.094	0.7887	-4447.371	0.8348	32272.51	0.545
		Differential slope	0.563108	0.5782	-0.163361	0.931	-0.204689	0.915	-3.138259	0.5168
		Coefficient of determination R^2	0.830192		0.834509		0.833445		0.830657	
	Real price of sorghum kernel in the state of Guanajuato	Differential intercept	7062.67	0.8378	7608.88	0.069	84079.1	0.0496	77491.15	0.5691
		Differential slope	-11.56745	0.1422	-18.59756	0.1106	-19.54512	0.0912	-19.57048	0.6013
		Coefficient of determination R^2	0.796583		0.768321		0.772127		0.748515	

Table 3. Continues...

Region	Model		1994		2008		2009		2020	
			Beta value	**P-value**	**Beta value**	**P-value**	**Beta value**	**P-value**	**Beta value**	**P-value**
Center	Real price of corn kernel in the state of México	Differential intercept	190659.6	0.3632	-785667.5	0.0208	-857702.4	0.0186	184266.4	0.9604
		Differential slope	190659.6	0.3632	381.9905	0.0496	351.6687	0.0307	14.91217	0.9861
		Coefficient of determination R^2	0.688453		0.72508		0.7273		0.691173	
	Real price of beans in the state of Puebla	Differential intercept	855.7167	0.8041	-5742.959	0.3419	-5111.738	0.4403	35950.25	0.87
		Differential slope	-0.849161	0.9357	1.310649	0.1751	1.069406	0.2369	-2.455735	0.8768
		Coefficient of determination R^2	0.850657		0.858358		0.856923		0.851512	
	Real price of sorghum kernel in the state of Morelos	Differential intercept	12547.9	0.6137	43600.43	0.2606	19713.95	0.5936	-682543.2	0.2299
		Differential slope	51.27476	0.8968	-60.69458	0.0642	-41.55941	0.1077	174.6457	0.2173
		Coefficient of determination R^2	0.772585		0.795232		0.79968		0.781566	
South-southeast	Real price of corn kernel in the state of Veracruz	Differential intercept	15888.65	0.8219	146107.9	0.1163	83421.09	0.3889	7228.048	0.9324
		Differential slope	-888.0041	0.1209	-42.53137	0.4461	-88.71212	0.0539	-6.855907	0.7533
		Coefficient of determination R^2	0.924621		0.924701		0.928601		0.918344	
	Real price of beans in the state of Chiapas	Differential intercept	-7227.075	0.2606	6467.361	0.4631	-2061.854	0.8601	-159226.3	0.5614
		Differential slope	15.18808	0.4531	-2.754115	0.0632	-1.33232	0.3345	11.48052	0.5597
		Coefficient of determination R^2	0.874855		0.886231		0.884342		0.884342	
	Real price of sorghum kernel in the state of Campeche	Differential intercept	-5976.195	0.3446	-24302.11	0.0917	-21414.12	0.14	42917.9	0.2837
		Differential slope	0.374026	0.8056	6.244166	0.0715	5.881178	0.0914	-14.33184	0.2466
		Coefficient of determination R^2	0.978857		0.979391		0.979394		0.978594	

Source: Table developed by the authors based on data from Eviews.

change in the price-production relationship for the main products, in the main producer states of the five regions of the Mexican agricultural sector.

The results in Table 3 show that the models are valid because the R^2 has >0.50 values. Additionally, except for a few cases, the 1994 and 2008 economic crises and the 2009 and 2020 health crises did not cause a structural change in the differential intercept and the differential slope (p>0.05), regarding the price-production relationship of the main producer states of the five regions of the Mexican agricultural sector. Table 4 shows the exceptions found in the study.

Table 4. Exceptions.

Crises	Exceptions	Place where the change took place	value
1994 Economic Crisis	Actual price of sorghum grain in the State of Sinaloa.	In the differential intercept	The value of the differential intercept is <0.05.
2008 Economic Crisis	Actual price of corn grain in the State of Sinaloa.	In the intercept and the slope.	The values of the differential slope and differential intercept are <0.05.
	Actual price of corn grain in the State of Mexico.		
2009 Health Crisis	Actual price of corn grain in the State of Sinaloa.	In the intercept and the slope.	The values of the differential slope and the differential intercept are <0.05.
	Actual price of corn grain in the State of Mexico.		
	Actual price of sorghum grain in the State of Guanajuato.	In the intercept.	The values of the differential intercept are >0.05.
2020 Health Crisis	There were no exceptions		

Source: Table developed by the authors.

Therefore, the results indicate that, except for a few cases, the economic and the health crises do not have an impact on the price-production relationship of the main producer states of the five regions of the Mexican agricultural sector. These states are the main producers of corn, sorghum, and bean grains. Our results are different from the findings of other researches about this subject (Basurto and Escalante, 2012; OCDE-FAO, 2011; Brambila *et al.*, 2014; Tonconi, 2015; Fernández, 2008; Flores, 2014; Méndez, 2011; Guzmán *et al.*, 2012; García, 2020; Benítez, 2022; Rojas 2009; Ortega *et al.*, 2010). These studies indicate that the economic and health crises have an impact on the price-production relationship of the product of the agricultural sector.

On the one hand, our results differ from the findings of Basurto and Escalante (2012), Becerril *et al.* (2011), Gómez (2008), Reynoso (2010), Ortega *et al.* (2010), and Blanke (2009). These authors indicated that the 1994 and 2008 economic crises —which had an impact on the economy, the supply, and the demand— affected the price-production relationship in the Mexican agricultural sector. Additionally, our results differ from the findings of CEPAL (2020), OECD-FAO (2011), Aparicio and Delgado (2009), Ayala and Chapa (2017), and Ríos (2020). These institutions and authors pointed out that the 2009 (H1N1) and 2020 (COVID-19) health crises had an impact on the price-production relationship of the Mexican agricultural sector.

On the other hand, our results about the 2020 (COVID-19) health crisis match the results of Vilaboa *et al.* (2021), Reynoso (2010), Brambila *et al.* (2014), Sosa and Ruíz (2017), Flores (2014), Orozco *et al.* (2017), and Obschatko (2020). These authors indicated that the agricultural sector was resilient to the crisis. Given its importance, the policies implemented to contain the pandemic were less severe for this sector. Additionally, measures aimed at maintaining or increasing the agricultural production during the health crises were implemented.

Basurto and Escalante (2012), OECD-FAO (2011), Roitbarg (2021) and Vilaboa *et al.* (2021) pointed out that the agricultural sector was more resilient to the economic and health crises than other sectors. Cardona *et al.* (2007), Roitbarg (2021), and Ortega *et al.* (2010) pointed out that the supply and the demand of the agricultural sector are inelastic. Consequently, the supply and the demand of this sector do not have significant reactions to changes in the price of products, because, even in the face of such changes, society keeps demanding the products.

CONCLUSIONS

The objective of this research was to determine if the 1994 and 2008 economic crises and the 2009 and 2020 health crises had an impact on the relationship between the price and the production of the main agricultural products in the main producer states of the five regions of the Mexican agricultural sector. Seventy structural stability tests with dichotomous variables were carried out. The five analyzed regions are the ones used by SADER (2022 b) to oversee the Mexican agricultural sector. The main producer states of each of the five regions were chosen, because they grow the main products of the agricultural sector (corn, sorghum, and bean grains). The results of the structural analysis evaluations indicate that the 1994 and 2008 economic crises and the 2009 and 2020 health crises did not cause structural changes, except for the following four cases: one during the 2009 health crisis, one case during the 1994 economic crisis, and two during the 2008 economic crisis.

Overall, the economic and health crises did not have an impact on the price-production relationship in the main producer states of the five regions of the Mexican agricultural sector. Therefore, the price-production relationship of the Mexican agricultural sector is resilient to economic and health crises —*i.e.*, the producers do not significatively alter their production in reaction to price changes resulting from disturbances caused by such crises. Therefore, the production of the agricultural sector is inelastic. The results about the non-existent relationship contradict several studies mentioned in the theoretical framework and the discussion section; however, some previous studies are consistent with the results of our study.

Therefore, we consider that the objective of this study was achieved. There were some limitations in this research: we did not evaluate all the products or all the states of the Mexican agricultural sector. Further research should focus on the structural analysis evaluations of other relationships and variables of the agricultural sector.

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