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Agricultural production and market prices in Mexico

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ABSTRACT

Objective: To establish if the price of the main products of the Mexican agricultural sector is cointegrated with the production of the main producing states in five agricultural regions of Mexico.
Design/Methodology/Approach: Thirty cointegration tests were carried out to determine if the prices of the main agricultural products in Mexico (corn kernel, sorghum kernel, and beans) influence the production of the main producing states in the five agricultural regions of Mexico.
Results: In the northwestern region, the price does not influence the production of the main producing states of corn kernel, sorghum kernel, and beans. In the northeastern, central-western, and central regions, the price does influence the production of the main producing states of the said produce; meanwhile, in most of the states in the southern-southeastern region, the price does not affect the production of the main producing states.
Study Limitations/Implications: The analysis did not include all states and their main products.
Findings/Conclusions: The price influences production, but its influence is not even in the five regions of Mexico or in the main producing states of corn kernel, sorghum kernel, and beans.

Keywords: agricultural production; market prices; cointegration; states.

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INTRODUCTION

The agricultural sector produces the food that society requires for its survival and forms value chains; therefore, it is considered the sector that creates the economy. Likewise, its production is influenced by several factors, including the prices of its products. For example, higher product prices encourage producers to increase their production, because high prices mean higher income. On the contrary, lower products prices would decrease production, which would cause the income of the producers to diminish (Bambilla *et al.*, 2014; Méndez, 2011; OECD-FAO, 2011; Terrones and Sánchez, 2010; García *et al.*, 2018). This phenomenon is based on the neoclassical economics theory, which has been used to analyze the agricultural sector of various countries and sets forth that producers seek to maximize their profit, minimize their costs, and increase the efficient use of their factors of production. However, this relationship is not the same for all producers, because it depends on several factors, such as the level of their technological and economic resources.

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Therefore, producers with greater access to economic and technological resources will be in a better position to take advantage of the increase in product prices than those producers with fewer economic and technological resources (de Grammont, 2010; Rosenzweig and Hillel, 2015; Roldán, 2012; Cardona *et al.*, 2007; Roitbarg, 2021). The agricultural sector has a twofold relevance: on the one hand, it provides the food that society demands for its survival; on the other hand, it creates value chains, since its processes require various inputs, such as tractors, credits from commercial and development banks, fertilizers, etc. Therefore, it is considered the creative sector of the economy. Likewise, its evolution has led to the creation of two groups: a highly-productive group with access to technological and economic resources; and a not very productive group with little access to technological and economic resources (de Grammont, 2010; Moreno *et al.*, 2011; Tonconi, 2015; Sosa and Ruíz, 2017; García *et al.*, 2018; Garcia, 2020; Roitbarg, 2021).

The agricultural sector is also influenced by the prices of its products. Therefore, when the population demands more products, prices increase, which causes producers to increase their production, in order to increase their income. Likewise, farmers compete among themselves and demand more production inputs; consequently, not all producers are able to take advantage of the price increase (Bambilla *et al.*, 2014; Tonconi, 2015; Flores, 2014; Guzmán *et al.*, 2012; García, 2020; Benítez, 2022; Cardona *et al.*, 2007; OECD-FAO, 2011). The neoclassical approach to economics indicates that economic agents in the agricultural sector seek to maximize profit, to minimize costs, and to maximize the efficient use of factors and that prices affect the production (Cardona *et al.*, 2007; Roitbarg, 2021). The latter phenomenon has been pointed out by various authors, including Bambilla *et al.* (2014), Tonconi (2015), Márquez *et al.* (2006), and OECD-FAO (2011), who have highlighted that product prices affect agricultural production. However, not all producers are affected the same way: only those with economic and technological resources can take advantage of a price increase (and are consequently able to considerably increase their production), unlike producers with fewer economic and technological resources (de Grammont, 2010; Moreno *et al.*, 2011; Rosenzweig and Hillel, 2015; Guajardo, 2012; Roldán, 2012). In Mexico, agricultural production is also affected by the prices of the products, which impact the income of the producers: when prices increase, the production of the Mexican agricultural sector also increases, in order to obtain a higher income (Márquez *et al.*, 2006; Flores, 2014; Acosta, 2005; Appendini, 2008; Cardona *et al.*, 2007; Roitbarg, 2021). Researches like those carried out by Guzmán *et al.* (2012) and Bambilla *et al.* (2014) indicate that, in Mexico, price and production have a positive relationship. Therefore, in order to determine the existence of this relationship and establish the conditions in which it occurs, it is necessary to determine whether or not the price of the main products of the agricultural sector in Mexico are cointegrated with the production of the main producing states of the five regions of the Mexican agricultural sector.

MATERIALS AND METHODS

Thirty cointegration tests were performed. The 1980-2021 databases of the states were obtained from the website of the Secretaría de Agricultura y Desarrollo Rural (SADER, 2022a). The five producing regions are the same as those used by SADER (2022b) to supervise the agricultural sector of Mexico. Likewise, according to SADER (2022a), the states with the highest production of the three main agricultural produces in Mexico in 2021 were chosen. Table 1 shows the main products and the states that had the highest production of each one in 2021.

Table 1 shows that the main products of the Mexican agricultural sector in 2021 were corn kernel, beans, and sorghum kernel. The table also shows the main producing states for each of the three products in the five regions analyzed. These states were examined by means of cointegration tests, to determine if their production is influenced by the prices of the products. Likewise, in order to carry out an analysis of actual data, the price database was deflated using the Índice Nacional de Precios al Consumidor (INPC) of the Instituto Nacional de Estadística y Geografía (INEGI, 2022).

Cointegration tests

Thirty cointegration tests (fifteen with a trend and fifteen without a trend) were carried out to determine if prices impact the agricultural production of the main producing states, regarding the main products of five Mexican regions. Cointegration tests determine whether or not the relationship has a long-term and non-spurious nature. Data for the 1980-2021 period was analyzed and a total of 42 observations were made for each cointegration test (Table 2).

Table 2 shows the influence of prices in the states with the highest production of the main agricultural products in the regions analyzed. For each state, cointegration tests (with and without trend) were used to examine the relationship of its production with the product prices from 1980 to 2021. According to Gujarati and Porter (2010), to perform the cointegration tests, it is first necessary to determine that the variables analyzed are non-stationary and of the same integration order (order one), by means of two Augmented Dickey Fuller (DFA) tests for unit root (with and without trend, one of order zero and the other of order one). The EViews software was used for this purpose. The DFA tests will have the form of the following equation (1).

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i-1}^{m} \alpha_i \Delta Y_{t-1} + \varepsilon_t \tag{1}$$

Where: ε_t is a white noise pure error term; $\Delta Y_{t-1}$the number of lagged difference terms that are frequently included.

Table 1. Products, regions, and states analyzed.

Main products of the Mexican agricultural	Northwest	Northeast	Center-West	Center	South-southeast
Corn kernel	Sinaloa	Chihuahua	Jalisco	Edo. de México	Veracruz
Beans	Sinaloa	Zacatecas	Guanajuato	Puebla	Chiapas
Sorghum kernel	Sinaloa	Tamaulipas	Guanajuato	Morelos	Campeche

Source: Table developed by the authors based on SADER (2022ab).

Table 2. Cointegration tests per region.

<table>
<tr><th>Region</th><th>States</th><th>State analyzed product</th><th>Cointegration tests (with and without trend)</th></tr>
<tr><td>Northwest</td><td>Sinaloa
Sinaloa
Sinaloa</td><td>Corn kernel
Beans
Sorghum kernel</td><td rowspan="5">It will be analyzed by means of cointegration tests (with and without trend) if the production of the main producing states of the main products produced by the Mexican agricultural sector of the five regions of the Mexican agricultural sector is influenced by prices. Where the independent variable is prices and the dependent variable is production.</td></tr>
<tr><td>Northeast</td><td>Chihuahua
Zacatecas
Tamaulipas</td><td>Corn kernel
Beans
Sorghum kernel</td></tr>
<tr><td>Center-West</td><td>Jalisco
Guanajuato
Guanajuato</td><td>Corn kernel
Beans
Sorghum kernel</td></tr>
<tr><td>Center</td><td>Edo. de México
Puebla
Morelos</td><td>Corn kernel
Beans
Sorghum kernel</td></tr>
<tr><td>South-southeast</td><td>Veracruz
Chiapas
Campeche</td><td>Corn kernel
Beans
Sorghum kernel</td></tr>
</table>

Source: Developed by the authors.

In all DFA tests, the Durbin-Watson statistic will be examined to verify the absence of autocorrelation problems. Therefore, the value of the Durbin-Watson statistic must be higher than the significance point (α=5%) and their corresponding k and n values. Next, in the order zero DFA tests, the *p*-value will be analyzed. If it is greater than 0.05, the series has a unit root and is non-stationary and, if it is lower than 0.05, the series has no unit root and is stationary. If the variables do not have a unit root and are non-stationary in order zero, it must be determined whether or not they belong to the integration order one (*i.e.*, they must be stationary in the first difference). Therefore, a second DFA test is carried out on the variables (with and without trend), but with differences (order one), analyzing again the Durbin-Watson statistic and the *p*-value of the test. To verify that the variable is of integration order one, the series must not have a unit root and must be stationary in the second difference. Therefore, the tests must have a <0.05 *p*-value. If the variables meet the two conditions, the thirty cointegration tests are carried out using the EViews software, based on Gujarati and Porter (2010). In this way, the augmented Engle-Granger test will be used to estimate the cointegrating regression —that will have the form of Equation (2)—, obtaining the residuals of the cointegrating regressions for each of the thirty tests.

$$Y_i = \beta_1 + \beta_2 X_{1i} + u_i \tag{2}$$

Where: Y_i=state production for a given month; β_1=intercept; β_2=cointegrating parameter; X_{1i}=real price of the product for a given month i; u_i=estimated residuals of the cointegrating regression; i=month within the study period.

The augmented Engle-Granger unit root tests will be applied to the residuals of the cointegrating regressions obtained with Equation (2), in order to obtain the Engle-Granger tau statistic. The residuals are determined to be stationary or not based on that statistic, consequently establishing if the variables are cointegrated. The *p*-value of the Engle-Granger tau statistic was evaluated for that purpose. If the said statistic is lower than 0.05, the cointegrating residuals lack a unit root, are stationary, and are cointegrated in the long run; otherwise, the cointegrating residuals have a unit root, are non-stationary, and are not cointegrated.

RESULTS AND DISCUSSION

Table 3 shows the results of the application of the DFA tests with and without trend, of order zero and one, from 1980 to 2021, to the actual price and produced quantity variables in the states that produce most corn kernel, sorghum kernel, and beans in the five regions of the Mexican agricultural sector.

Table 3 shows that, according to the results of the DFA tests of order zero and one, there is no evidence of a positive serial correlation in the variables examined, since the value of the Durbin-Whatson statistic is above the point of significance in all cases. Likewise, the third column includes the *p*-values of the DFA tests without trend and with a trend of order zero, for which, in most cases, the *p*-values are greater than 0.05, indicating that the series have a unit root and are non-stationary (α=5%). The only exceptions are the actual price of sorghum kernel in Campeche (without trend), the amount of corn kernel produced in the State of Mexico and the amount of beans produced in Puebla (both without and with trend), and the amount of corn kernel produced in Veracruz (with trend). In Table 3, column five, all the *p*-values of the DFA tests of order one are lower than 0.05, indicating that the series do not have a unit root and are stationary, with and without trend (α=5%); therefore, all the variables belong to integration order one. In conclusion, the variables in the tests with and without a trend meet the two conditions: to be non-stationary and to belong to integration order one (with the abovementioned exceptions). Based on this, Table 4 shows the results of the augmented Engle-Granger unit root tests, applied to the residuals of the cointegrating regressions (with and without trend), corresponding to the prices of the production of corn kernel, sorghum kernel and beans in each analyzed state (with the exception of the states that did not meet the conditions for the application of the cointegration test, which are Puebla and the State of Mexico).

Table 4 shows the *p*-values of the Engle-Granger tau statistic for the augmented Engle-Granger test applied to the residuals of the cointegrating regressions. The *p*-values are greater than 0.05 in the northwestern region, which indicates that the cointegrating residuals have a unit root and are non-stationary; therefore, the series are not cointegrated —*i.e.*, the price does not affect production. In the northeastern, central-western, and central regions, the *p*-values are lower than 0.05; consequently, the cointegrating residuals do not have a unit root and are stationary, indicating that the series are cointegrated in the long run —*i.e.*, price affects the production. In the southern-southeastern region, the *p*-values were greater than 0.05, in most of the producing states, indicating that the cointegrating residuals have unit roots and are therefore non-stationary. Consequently, the series are not cointegrated —*i.e.*, the price does not affect production. However, the corn kernel produced in the state of Veracruz with a trend is an exception regarding price: the *p*-value is lower than 0.05,

Table 3. Results of the DFA tests of order zero and one (with and without trend).

Región	**Variable Real price and quantity produced by the State.**	**P-value (zero-order DFA test).**	**Durbin-Watson and Significance point of the Durbin-Watson statistic for an alpha of 5% and a n=42. There is positive serial correlation (zero order).**	**P value (first order DFA test).**	**Durbin-Watson and Significance point of the Durbin-Watson statistic for an alpha of 5% and a n=42. There is positive serial correlation (order one).**
Northwest	Real price of corn kernel Sinaloa	0.2486	No, because 2.30>1.60	0	No, because 2.07>1.600
	Real price of corn kernel Sinaloa (with trend)	0.3544	No, because 2.16>1.659	0	No, because 2.06>1.721
	Real price of beans Sinaloa	0.131	No, because 2.083>1.854	0	No, because 2.28>1.659
	Real price of beans Sinaloa (with trend)	0.1292	No, because 2.0298>1.854	0	No, because 2.29>1.721
	Real price of sorghum kernel Sinaloa	0.092	No, because 2.026>1.60	0	No, because 2.083>1.659
	Real price of sorghum kernel Sinaloa (with trend)	0.243	No, because 1.959>1.60	0	No, because 2.09>1.721
Northeast	Real price of corn kernel Chihuahua	0.5847	No, because 2.15>1.60	0	No, because 2.04>1.600
	Real price of corn kernel Chihuahua (with trend)	0.6041	No, because 2.029>1.60	0.0001	No, because 2.02>1.721
	Real price of beans Zacatecas	0.4729	No, because 2.155>1.854	0	No, because 2.164>1.659
	Real price of beans Zacatecas (with trend)	0.5479	No, because 2.087>1.924	0	No, because 2.171>1.721
	Real price of sorghum kernel Tamaulipas	0.1309	No, because 2.0613>1.60	0	No, because 2.71>1.659
	Real price of sorghum kernel Tamaulipas (with trend)	0.2396	No, because 2.956>1.60	0.0001	No, because 2.077>1.721
Center-West	Real price of corn kernel Jalisco	0.3618	No, because 1.914>1.854	0	No, because 2.13>1.600
	Real price of corn kernel Jalisco (with trend)	0.6212	No, because 2.0732>1.60	0	No, because 2.15>1.659
	Real price of beans Guanajuato	0.7183	No, because 2.324>1.854	0	No, because 2.12>1.600
	Real price of beans Guanajuato (with trend)	0.2686	No, because 2.16>1.854	0.0003	No, because 2.06>1.924
	Real price of sorghum kernel Guanajuato	0.1269	No, because 2.4134>1.60	0	No, because 1.916>1.600
	Real price of sorghum kernel Guanajuato (with trend)	0.2456	No, because 2.30>1.659	0	No, because 1.914>1.659
Center	Real price of corn kernel Edo. de México	0.9953	No, because 1.855>1.600	0	No, because 1.854>1.600
	Real price of corn kernel Edo. de México (with trend)	0.6669	No, because 1.865>1.659	0.0009	No, because 1.891>1.721
	Real price of beans Puebla	0.9995	No, because 1.721>1.600	0.0002	No, because 1.942>1.600
	Real price of beans Puebla (with trend)	0.7208	No, because 1.739>1.659	0.0003	No, because 1.936>1.659
	Real price of sorghum kernel Morelos	0.9994	No, because 1.919>1.600	0.0008	No, because 1.845>1.659
	Real price of sorghum kernel Morelos (with trend)	0.9043	No, because 1.900>1.721	0.0001	No, because 1.822>1.721
South-southeast	Real price of corn kernel Veracruz	0.9997	No, because 1.706>1.600	0.0005	No, because 1.833>1.600
	Real price of corn kernel Veracruz (with trend)	0.8061	No, because 1.797>1.659	0.0004	No, because 1.7781>1.659
	Real price of beans Chipas	0.9939	No, because 1.749>1.600	0.0001	No, because 1.983>1.600
	Real price of beans Chiapas (with trend)	0.6333	No, because 1.745>1.659	0.0003	No, because 1.943>1.659
	Real price of sorghum kernel Campeche	0.0195	No, because 2.042>1.600	0	No, because 2.063>1.600
	Real price of sorghum kernel Campeche (with trend)	0.0775	No, because 2.021>1.659	0	No, because 2.064>1.659
Northwest	Produced amount of corn kernel Sinaloa	0.6475	No, because 2.11>1.600	0	No, because 2.07>1.600
	Produced amount of corn kernel Sinaloa (with trend)	0.1689	No, because 1.85>1.600		No, because 2.078>1.659
	Produced amount of beans Sinaloa	0.0503	No, because 2.20>1.721	0	No, because 1.8260>1.721
	Produced amount of beans Sinaloa (with trend)	0.1357	No, because 2.18>1.786	0	No, because 1.8286>1.786
	Produced amount of sorghum kernel Sinaloa	0.258	No, because 1.946>1.786	0	No, because 2.03>1.659
	Produced amount of sorghum kernel Sinaloa (with trend)	0.0777	No, because 1.8578>1.659	0	No, because 2.04>1.721

Table 3. Continues...

Región	**Variable Real price and quantity produced by the State.**	**P-value (zero-order DFA test).**	**Durbin-Watson and Significance point of the Durbin-Watson statistic for an alpha of 5% and a n=42. There is positive serial correlation (zero order).**	**P value (first order DFA test).**	**Durbin-Watson and Significance point of the Durbin-Watson statistic for an alpha of 5% and a n=42. There is positive serial correlation (order one).**
Northeast	Produced amount of corn kernel Chihuahua	0.274	No, because 2.081>1.786	0.0001	No, because 2.15>1.786
	Produced amount of corn kernel Chihuahua (with trend)	0.3667	No, because 2.002>1.854	0.001	No, because 2.16>1.854
	Produced amount of beans Zacatecas	0.211	No, because 1.97>1.786	0	No, because 2.1184>1.659
	Produced amount of beans Zacatecas (with trend)	0.3562	No, because 1.95>1.91	0	No, because 2.127>1.721
	Produced amount of sorghum kernel Tamaulipas	0.2246	No, because 2.03>1.659	0	No, because 2.16>1.600
	Produced amount of sorghum kernel Tamaulipas (with trend)	0.5232	No, because 2.014>1.721	0	No, because 2.175>1.659
Center-West	Produced amount of corn kernel Jalisco	0.4072	No, because 1.822>1.721	0	No, because 1.8581>1.659
	Produced amount of corn kernel Jalisco (with trend)	0.6454	No, because 2.0802>1.91	0	No, because 1.8698>1.721
	Produced amount of beans Guanajuato	0.2331	No, because 2.060>1.91	0	No, because 2.07>1.600
	Produced amount of beans Guanajuato (with trend)	0.1395	No, because 2.060>1.91	0	No, because 2.074>1.659
	Produced amount of sorghum kernel Guanajuato	0.2608	No, because 2.0843>1.786	0	No, because 1.90>1.600
	Produced amount of sorghum kernel Guanajuato (with trend)	0.2246	No, because 2.027>1.91	0	No, because 1.9010>1.659
Center	Produced amount of corn kernel Edo. de México	0.0005	No, because 1.917>1.600	0	No, because 2.076>1.600
	Produced amount of corn kernel Edo. de México (with trend)	0.0035	No, because 1.918>1.659	0	No, because 1.821>1.659
	Produced amount of beans Puebla	0.0027	No, because 2.080>1.600	0	No, because 2.027>1.786
	Produced amount of beans Puebla (with trend)	0.0005	No, because 2.051>1.659	0.0003	No, because 2.026>1.854
	Produced amount of sorghum kernel Morelos	0.3651	No, because 2.148>1.659	0	No, because 1.960>1.659
	Produced amount of sorghum kernel Morelos (with trend)	0	No, because 1.9606>1.659	0	No, because 1.992>1.721
South-southeast	Produced amount of corn kernel Veracruz	0.2378	No, because 2.336>1.600	0	No, because 2.059>1.600
	Produced amount of corn kernel Veracruz (with trend)	0.0187	No, because 1.959>1.659	0.0001	No, because 2.048>1.786
	Produced amount of beans Chipas	0.257	No, because 2.114>1.600	0	No, because 2.030>1.600
	Produced amount of beans Chiapas (with trend)	0.5721	No, because 2.036>1.659	0	No, because 2.045>1.659
	Produced amount of sorghum kernel Campeche	0.9018	No, because 2.238>1.600	0	No, because 2.071>1.600
	Produced amount of sorghum kernel Campeche (with trend)	0.5437	No, because 2.153>1.659	0	No, because 1.925>1.721

Source: Table developed by the authors.

Table 4. Augmented Engle-Granger unit roots applied to the residuals of the cointegrating regressions (with and without trend).

Region	Cointegration test	P-values of the Engle-Granger tau statistic	They are cointegrated
Northwest	Price of corn kernel with corn kernel production in the state of Sinaloa without trend.	0.1945	No.
	Corn kernel price with corn kernel production in the state of Sinaloa with trend.	0.1296	No.
	Bean price with bean production in the state of Sinaloa without trend.	0.371	No.
	Bean price with bean production in the state of Sinaloa with trend.	0.6082	No.
	Sorghum kernel price with sorghum kernel production in the state of Sinaloa without trend.	0.0545	No.
	Sorghum kernel price with sorghum kernel production in the state of Sinaloa with trend.	0.1726	No.
Northeast	Price of corn kernel with corn kernel production in the state of Chihuahua without trend.	0.0056	Yeah.
	Corn kernel price with corn kernel production in the state of Chihuahua with trend.	0.0195	Yeah.
	Bean price with bean production in the state of Zacatecas without trend.	0.001	Yeah.
	Bean price with bean production in the state of Zacatecas with trend.	0.0003	Yeah.
	Sorghum kernel price with sorghum kernel production in the state of Tamaulipas without trend.	0.0009	Yeah.
	Sorghum kernel price with sorghum kernel production in the state of Tamaulipas with trend.	0.0042	Yeah.
Center-West	Price of corn kernel with corn kernel production in the state of Jalisco without trend.	0.0368	Yeah.
	Corn kernel price with corn kernel production in the state of Jalisco with trend.	0.0149	Yeah.
	Bean price with bean production in the state of Guanajuato without trend.	0	Yeah.
	Bean price with bean production in the state of Guanajuato with trend.	0.0001	Yeah.
	Sorghum kernel price with sorghum kernel production in the state of Guanajuato without trend.	0.0258	Yeah.
	Sorghum kernel price with sorghum kernel production in the state of Guanajuato with trend.	0.049	Yeah.
Center	Price of corn kernel with corn kernel production in the Edo. De México without trend.	0.0024	Yeah.
	Corn kernel price with corn kernel production in the Edo. De México with trend.	0.0101	Yeah.
	Bean price with bean production in the state of Puebla without trend.	0.0012	Yeah.
	Bean price with bean production in the state of Puebla with trend.	0.0007	Yeah.
	Sorghum kernel price with sorghum kernel production in the state of Morelos without trend.	0.0339	Yeah.
	Sorghum kernel price with sorghum kernel production in the state of Morelos with trend.	0.0023	Yeah.
South-southeast	Price of corn kernel with corn kernel production in the state of Veracruz without trend.	0.1028	No.
	Corn kernel price with corn kernel production in the state of Veracruz with trend.	0.0262	Yeah.
	Bean price with bean production in the state of Chiapas without trend.	0.5034	No.
	Bean price with bean production in the state of Chiapas with trend.	0.2553	No.
	Sorghum kernel price with sorghum kernel production in the state of Campeche without trend.	0.9706	No.
	Sorghum kernel price with sorghum kernel production in the state of Campeche with trend.	0.5611	No.

Source: Table developed by the authors using EViews.

which indicates that the cointegrated residuals do not have a unit root and are stationary; consequently, the series are cointegrated in the long run —*i.e.*, price affects the production.

CONCLUSIONS

The cointegration tests indicate that, in the northwestern region, the price is not cointegrated with the production of the main producing states of corn kernel, sorghum kernel, and beans —*i.e.*, the price does not affect the production of these states. In the northeastern, central-western, and central regions, the price is cointegrated with the production of the main producing states of corn kernel, sorghum kernel, and bean —*i.e.*, the price affects the production of the states. In most of the cases of the southern-southeastern region, the price is not cointegrated with the quantities produced in any of the main producing states of corn kernel, sorghum kernel, and beans —*i.e.*, the price does not affect production in these states. The only exception is the price of corn kernel produced in the state of Veracruz with a trend, where the price is cointegrated with the quantities produced —*i.e.*, the price affects production. This indicates that price influences the production of the agricultural sector, but its influence is not the same, neither in the five regions of Mexico, nor in the main producing states of corn kernel, sorghum kernel, and beans. The production of some states and regions is influenced by other elements beside prices, although this relationship does take place in other states and regions. This phenomenon can be attributed to the conditions of each state and region of the Mexican agricultural sector.

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