Corn price volatility and producer income protection

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ABSTRACT
Objective: To estimate the risk indicator of the future price of yellow corn #2 at the Chicago Futures Exchange (USA) regarding the spot price of white corn in the main producing regions in Mexico through the financial volatility indicator.
Methodology: The research used the returns of the monthly time series corresponding to the spot price of white corn from January 1998 to December 2020, considering five producer-consumer regions of Mexico and the future price of yellow corn #2 as listed on the Chicago Stock Exchange. To quantify volatility, the generalized autoregressive conditional heteroskedasticity model of order (1,1) was estimated.
Results: The yellow corn #2 volatility indicator was 0.9870 (future price). In the case of the spot price of white corn in Mexico, the volatility was 0.7977 for the national price, 0.3385 for the central region, 0.3206 for the western region, and 0.0078 for the southeast region.
Implications: The high volatility of yellow corn #2 (close to unity) shows that the international market for this commodity is riskier than the national market or regional markets in Mexico.
Conclusions: The national white corn market proved to be riskier than the west, center, and southeast regional markets, which have a higher volatility indicator.

Keywords: futures market, autoregressive conditional heteroskedasticity, risk coverage, supply, agricultural policy.

INTRODUCTION

In Mexico, the promotion of corn production has been a priority sectoral policy, because it is the fundamental grain in the population diet. The guaranteed price of this crop was maintained until 1999, the year in which the Compañía Nacional de Subsistencias Populares (CONASUPO) was liquidated. This policy was in force for 15 years (1993-2007), to face the total opening to free trade and international competition of this grain with the country's trading partners (Ortiz and Montiel, 2017; Valdes, 2018).

During the 2000-2019 period, corn imports registered a 5.5% average annual growth rate. According to the Agencia de Servicios a la Comercialización y Desarrollo de Mercados Agropecuarios (ASERCA, 2020), between 2011 and 2019, yellow corn and white corn accounted for an average of 91.2% and 8.8% of total imports, respectively. In 2019, the cultivation of this staple grain ranked first in the harvested area, with 34.6% of a total of 19.4 million hectares.

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Given the commercial opening of applied agriculture in the 1983-2018 period, Zahniser *et al.* (2019) and Motamed *et al.* (2008) point out that the different regions of Mexico are not equally integrated with the United States market. Therefore, white corn prices throughout Mexico can change along, but in different degrees, with the price of yellow corn #2 in the United States. The Apoyos y Servicios a la Comercialización Agropecuaria (ASERCA) decentralized public organization was created in 1991. ASERCA implemented and monitored part of the public policies that benefited producers, strengthening the development of the sector, agricultural profitability, and producers' income. In addition, it solved problems that arose when producers stopped receiving support from CONASUPO (Godínez, 2006; Varangis, Larson, and Anderson, 2002).

In the federal administration of the 2000-2006 period, ASERCA's coverage was extended to support five crops (cotton, beans, wheat, sorghum, and soybeans) in face of the commercial opening. It also helped corn growers to purchase futures contracts for yellow corn #2, which are quoted on the Chicago Futures Exchange, under the argument that white and yellow corn are interchangeable with each other in the offer. Support through futures contracts ended in 2018, because in 2019 ASERCA's budget was reduced by 88.2 %.

The acquisition of coverage contracts in the futures market of the Chicago Stock Exchange is subject to high speculation; therefore, its prices register high volatility, as can be deduced from the works of Engle (1982) and Bollerslev (1986). In addition, the magnitude of the volatility of the yellow corn #2 future price (transmitted to the spot price of white corn in Mexico) is not well known. Therefore, if Mexico is the main importer of yellow corn from the United States, it is important to provide elements for decision-making in the design of white corn agri-food policies in Mexico. The objective of this research was to estimate the magnitude at which the risk of the yellow corn #2 futures price in the Chicago Futures Exchange is passed on to the spot price of white corn in the main producer-consumer regions of Mexico. This magnitude was determined through the financial volatility indicator for the 1998-2020 period, to analyze the effect of coverage on the income of producers as a tool to protect the income of surplus white corn producers.

MATERIALS AND METHODS

In the study, four white corn producing regions in the country were considered: 1) the western region that includes Sinaloa and Jalisco; 2) the central region that groups Mexico City and the State of Mexico; 3) the southeast region made up of Chiapas and Yucatán; and 4) a "national" region that includes Chiapas, Chihuahua, Mexico City, Durango, Jalisco, State of Mexico, Nuevo León, Sinaloa, Tamaulipas, Yucatán, and Zacatecas.

Variables definition

Table 1 shows the definition of the main variables used in the study.

The sampling period of the study covered 22 years, from January 1998 to December 2020, obtaining a sample of 264 observations. The monthly series of price data for yellow corn #2 listed on the Chicago futures market was obtained from the Economic Research Service (ERS-USDA, 2021), while the price of white corn was obtained from the Servicio

Table 1. Definition of study variables.

Variable	Description	Units
PBOCC	Price of white corn Western Region	USD/ton
PBCEN	Price of white corn Central Region	USD//ton
PBSTE	Price of white corn Southeast Region	USD//ton
PBNAL	National white corn price	USD//ton
PAMBC	Price of yellow corn #2 listed on the futures market of the Chicago Stock Exchange	USD//ton

Note: USD=United States dollar; t=metric ton. Source: table developed by the authors.

Nacional de Información e Integración de Mercados of the Secretaría de Economía (SNIIM, 2021).

Non-stationarity contrast tests

The methodology used to determine if the time series are stationary was the Dickey-Fuller unit root (DF) contrast test (Brooks, 2019). In the case of the financial concept of volatility analysis, the so-called performance or profitability was used. Brooks (2019) indicates that, in financial analysis, it is better to express asset prices as simple price performance or profitability. Given that the prices of certain commodities (*e.g.*, coffee and corn) behave like the prices of financial or similar assets, their residuals also have high variability and heteroskedasticity.

RESULTS AND DISCUSSION

Descriptive statistics

To quantify the volatility of the white and yellow corn prices, these were transformed into yields or simple profit, based on the proposals of Brook (2019) and Pérez (2006). Table 2 shows the descriptive statistics of the four series of the white corn profitability and the series of the yellow corn #2 profitability.

Unit root test

The values of (τ) were established using the augmented Dickey Fuller test (ADF) for unit root, including only the intercept in the regression equation. The values of τ for the profitability of the five-time series were higher than the critical values for the 1, 5, and 10%

Table 2. Descriptive statistics of the profitability of white and yellow corn.

Statistics	PMBOCC	PMBCEN	PMBSTE	PMBNAL	PAMBC
Average	0.3034	0.3046	0.3126	0.3052	0.8032
Maximum	45.0861	22.2119	23.3661	22.6043	89.9500
Minimum	−31.6218	−18.1686	−16.5859	−17.2037	−41.1700
Standard deviation	6.4303	4.3940	5.5306	4.3429	12.1155
Symmetry coefficient	1.1004	0.4160	0.6037	0.5113	2.0284
Kurtosis	13.3615	6.6185	5.7773	7.7817	17.5227

Source: table developed by the authors.

confidence levels; consequently, all the time series were stationary. The abovementioned GARCH (1,1) model was used in the research. For the analysis of the volatility of the series of interest, the following two equations were estimated: the mean regression equation and the variance equation that corresponds to GARCH itself (1,1).

Table 3 shows the estimated results of both equations for each of the white and yellow corn series. This table also includes the price volatility of these corns, which is considered a measure of the market risk that their buyers and sellers must face. They must also try to minimize or transfer the said risk to other market agents, through financial instruments (*e.g.*, coverage or insurance premiums).

Table 3. Estimation of the volatility of corn with the GARCH model (1,1).

Variable	Equation / Parameter	Coefficient	Standard error	Z-value
RPMAMRD	Equation of the mean:			
	α	−0.04335	0.23595	−0.18371
	Variance equation:			
	α_0	0.41254	0.11351	3.63451
	α_1	0.04216	0.01049	4.02090
	β	0.94485	0.01297	72.85510
RPMBRDNAL	Ecuación de la media:			
	α	−0.31168	0.29382	−1.06077
	Variance equation:			
	α_0	5.95383	1.25095	4.75929
	α_1	0.26910	0.05640	4.77171
	β	0.52855	0.07143	7.39944
RPMBRDOCI	Equation of the mean:			
	α	−0.10931	0.41122	−0.26582
	Variance equation:			
	α_0	29.56558	9.45214	3.12793
	α_1	0.23223	0.07434	3.12376
	β	0.08834	0.20718	0.42638
RPMBRDCEN	Equation of the mean:			
	α	−0.08040	0.25434	−0.31609
	Variance equation:			
	α_0	16.00216	2.42771	6.59146
	α_1	0.41661	0.09442	4.41254
	β	−0.07809	0.07834	−0.99682
RPMBRDSTE	Equation of the mean:			
	α	−0.24175	0.42394	−0.57023
	Variance equation:			
	α_0	45.37773	116.81590	0.38846
	α_1	0.01607	0.03560	0.45159
	β	−0.00825	2.57997	−0.00320

Source: table developed by the authors.

The coefficient column shows the estimated values for the parameters of the equation of the mean, which are assumed to be shaped like a random walk with drift. In the case of the estimated parameters for the GARCH (1,1) model, the restrictions ($\alpha_1 > 0$ and $\beta > 0$) are fulfilled. The interpretation corresponding to GARCH (1,1) is $\alpha_1 + \beta = 0.2691 + 0.528551 = 0.798$ —that is, the sum of the coefficient of the ARCH effect and the parameter of the conditional variance with a one-period lag. This implies that the price of white corn for the following month is highly dependent on the price of the previous period, showing a high persistence of volatility (particularly, of the national corn price) and therefore a greater risk.

In the southeast region (RPMBSTE), both the parameter of the ARCH effect (α_1) and the conditional variance (β) were not statistically significant. Likewise, the magnitude of volatility ($\alpha_1 + \beta = 0.0078$) does not affect white corn.

For their part, Ortiz and Montiel (2017) used the multivariate stochastic volatility analysis to show that the corn price in the futures market during the 2007-2012 period was not strongly related to the prices recorded in some states of the country. Therefore, they conclude that, despite the increased use of white corn, the coverage provided by the ASERCA program has failed to properly fulfill its purpose: protecting the income of Mexican farmers who plant this grain.

Similarly, the present study found out that the average price of white corn in Mexico has a high volatility that, given its magnitude (0.798), tends to persist over time. The southeast region (Chiapas and Yucatán) is not affected by the said volatility. Meanwhile, Echánove (2011) highlights that the government implemented support programs since the 1990s, including contract farming, whose purpose was to provide security, both to producers and buyers, in the grain commercialization sector. In 1996 producers (mostly of white corn) began to use the program to acquire stock instruments on the Chicago Stock Exchange, with yellow corn #2 as their underlying. The coverages operated by ASERCA involve a position in the futures market opposed to the position of the participant in the domestic spot market. Consequently, any loss in the spot market is compensated with the coverage in the futures market (Ortiz and Montiel, 2017) and, at no point in time, do the producers —who are protected with the coverage signed with ASERCA— lose their monetary income as a result of the fall in the price implied in the high volatility. When the volatility implied a higher price than the one stipulated in the contract for the coverage acquired through ASERCA, the producers were not only protecting their income, but also obtained additional income from the difference in the prices of the contract and the yellow corn futures price. They only reimbursed ASERCA less than 50% of the amount which the said institution provided them to acquire the so-called base. In their analysis of the results of the volatility estimates, Ortiz and Montiel (2017) do not indicate how this type of risk would affect white corn producers in Mexico. At budget level, the official resources allocated to agriculture by contract are insufficient —as the budget allocated to the agricultural sector usually is (Echánove, 2011).

CONCLUSIONS

The profitability of the price of yellow corn #2 —the underlying commodity of the coverage that ASERCA acquired to support white corn producers in the western region

(Sinaloa and Jalisco)— is highly volatile. The extreme closeness to the unity of this risk indicator implies a persistent volatility in the yellow corn #2 market and that the price of the next period depends almost entirely on the previous period. In the case of Mexico, the profitability of the white corn price in the national region has high volatility (0.798), which implies a high risk for white corn as the only national market. In conclusion, since the central and the western regions face a greater market risk and greater financial risk than the southeast region, their income could have greater variability and therefore greater risk. The need to design coverage mechanisms for corn producers will enable agricultural policy makers to develop programs and sectoral laws that encourage the national production and supply of this basic grain.

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