

ANALYSIS

OF MEXICAN CORN PRICES IN THE CHICAGO BOARD OF TRADE FUTURES MARKET,

PERIOD 2000-2016



Analysis of Mexican Corn Prices in the Chicago Board of Trade Futures Market, period 2000-2016

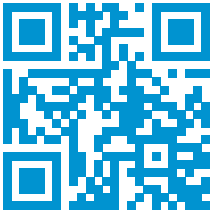
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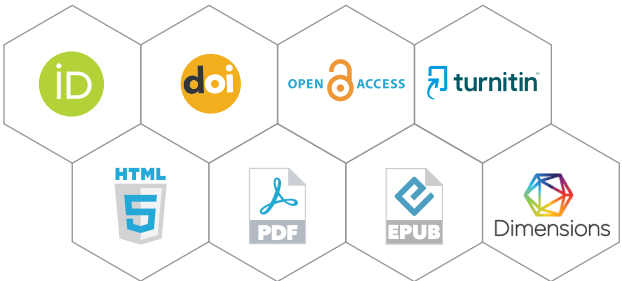
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Abstract

Several changes affecting the original purpose of acquiring and using futures financial instruments have taken place during the last few decades. As speculation gains ground in its profit-seeking role, it generates alarming differences between real production amounts and those commercialized through financial groups around the world. This research outlines an analysis of the relationship between real production prices and those arising from speculation. We hereby analyze Yellow Mexican corn prices based on *spot* and *physical* markets and on the results of speculation within the Chicago Board of Trade (CBOT) which belongs to the United States based CME Group. To this aim, we applied a linear regression analysis using the Ordinary Least Squares (OLS) method and time series data. We consider this tool to be the most adequate to test our research hypothesis under the available databases.

Keywords: *Futures, Prices, Real Production, Speculation.*

Resumen

Durante las últimas décadas se han producido varios cambios que afectan el propósito original de adquirir y utilizar instrumentos financieros de futuros. A medida que la especulación gana terreno en su rol lucrativo, genera alarmantes diferencias entre los montos reales de producción y los comercializados a través de grupos financieros alrededor del mundo. A través de esta investigación se esboza un análisis de la relación entre los precios reales de producción y los derivados de la especulación. Los precios del maíz amarillo mexicano se analizan con base en los mercados spot y físico y en los resultados de la especulación dentro del Chicago Board of Trade (CBOT) del CME Group en Estados Unidos. Se ha aplicado un análisis de regresión lineal utilizando el método de mínimos cuadrados ordinarios (OLS) y datos de series temporales. Se ha considerado que esta herramienta es la más adecuada para probar la hipótesis de investigación bajo las bases de datos disponibles.

Palabras clave: *futuros, precios, producción real, especulación.*

Introduction

Due to the duration of agriculture production cycles, the industry has historically relied on the banking system to guarantee its recapitalization and to decrease the volatility risk of agricultural products. On account of this, by the end of the 19th century several economic proposals came about in an attempt to achieve both of these objectives

Futures exchanges on agricultural products were created with this very purpose in the United States of America (USA), which is where the first experiences using financial instruments to guarantee the prices of certain products took place (CME, 2017a). However, the evolution of the capitalist system's conditions and characteristics have caused a series of changes in the particularities of use of such instruments. Therefore, the objective of using futures, in recent decades, differs greatly from that with which it was originally developed. Nowadays, speculation holds a preponderant role in obtaining profits, which creates an alarming difference between real production amounts and those traded in financial groups around the world (Rubio, 2010; Soto, 2012).

In this vein, it has become more and more important to analyze the causes that give rise to this phenomenon as well as other price differentiation factors. In order to achieve this, and due to the limitations of this paper, we decided to analyze one specific agricultural commodity: Mexican yellow

corn, including its prices in the Mexican spot market and those resulting from stock exchange activity in the CME Group's CBOT, based in the USA.

In order to develop the present analysis, we first needed to elaborate a diagnostic study which included the description and characterization of the current situation as well as the necessary explanatory elements that give body to and accompany statistical analysis. We used Ordinary Least Squares (OLS) in order to suggest a plausible solution at the end of the analysis.

Chapters Summary

This book consists of five parts plus the appendices, a list of references, an index of acronyms and abbreviations, and a glossary. The first part corresponds to the research rationale; the second part covers everything concerning the theoretical framework; the referential framework is developed within the third part; the fourth part describes the normative framework; and finally, the fifth part comprises the research methodology.

The first part gives structure to and defines the research work while containing the research problem which, in turn, leads to the research questions, objectives, and hypotheses. Then follow the sections on justification; type of research; variables and instruments; universe; study sample; and scope and limitations.

The second part contains the theoretical framework, integrated by chapter one, on financial definitions, speculation, financialization and prices.

The third part covers the referential framework. Chapters two and three are developed here, presenting the relationship between real production and speculation, and its incidence in the agricultural industry and the futures market. We also provide a brief description of the current situation of Mexican corn.

The fourth part refers to the regulatory framework of corn futures in Mexico and in the United States. It contains chapter four, on the operation of the futures market in both countries, which develops the corresponding

regulations of the Mexican Derivatives Exchange (MexDer), in the case of Mexico; and the CME Group (specifically the CBOT) in the case of the United States.

Finally, the fifth part contains the research methodology: chapter five describes the model used; and chapter six displays the results obtained.

First part

RESEARCH RATIONALE

The Problem

Much has been said in recent decades about the growth of financial markets. One of the aims of these analyses has been finding the relationship between the real economy output and the amounts quoted on world stock exchanges.

To outline the problem, we will start by defining what the futures market is. It should be first noted, that the concept of futures belongs to the discipline of finance, which is “the study of how people allocate resources over time in an uncertain environment”¹ (Bodie & Merton, 1999). When individuals implement financial decisions, they do so through the financial system, which is the set of “markets, intermediaries, service companies and other institutions whose purpose is to implement the financial decisions of families, companies and governments” (Bodie & Merton, 1999, p. 22). This market is managed using financial instruments (derivatives) such as stocks, bonds, currencies, options, futures, etc.

The present analysis will focus on the derivatives known as futures. Futures are financial instruments whose value is derived from the price movements of another asset or underlying asset, which is the actual merchandise being traded (BANXICO, 2016). Depending on the characteristics of the underlying asset, there are different types of futures: *i*) Financial, *i. e.* those

¹ Uncertainty occurs when an individual in a decision-making situation makes decisions based on his or her own expectations about market imperfections rather than on probability and statistical calculation of actual historical data (Knight, 1921).

referring to interest rates, stocks², currencies, bonds³, and credit risk⁴ among others; *ii*) Non-financial, *i. e.* natural resources or raw material commodities⁵; *iii*) Based on weather conditions; *iv*) General price and inflation indexes⁶ (Nino, 2002). Each of these futures derivatives has its own market and its specific stock exchanges, featuring a list of products from each and every country.

The object of the present research is to understand the relationship between real production and speculation⁷. Furthermore, we will analyze the phenomenon by which the economic growth and the profitability of real economy companies have decreased, while the financial sector has had a great expansion with high profit levels.

One of the most important current discussions in the sector is that there is a new paradigm in world agriculture, especially in international agricultural markets, which started developing from the first decade of the 21st century onwards. In this vein, Suárez (2012) points out that there is a “predominance of financial capital over the international market of agricultural commodities and over the determination of the use and destination of agricultural land and food itself” (p. 15). This means that the purpose for

² “The financial instrument representing ownership and, generally, voting rights in a corporation. A certain share of a company’s stock gives the owner title to that fraction of the votes, net earnings, and assets of the corporation” (Samuelson, 2006, p. 703).

³ “An interest-bearing certificate issued by a government or corporation, promising to repay a sum of money (the principal) plus interest at a specified date in the future” (Samuelson, 2006, p. 104).

⁴ “When an investor grants a credit to a debtor, there is the possibility that a loss will occur if the debtor does not fully comply with the financial obligations agreed in the contract in relation to the time, form, or amount to be paid” as well as the “Decrease in the value of the assets due to the deterioration of the credit quality of the counterparty, even in the case that the counterparty fully complies with what was agreed” (Pérez, 2013, p. 24).

⁵ Products underlying a futures contract on an established commodities exchange. These are physical goods that constitute basic components for more complex products. They are classified into grains, softs, energies, metals, meats, financial, indexes and currencies.

⁶ Inflation, or inflation rate, “is the percentage of the annual increase in a general price level” (Samuelson *et al.*, 2006).

⁷ “Financial speculation is a global phenomenon that has behaved dramatically since the explosion of international liquidity in the 1970’s and the policies aimed at liberating capital markets. Said liquidity remains constant today in a system that began developing after the disappearance of the gold dollar pattern and the widespread establishment of flexible exchange rates” (Zapata, 2003, p. 100).

which futures goods are acquired has been rearranged by a growth of speculative investments in the agricultural commodities exchanges.

Until the late 1980's, eighty percent of futures contracts and financial derivatives (options⁸, OTC contracts⁹, swaps¹⁰, etc.) were in the hands of several actors in agri-food chains (producers, traders, processors, exporters). The remaining twenty per cent were in the hands of speculators who injected liquidity into the market. In the last five years, the production has been inverted, as speculative investment funds hold 80% of the financial derivatives on agricultural futures and operators of the real agri-food economy hold the remaining 20% (Suárez, 2012, p. 16).

According to information from the World Bank (WB) (2011), starting in 2008, G-20¹¹ meetings focused on reforming the regulation of the global financial market, in the context of the financial crisis. The Financial Stability Board was established in 2009 with the aim of identifying vulnerabilities in the development and implementation of a supervisory process to ensure global financial stability. This became necessary because the crisis exposed fundamental weaknesses in the structure of the Over the Counter (OTC) derivatives markets linked to agricultural production. It especially focused on products such as soy, wheat and corn from poor and mostly rural countries, known in the financial jargon as No street territories.

⁸ It is the right to buy or sell a stock at a particular price at a specific future date. An Option will only conclude a transaction on the specified date when it is favorable to its owner (Wei, 2014).

⁹ Over the Counter (OTC) is a type of off-exchange market that is not organized institutionally. It is composed of private and bilateral contracts between financial intermediary companies and the client.

¹⁰ A derivative financial instrument that consists of a bilateral exchange of money or future financial instruments. They are *interest rate swap*, *currency swap*, *commodity swap* and *equity swaps*. They are generally used to hedge risk or take advantage of certain market conditions (Wei, 2014).

¹¹ The forum where heads of State, central bank governors and finance ministers from 19 countries and the European Union meet since 1999. It is made up of seven of the most industrialized countries: Canada, France, Germany, Italy, Japan, Russia (G-8), the United Kingdom and the United States, plus eleven countries: Australia, Mexico, India, South Korea, Indonesia, Turkey, Saudi Arabia, South Africa, Argentina, Japan and the European Union.

In this regard, as described by De Schutter (2010), Morgan Stanley, Investment Banking & Capital Markets estimated that the number of outstanding corn futures contracts held by hedge funds increased from 500 000 in 2003 to nearly 2.5 million in 2008. This means that futures and options traded on commodity exchanges increased by more than five times between 2007 and 2008.

On the other hand, corn production continues to increase at a global level. According to data from the Trusts Instituted in Relation to Agriculture (FIRA by its acronym in Spanish, 2015), corn is the most widely produced agricultural commodity in the world and it is one of the most influential products in international markets. The 2014/15 trade cycle presented the highest level of world production in history, totaling 1 009 million tons. The production expectations for 2015/16 estimated a decrease of 3.6 percent, coming down to 972.6 million tons. The consumption was also up to 976.7 million tons in 2014/15.

The dynamics between world production and consumption has led to a significant accumulation of inventories during the last few trade cycles. The highest global inventory volume in the last 15 years was observed in 2014/15, totaling 196.0 million tons. World corn exports increased significantly due to current availability, totaling 133.0 million tons for the 2014/15 cycle. While the international reference price of corn remained at very low levels, FIRA (2015) estimated that the price of 2 FOB Gulf¹² yellow corn averaged \$165.5 USD per ton in September 2015. This was 2.2 percent higher than during August 2015 and 2.0 percent higher than in September 2014.

Futures maturing in 2016 showed a recovery in grain prices towards the middle of that year. In contrast to production, FIRA (2015), pointed out that futures trading levels are currently down due to the wide availability of grain in the USA and the world according to international CBOT prices.

¹² "Free on board (FOB) is a condition of sale in an international transaction that includes the cost of the goods to be shipped and the loading of the vessel but not the transport costs. The seller has the obligation to load the goods on board the vessel at the port of shipment specified in the sales contract. The buyer selects the vessel and pays the sea freight. The transfer of risks and costs occurs when the goods pass the ship's rail. The seller takes care of the export formalities" (ICC, 2010). 2 FOB Gulf yellow corn refers to the future price of a specific type of free on-board corn traded from the Gulf of Mexico.

The related literature suggests a reconfiguration of the market composition between agri-food chain actors and speculators. This corresponds to what has been known as agricultural financialization. The term financialization does not have a precise definition in the existing literature. However, certain characteristics tend to coincide, and it is generally understood as a relationship between different phenomena: “changes in financial markets, the new role of investment and financial income on macroeconomic dynamics, the growing importance of the interests of financial capital within business management, etc.” (Medialdea & Sanabria, 2012, p. 198).

Medialdea and Sanabria (2012) point out a series of elements that favor the increase of financial capital and the development of international financial markets: *i)* A decrease in the profitability obtained through productive activities which stimulates the search for alternative businesses and encourages the expansion of the financial sphere; *ii)* The need to finance the public and current account deficits of developed countries; *iii)* The new financial strategies focused on internationalization processes; *iv)* The disorganization of raw material markets; and, *v)* The development of information and communication technologies. These elements lead to a process of financialization of the world economy in which the agricultural sector plays a fundamental role.

In the case of Mexico, the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA, by its acronym in Spanish) authorized the sale of futures on Mexican agricultural commodities as of 1993. This action derived from the public-private production partnership that made the 1992 agrarian reform possible, in addition to the release of Mexican finances in 1986. About the 2008 food crisis, Godinez (2007) and Rubio (2010) point out that: “in the rural area, the so-called ‘food crisis’ has provoked a rise in prices and with it a rise in the profits of a select group of agri-food entrepreneurs and transnationals [...] This has led to an increase in the sown area of developed countries, mainly the United States” (Rubio, 2010, p. 2).

One of the axis of this crisis is enhanced by the Economy’s general financialization process and the growing speculation within financial markets, which have generated a series of stock market bubbles. Unlike other sectors, such as the USA real estate, the agricultural sector underwent a quite different process. As Rubio (2010) points out:

The agri-food sector has not faced a productive crisis that would generate a fall in profitability and business failure as has happened in the industrial sectors. Instead, it is immersed in a restructuring and productive reconfiguration process that is disrupting the fundamental patterns developed by the neo-liberal model (p. 2).

The effects produced by international treaties on agriculture must be taken into account in this scenario, such as the specific case of the North American Free Trade Agreement (NAFTA) in Mexico. This paper aims to delimit the analysis of the aforementioned process within the current situation of both the Mexican and the world corn market. In turn, this will allow a better understanding of the current situation of Mexican corn as well as its medium- and long-term perspectives.

On the one hand, we develop an analysis of the commodities futures markets in relation to agricultural production. We focused mainly on cereals, such as the Mexican yellow corn quoted in the CME Group¹³, specifically in one of the four Designated Contract Markets (DCM's) that compose said group: the CBOT¹⁴. On the other hand, in order to analyze the quantity produced and the internationally traded volumes of Mexican yellow corn, it was necessary to analyze data related to price quotations from national distribution centers and SAGARPA's databases, among others.

Problem Statement

A new paradigm has been proposed in world agriculture since the first decade of the 21st century, especially in international agricultural markets. It is the “predominance of financial capital over the international market of

¹³ CME Group is the largest and most diverse derivatives market in the world. The CBOT and The CME made an agreement in 2006 to merge into a single entity as of 2007, in what is now known as CME Group. It is made up of four Designated Contract Markets or main futures markets, namely CME, CBOT, NYMEX and COMEX.

¹⁴ Founded in 1848, the Chicago Board of Trade (CBOT) is one of the oldest commodity financial institutions in the world. It is where most agricultural futures are currently traded, and it is part of the CME Group as one of the four Designated Contract Markets.

agricultural commodities and over the determination of the use and destination of agricultural land and food itself” (Suárez, 2012, p. 15).

As a result, the Mexican agricultural sector, specifically that of yellow corn producers, has experienced the following phenomenon: On the one hand, the financial sector has had a great expansion, with high profit rates at the global level by trading with this commodity in organized stock exchanges. On the other hand, economic growth and the profitability of agents in the agri-food chain have decreased at the local level.

Several changes affecting the original purpose of acquiring and using futures on agricultural commodities have taken place during the last few decades. As speculation gains ground in its profit-seeking role, it generates alarming differences between real production amounts and those commercialized through financial groups around the world.

This research outlines an analysis of the relationship between real production prices and those arising from speculation.

Finally, this research aims at proposing an updated reading of the agricultural industry, specifically of one of the most important products both in commodity exchanges worldwide and in the national agricultural industry. The main beneficiaries of this work should be policy makers and scholars who require information on the relationship between the prices of basic agricultural products and those of commodity futures, specifically of Mexican yellow corn. This is relevant because, nowadays, the prices for agri-food chains and consumers in Mexico are based on international prices governed by speculation and geopolitical decisions, instead of obeying the national market and answering to the needs of the Mexican population.

Research Questions

What is the relationship between the prices of real Mexican corn production and the prices resulting from the speculation of the yellow corn traded on the CBOT futures market during the 2000-2016 period, using the OLS model?

Specific Question

What are the main variables that explain the relationship between the prices of real Mexican corn production and the prices resulting from the speculation of the yellow corn traded on the CBOT futures market during the 2000-2016 period, using the OLS model?

Research Objective

Analyze the relationship between the prices of real Mexican corn production and the prices resulting from the speculation of the yellow corn traded on the CBOT futures market during the 2000-2016 period, using the OLS model.

Specific Objective

Identify the main variables that explain the relationship between the prices of real Mexican corn production and the prices resulting from the speculation of the yellow corn traded on the CBOT futures market during the 2000-2016 period, using the OLS model.

Research Hypothesis

The following section will provide provisional answers to the research questions, since “The hypotheses indicate what we are trying to prove and are defined as tentative explanations of the phenomenon under investigation” (Hernández, 2006, p. 122).

General Hypothesis

The existing relationship between the prices of real Mexican corn production and the prices resulting from the speculation of the yellow corn traded on the CBOT futures market during the period 2000-2016, using the OLS model, is defined as follows:

HO = The real production prices of Mexican corn are caused by the speculation prices of the Mexican yellow corn quoted in the CBOT futures market.

This is simplified in the following function:

$$y = f(x_1)$$

Where:

y = Mexican corn prices during the 2000-2016 period,

x_1 = Prices resulting from speculation on CBOT yellow corn during the 2000-2016 period

Specific Hypothesis

*SHO*₁ = The productive restructuring of the Mexican agricultural industry and the financialization of Mexican agriculture are the main variables that explain the existing relationship between the prices of real Mexican corn production and the prices resulting from the speculation of the yellow corn quoted on the CBOT futures market during the 2000-2016 period.

This is simplified in the following function:

$$y = f(x_1, x_2)$$

Where:

y = Relationship between real production prices and speculative prices

x^1 = Productive restructuring of the agricultural industry

x^2 = Financialization of Mexican agriculture

Justification

The characteristics of contemporary capitalism and the changing structure of markets, in particular financial markets, make it necessary for scholars to propose possible solutions to current questions. For this reason, this essay intends to provide a solution to some questions concerning the relationship between real production and speculation. This is done by means of comparing the production of the real economy and the amounts of quotations on the futures markets, taking the prices of corn in Mexico (both real prices and futures prices) as a case study.

This research aims at proposing an updated reading of the agricultural industry, specifically of one of the most important products both in commodity exchanges worldwide and in the national agricultural industry.

The main beneficiaries of this work should be policy makers and scholars who require information on the relationship between the prices of basic agricultural products and those of commodity futures prices, specifically of Mexican yellow corn.

Relevance

This research will provide knowledge on how Mexican yellow corn prices are determined by the prices obtained from yellow corn speculation quoted on the CBOT futures market during the 2002-2016 period. This is relevant because, nowadays, the prices for agri-food chains and consumers in Mexico are based on international prices governed by speculation and geopolitical decisions¹⁵, instead of obeying the national market and answering to the needs of the Mexican population.

¹⁵ Geopolitics, as first defined by Kjellén in 1916, “is the influence of geographical factors, in the broadest sense of the word, on political development in the life of peoples and States” (Atencio, 1982, p. 24).

Social Relevance

Today, the impact that financial markets have on the economic situation and the relationship between countries cannot be ignored, since financial markets are international markets¹⁶. In the case of agriculture, it is intuitively believed that financial transactions currently have a great influence on the Mexican agricultural industry, whose productive base in Mexico has historically been found in the peasant economic unit (UEC by its acronym in Spanish)¹⁷. Corn, the product on which this research will focus, is one of the essential grains that make up the national diet. It is closely related to the market basket, to national food sovereignty, and to the calculation of the National Consumer Price Index (INPC by its acronym in Spanish)¹⁸. Thus, the results of this study intend to provide knowledge aimed at social benefit.

Practical Effects

Understanding the new composition of the agricultural financial market with respect to the production scheme will allow decision makers to apply public policies and trade policies in line with the current situation and help generate social and economic benefits.

Theoretical Value

There is still no clear data on the process through which the disparity between real production and the amounts quoted on the stock exchange has

¹⁶ The markets where residents from different countries exchange assets (Krugman *et al.*, 2012).

¹⁷ "They are those peasant units in our country that develop production to a certain extent on a commercial basis without abandoning self-supply and are based on family labor. However, in many cases they resort to the eventual aid of extra labor and have control over or ownership of a small land property" (Bartra, 1982, p. 26).

¹⁸ The National Consumer Price Index (INPC by its acronym in Spanish) is an economic indicator whose purpose is to measure over time the variation of prices of a fixed basket of goods and services representative of household consumption (BANXICO, 2016).

widened. Therefore, it is important to carry out a theoretical review on the subject as it will allow for the fertilization of scientific knowledge; and the understanding of both contemporary capitalism and the international situation of the production and commercialization of goods.

Time and Space Frame

The time frame for this research will be the 2000-2016 period. This will facilitate the analysis of the processes derived from the Mexican agrarian reform. Furthermore, this allows for a comparison between the trading environment of real corn production and the amounts quoted in the stock exchange before and after NAFTA. It will also provide a view on the international economic readjustments resulting from the 2007 financial crisis.

The space frame will be Mexico; however, the analysis will also consider the amounts quoted in the Chicago, Illinois based CBOT, in the USA.

Feasibility of the Research Project

Enough theoretical and statistical elements are available to carry out the present analysis. The CBOT quotations will be used to analyze the commodity futures markets regarding agricultural production, specifically in the cereal branch and in the case of yellow corn. The analysis will focus mainly on the quotes published by the National Information and Market Integration System (SNIIM by its acronym in Spanish) for Mexico.

To analyze the quantity of Mexico's yellow corn production and the volumes traded internationally, it is essential to review the national average wholesale price quotations from Mexican distribution centers, SNIIM databases, and FIRA, among others.

Type of Research and Approach

Scope

The scope of this analysis will cover the following types of research:

Exploratory

The topic presented is relatively new, in the sense that there is little information on the relationship between real economy and the futures market in general, specifically on Mexico's corn production.

Descriptive

Data will be collected to explain the phenomenon and the context in which it occurs. This will help identify the variables needed to carry out the analysis.

Correlational

It is also a correlational research since it aims at relating two concepts. It will allow us to observe the relationship between Mexico's corn production and the price on the corn futures exchange known as the CBOT.

Approach

The research is meant to have a quantitative approach due to the statistical instruments for data analysis used.

Identification of Variables

General Hypothesis Variables

Table 1. *General Hypothesis Variables*

<i>Dependent Variable</i>	<i>Independent Variable</i>
Mexican corn prices during the 2000-2016 period	Prices resulting from speculation on CBOT yellow corn during the 2000-2016 period

Source: Authors' own design (2019).

Specific Hypothesis Variables

Table 2. *Specific Hypothesis Variables*

<i>Dependent Variables</i>	<i>Independent Variables</i>
Relationship between real production prices and speculative prices	Productive restructuring of the agricultural industry
	Financialization of Mexican agriculture

Source: Authors' own design (2019)

Instruments

Quantitative

In order to carry out the necessary analysis for this research we will use instruments such as databases, statistical tools, and statistical methods (OLS model), among other elements.

Universe and Sample of Study

Universe

All commodities relating to agricultural production listed on the CME Group. Data on Mexico's total agricultural production obtained from SAGARPA.

Sample

Commodities referring to yellow corn production quoted in the CBOT Designated Contract Market during the 2000-2016 period. Data on total Mexican corn production for the 2000-2016 period obtained from SAGARPA.

Scope and Limitations

Scope

The present research will be composed of data regarding Mexico's corn production obtained from SAGARPA and from the CME Group, corresponding to the fluctuations of corn commodities in the futures market of the CBOT Designated Contract Market during the 2000-2016 period.

Limitations

The Mexican financial market currently does not have its own stock exchange where futures on real Mexican production can be traded. Therefore, Mexican companies that acquire futures usually do so under OTC schemes or through financial intermediaries that use purchase and standardization programs from derivatives trading groups around the world. For this reason, we decided to analyze the CME Group and its relationship with MexDer. The former is the most important group in the sector, and the latter is the only one that markets futures on corn production in Mexico, in addition to having an institutional link between them. This represents a limitation on the analysis, since the data obtained may only constitute an estimate of the problem as a whole.

Similarly, Mexico's *Central de Abastos* databases and SAGARPA's pricing systems are estimates created from the daily price fluctuations and quantities traded. They cannot be considered totally accurate.

SECOND PART

THEORETICAL FRAMEWORK

This Theoretical Framework is based on the research problem and on the composition of both the research goals and the research questions. The aim of this section is to provide theoretical support for this essay, so that we can draw a panorama of the existing research within the field, and thus provide a guideline for further investigation. It also aims at describing the terms used during the analysis of our specific subject and to provide the guidelines used for choosing the appropriate methodology and measurement instruments as well as for obtaining the subsequent evaluation of results.

The theoretical bases for the definition of commodity futures; speculation; and production restructuring and financialization in the agricultural sector will be addressed here. The emphasis will be on the process of financialization of the agricultural sector.

I. Finances and International Business

This chapter discusses the relationship between finance and international business. It is divided in two sections: the first one covers the theories regarding international trade; the second one summarizes the main theoretical proposals that constitute international finance.

International Trade Theories

Making trade possible between nations brought about a rapid development in trading capital and gave rise to the capitalist system. During the 16th and 17th centuries, the great trade revolutions, together with some geographical discoveries, were key in the transition from a feudal to a capitalist production system. The world market is the material basis for this production regime; the imminent need to produce on an ever-larger scale is the driving force behind the constant expansion of said world market (Marx, 1882). International trade theories sprouted from this change, striving to understand and act on a once new economic process.

Later on, modern proposals on international trade and new theoretical trends would emerge in an attempt to explain the specific aspects of trade within the current capitalist structure. Nowadays, the world's largest and most important companies focus their economic activities on both international relations between countries and a continued expansion of world

trade based on the liberalization of international regulations. Hence, there is a pressing need to define the foundations of trade from its beginnings to the present day (Appleyard & Field, 2003).

Mercantilism is the first trend in the economic thought¹⁹ of capitalist societies. It was developed in Western Europe between the 16th, the 17th and through the middle of the 18th centuries. It gave rise to theoretical proposals such as those of Mun (1621, 1644), in his works *A Discourse of Trade from England unto the East Indies* and *Discourse on England's Treasure by Foreign Trade*; and those of Petty (1899) developed in a vast number of publications, mainly in his *Economic Writings*.

The postulates constituting this kind of economic thought were: *i*) Trade is the only way to increase wealth (frugal consumption to increase the amount of exportable goods); *ii*) Increasing the use of domestic land and natural resources to reduce imports; *iii*) The reduction of export tariffs and export of goods with inelastic demand. These were originally proposed by Mun²⁰ (1944).

For mercantilists, the economic system consisted mainly of three components: *i*) The manufacturing sector; *ii*) The rural sector; *iii*) The foreign colonies. One of the pillars of mercantilist thought was the static vision of world resources, considered as a zero-sum game. There, the economic gain of one country was obtained at the expense of another (Appleyard & Field, 2003).

This theoretical trend played a strong role in the birth of industrial development but, above all, in trade. Its fundamental characteristics were the following: *i*) Economy's fundamental objective was to achieve a favorable balance of trade, which meant having more exports and less imports; *ii*) It was believed that wealth should be created through circulation, so the accumulation of precious metals (preferably gold and silver) was an abstract and general form of wealth; *iii*) The State had a strong participation in the economy, playing a protectionist and restrictive role; *iv*) The conformation

¹⁹ Some authors do not consider it a formal school of thought but rather a set of similar attitudes towards domestic economic activity and the role of international trade (Appleyard & Field, 2003).

²⁰ "The common means for increasing our wealth and our treasure is foreign trade, in which we must always observe this rule: sell to foreigners per year more than we consume from them in value" (Mun, 1664 in Appleyard & Field, 2003, p. 15).

of Nation States was in its earlier stages; *v*) There was an impulse towards geographical discoveries and the colonization of new territories; *vi*) Reforms in religious terms allowed for the appreciation of trade in cultural terms.

Emerging countries were facing a crisis as a result of territorial confrontations; national war conflicts; the granting of exclusive commercial rights on trade routes; the birth of trade monopolies; and the over-accumulation of precious metals and their importance over the productive sectors (Appleyard & Field, 2003). This situation led to a general increase in prices. The analysis of the effects of said crisis on the economy was synthesized in the first proposals of the *Quantity Theory of Money*²¹ by authors such as Bodin (1568), Apilcueta (1556) and Hume (1752).

Hume was one of the first critics of Bullionism or Metalism in mercantilist processes. In *Political Discourses* (1752), he exposes the development of the price-specie flow and lays the foundation for the critique against metal accumulation: “Hume argued that gold accumulation by means of a trade surplus²² would increase the money supply²³ and, therefore, prices and wages; this would reduce the competitiveness²⁴ of a country having surplus” (Appleyard & Field, 2003).

Hume’s price-specie flow mechanism (1752) rests on four assumptions: *i*) There must be a link between money and prices sustained on the Quantity Theory of Money; *ii*) Demand for traded goods is price elastic²⁵; *iii*) In order to establish the necessary link between price and wage behavior there must be a perfect competition in product and factor markets; *iv*) The gold standard both exists and is generalized (Appleyard & Field, 2003).

²¹ This theory suggests a direct relation between the amount of money and general price levels; this relation determines price levels.

²² It refers to the moment when the total value of exports is higher than the total value of imports of a country, based on its balance of trade (Samuelson *et al.*, 2006).

²³ On a strict definition [...] M_1 includes coins, cash and all direct or check deposits; this is money for transactions. Broadly, [...] M_2 comprises all that is included in M_1 plus certain liquid or quasi-money assets, such as savings deposits, money market funds and the like (Samuelson *et al.*, 2006, p. 718).

²⁴ In its oldest and most common meaning, the term competitiveness refers to the extent to which the prices of the goods and services from any given country can compete with those of other nations (Berdugo, 2014).

²⁵ A term widely used in economics to denote the response of one variable to variations in another. The elasticity of X with respect to Y is the percentual variation in X for each 1% variation in Y .

Smith (1776) was another critic of mercantilism. He “perceived that the wealth of a nation was reflected in its productive capacity [...] not in its possession of precious metals” (Appleyard & Field, 2003). The focus of both, individuals and nations, should then be on productive activity rather than accumulation. A major premise in Smith’s work is the importance of specialization and of the exchange of goods and services. This would naturally lead to the division and specialization of labor. Another one of his principles is that the government should follow a *laissez faire*²⁶ policy, thus proposing the removal of the protectionist market barriers believed necessary by mercantilist proposals.

In commercial terms, Smith (1776) proposed that specialization and exchange between countries should be one of the central points of the Economy. Countries should specialize in and export those goods in which they have an absolute advantage, and they should import those goods in which the trading partner has an absolute advantage. This mutually beneficial exchange was seen as a positive-sum game, and it was used as an argument for countries to reduce the trade controls prevailing during the mercantilist period (Appleyard & Field, 2003).

Later came the proposals that make up the “Pure and the Monetary theories of International Trade”; these contemplate two fields of study: *i*) Pure Theory, which refers to value analysis applied to international exchange; and *ii*) Monetary Theory, which contemplates mainly two aspects: the application of monetary principles to international exchange; and the analysis of adjustment processes through the use of monetary, exchange, and financial instruments to counteract the asymmetric effects of the balance of payments (Monje, 2001). Both fields of study have underpinned trade policy in modern states.

Ricardo (1817) expounded on Smith’s proposals in his work *On the Principles of Political Economy and Taxation*. He explained how profits from foreign trade tend to result in absolute advantage and raised what is known to this day as the basic Ricardian model, which holds the following assumptions: *i*) Each country has a fixed resource endowment, and all units of each resource are identical; *ii*) Factors of production are completely flexible for

²⁶ From the French “let do”, it is a popular expression coined in France that proposed the philosophy of individual freedom of choice and action; it became popular through Smith’s economic proposals (1776).

alternative uses within a country. Factor of production prices are also equal among said alternative uses; *iii*) Factors of production are fully externally mobile; *iv*) The Labor Theory of Value is embedded within this model; *v*) There is a fixed level of technology in both countries; *vi*) Unit costs of production are constant; *vii*) There is full employment; *viii*) The economy is characterized by perfect competition; *ix*) There are no state barriers to economic activity; *x*) There are no transport costs; *xi*) The analysis is simplified to two countries and two commodities.

As a complement to the Theory of Absolute Advantage, Ricardo put forward the Theory of Comparative Advantage. The latter states that countries show a tendency to competitively specialize, produce and export those goods whose production costs are relatively lower with respect to the rest of the world; these goods are therefore comparatively more efficient than others. On the other hand, countries tend to import those goods in which they are less efficient (Appleyard, 2003). Thus, the terms of international trade are determined by the price relations established between countries. The point of trade balance between the two countries is determined by a comparative relevance and by the elasticity of each country's demand for the other's product (Appleyard & Field, 2003).

To complement the classical approaches to trade, it is imperative to discuss the emergence and development of the earliest phases of capitalism as understood by Marx (1892). He considered that free trade brought about a social revolution that would necessarily mean a restructuring of countries. In his work *Capital*, he describes the world market and the existing international division of labor and he lays the foundations for understanding how international markets are created and shaped.

Factor Proportions Theory states that nations differ in their total factors of production²⁷ even when their applied technology is equivalent. Although this theory is applicable to some countries because of its characteristics, its critics state that it is not sufficiently explanatory as it assumes that there are no economies of scale, that technologies are identical in all countries, that products do not differ from each other, and that the set of national factors is fixed (Monje, 2001).

²⁷ Land, labor, natural resources, and capital.

Heckscher (1919) and Ohlin (1933) stand out among these critics. They proposed the Heckscher-Ohlin Theorem basing their model on a critique of Ricardo's Theory of Comparative advantage. It postulates that international trade patterns do not depend on labor productivity but on the surrounding conditions. This theorem studies the effects of factor endowments on international trade and attempts to demonstrate whether the differences between relative factor endowments are enough to form a basis for international trade. This model implies that factor prices between trading countries tend to be equalized through trade (Appleyard & Field, 2003).

Also, the Equilibrium Theory in International Trade is based on market studies and the prices of goods. It focuses on prices and quantities that favor balance in trade processes. On the other hand, Localization Theory points out that there is an unequal distribution of natural resources. This eventually causes a difference in exchange conditions between world regions, based on their unbalanced endowments of natural resources (Monje, 2001).

Arghiri (1964) and Marini (1974) are the main contributors to the Theories on the Origin of Unequal Exchange. They cover the consequences of trade derived from productive differences and unequal exchange between countries. One element contained in the analyses of unequal trade is tariff disparities. Arghiri (1964) tries to show that unequal exchange is not caused by the existence of different types of products; it rather depends on the type of country of origin. On the other hand, Mauro (1974) sets out his analysis from the viewpoint of the countries' productivity.

International Finances

The concept of Finance is very broad as it has been developed through practice rather than through academic means. Even within the academic sector, there are some semantic differences, which originated from methodological perspectives. The first definition is illustrated in Warren Buffet's assertions (1998) as quoted by Hagstrom (1998, p. 165): "unlike scholars, risk is too complex to be evaluated solely by statistical means, as stated by financial theory". Sharpe (1976), for his part, points out that financial the-

ory is an abstract but rigorous theory, and that there have been attempts to model its behavior since its very beginnings.

The existence of Finance as a science responds to the specific characteristics of capitalist development, which are, as Chiavenato (2006) points out:

The development of new forms of capitalist organization. Enterprises with solidary partners (typical forms of commercial organization whose capital comes from the profits obtained, industrial capitalism) that take an active part in the direction of the business, gave rise to the so-called financial capitalism (p. 31).

According to him, financial capitalism has four main characteristics: *i)* The preponderance of bank and credit institution investments; *ii)* A vast accumulation of capital due to monopolies; *iii)* The separation between companies' ownership and management; *iv)* The development of *holding companies*.

In 1920, Dewing published *The Financial Policy of Corporation*, where he lays the foundations of the classic vision of a company's financial management. Later, in the thirties, during the USA Great Depression, Keynes (1939) published the *General Theory of Employment, Interest and Money*, where he set forth a series of possible responses to the economic crisis unleashed all over the world after the New York stock exchange crash of 1929.

Around the nineteen-forties, Schneider (1944) published and elaborated a methodology for the analysis of investments, which established the criteria for financial decisions. In the 1950s, with the creation of complex information systems, the possibility for financial managers to have a greater mound of information that would allow them to make decisions began to open up. Thus, they began to develop complex analytical tools and research techniques for their operations and decisions. The works of Markowitz (1958) on the Financial Asset Balance Model, and those of Modigliani and Merton (1958) were also published during that decade.

From here on, it was necessary to draw up lines of work that would allow the research and analysis of financial markets, creating Financial Economics (FE) as a vast field of research. In this sense, Marín and Rubio (2001) point out that

Financial economics consisted simply of a collection of anecdotes and rules without any scientific content, with a focus solely on enhancing purely descriptive knowledge. The equilibrium nature of capital markets and their consequences in financial asset valuation in a world of uncertainty were totally ignored [...] the mistake of attempting to value assets on an individualized basis was made taking into account exclusively payment flows generated by these companies [...] in modern finance theory it is clear that the value of assets cannot be understood without referring to the prices of other securities existing in the economy (p. 5).

In the nineteen-seventies, Ross set forth the Arbitrage Pricing Theory (APT) (1976) which aims at linear modeling the expected returns of a financial asset; the rate of return derived from the model is used to estimate the asset price. Markowitz and William Sharp (1990) presented the Investment Selection Theory and the Capital Asset Pricing Model.

In practical terms, Finance can be understood as Financial Theory, Corporate Finance, Public Finance, International Finance and Financial Management, among others (Parada, 2005).

Nowadays, Financial Engineering (FE) is the method through which financial instruments are used. It is “the part of financial management dealing with a combination of investment and financing instruments in the most appropriate way to achieve a pre-established objective” (Mascareñas, 1992, p. 34). It is based on the Put-Call²⁸ Parity Theorem, which is the fundamental theorem of Finance. This theorem is mainly implemented through the Black-Scholes model, which is used in financial mathematics to determine the price of certain financial assets, and was first published by Merton (1973). In this regard, Sánchez (2010, p. 7), states that “this model, although having some rough points in its demonstration, has proven to be a very useful tool in the valuation process of certain types of derivatives”.

²⁸ The Put-Call Parity refers to the relation between the value of a *call* and the *put* registered in the same stock market with the same strike price and the same maturity term. Specifically, the parity indicates that the sum of the *put* value and the stock market price is equal to the sum of the *call* value and the actual value of the strike price. This relation is independent of any price model.

Merton, Scholes, and Black developed a methodology for the valuation of derivative financial assets in 1973, modeling the dynamic behavior of prices through “Brownian movements”²⁹ (Balbas, 2008).

Understanding both the theory of trade and the development of international finance is fundamental to the development of the topic under analysis. Therefore, the following chapter digs deeper into the concepts that give foundation and substance to the analyzed variables.

²⁹ Random process to describe the behavior of variables that move in time. They were introduced into mathematical financial models to find answers to the problem of having large numbers of factors that influence the valuation of underlying assets. The pioneers in its use were Merton (1973) for the study of finance and Itô (1944) in the development of the stochastic calculation required in such models (Pérez, 2015).

II. Futures, Speculation, Financialization and Prices

This chapter develops the concepts that provide our research with theoretical substance. It begins with a definition of the futures market financial instruments in general and of commodities, in particular; then it defines what is meant by speculation and links this concept to that of financialization and its characteristics in the agricultural sector. Finally, we present the latest fundamental arguments on price creation and stipulation.

Futures and Commodities

Futures contracts are essentially forward contracts traded on the stock market. There are four characteristics that guarantee their functionality: *i)* The standardization of contracts that can in turn be elaborated according to the client's needs; *ii)* The Clearing house as a legally independent entity that guarantees all transactions; *iii)* The possibility of directly revaluing all positions and therefore paying or receiving daily margins³⁰ according to such revaluation; *iv)* The accelerated development in telecommunications that allows for the instantaneous transmission of news as well as the recording and monitoring of the total operation volume on a global scale. These, in

³⁰ As Mansell points out when referring to futures contracts, "margins" are different from "margin" as used in stock brokerage.

turn, guarantees one more characteristic that makes possible the success of futures markets: liquidity³¹ (Mansell, 1992).

A series of regulatory problems related to intellectual property rights slowed down the development of the futures contract concept during the seventies and early eighties (CME Group, 2013). However, by the beginning of the nineteen-eighties, its standardization and popularization became possible after the progress, on a global scale, of the relevant legal frameworks.

On the other hand, derivative financial instruments “are contracts whose price derives [...] from the value of an asset, which is known as the underlying asset of said contract. These underlying assets can also be financial instruments, [...] they can be physical goods such as gold, corn or oil” (Díaz & Aguilera, 2013). The objective of derivatives is to manage the risk that may result from unexpected movements in the prices of underlying assets both for the agents seeking to reduce such risk as well as for those who intend to run it.

However, the main function of derivatives is to serve as a hedge against fluctuations in the value of prices of the underlying assets; this is applicable to stock portfolios, payment obligations contracted at a variable rate, payments or collections in foreign currency at a certain term, and cash flow planning (Díaz and Aguilar, 2013).

Table 3. *Derivatives Classification*

<i>Financial</i>	<i>Non-Financial</i>	<i>Others</i>
• Currencies	• Basic Physical Assets	• Weather Conditions
• Interest Rates	• Grains	• General Price and Inflation Indexes
• Listed Securities	• Softs	
• Price Indexes	• Energies	
• Shares	• Metals	
• Bonds	• Meats	
• Credit Risk		

Source: Authors' own design (2019).

Commodities are products underlying a futures contract of an already established commodity exchange, *i. e.* the physical goods that constitute the

³¹ The ability to buy or sell quickly (Mansell, 1992).

basic components for more complex products. They are classified into grains, softs³², energies, metals, meats, financial, indexes and currencies. As Dunsby, Eckstein, Gaspar, and Mulholland (2008, p. 5) point out, investors do not actually invest in physical commodities themselves, but in the future of commodities.

Thus, when we talk about investments in commodities, we are talking about investments in the futures market; at the same time, the commodities index is the commodities futures index. Desireé (2008) sustains that

Primary products, such as coffee, sugar cane, wheat, corn, rice, beans, and sorghum, do not differ in their production phase, and their commercialization is generic, without brands that add specific value. Therefore, they are considered within the group of products known as agricultural commodities. But there are also non-agricultural commodities such as petroleum, gold, silver, copper, among others (p. 1).

Speculation

It was Marx (1894) who raised the first few notions on speculation in the financial sector and on its relationship with the assessment of the real economy. He considered this expression of capital to be fictitious³³ and used it to designate those financial assets whose value did not correspond with any real capital. However, because of the limitations of his time and of capitalism's degree of development then, he only analyzed public securities, share

³² Softs: Agricultural commodities originated from raw materials with a certain transformation process; these include products such as sugar, coffee, cotton, cocoa, and orange juice (Index mundi, 2017).

³³ This is an economic concept described in the relevant literature as a phenomenon alien to the process of real capital reproduction, and it is used together with the concept of speculation to explain the financial phenomena that take place in contemporary capitalism. As Pacheco (2006) points out, "The formal identity between speculation and fictitious capital is manifested in the widely extended concept of speculative capital. Speculative capital is generally understood as capital that is valued from the differences of interest rates produced between different countries. However, what is relevant at this stage of so-called global capitalism is not the existence of a particular form of capital that is valued based on speculation, but the transnational character of speculation itself" (p. 25).

capital, bank loans and real estate. He did not analyze the newest financial instruments such as notional amounts³⁴, which underlie derivatives traded on modern financial markets (Astarita, 2008).

It has been argued that, even from the classical point of view, “traditional” speculation would not generate any economic value. As De Schutter (2010) says, “a speculator, unlike other investors [...] does not generate new capital [...] if the speculator goes bankrupt, his creditors will have nothing to meet their debt” (p. 4). In Marx’s (1894) words:

capital³⁵ is revealed here as a mysterious and autochthonous source of interest, of its own increase (...). In interest-bearing capital, therefore, this automatic fetish of value that values itself, of money that bears money, appears in all its nakedness without unveiling in the least the traces of its birth (p. 373).

At the beginning of the nineteen-nineties, Bachelier (1990) published a doctoral thesis titled *Theory of Speculation* where he proposes the basic mathematical modeling of efficient markets and the valuation of options under the scheme of classical theory.

Marín and Rubio (2001) point out that

economic organizations [...], can be characterized as members of two alternative groups: companies, whose physical assets are the means of production for the economy and issue financial assets to finance their production

³⁴ The amount of the underlying asset in a derivative instrument where the underlying asset is generally not deliverable. They serve as a basis for calculating the final spot settlement or for calculating the sequential cash flows in the case of a multi-period instrument such as a swap.

³⁵ This refers to financial capital understood in general terms: capital loaned at interest, bank capital, and capital applied to different investment funds, as pointed out by Sweezy (1994), Amin (2008), Foster (2010), among others. However, it should be noted that for the Marxist theory, financial capital is composed in part of money capital and the portion of mercantile capital that specializes in the handling of money, banks, and all institutions that carry out monetary operations. It is important to differentiate it from productive capital which is one of the specific functional forms of capital value within the global cycle of industrial capital (“industrial, in the sense that it includes all branches of production exploited on capitalist bases” [Marx, 1885]). It also refers to capital that is occupied in the production sphere: its function is to create more value from already existing value.

activities; and financial intermediaries, which are holders and issuers of financial assets and only invest indirectly in physical or real assets (p. 4).

De Schutter (2010) says about traditional speculation that it is based on the market's most basic functioning (supply and demand) for any basic product. In turn, Mansell sustains that financial markets "are developed with the purpose of meeting the needs of risk managers, not those of speculators" (Mansell, 1992, p. 304). This is argued in response to the assertion that derivatives markets could become a haven for speculators, thus resulting in a destabilization of prices.

In this regard, Soto (2010) describes the two existing points of view; *i*) the orthodox view, which states that derivative financial instruments were created solely to reduce financial risks and improve financial efficiency through maintaining price stability; and *ii*) the heterodox view, which sustains that derivatives also serve as a means to carry out speculative activities with the goal of generating profits³⁶.

Productive Restructuring in the Agricultural Sector

Along with the economic development of the capitalist system, there have been a series of theoretical proposals that allow us to understand the structure of agricultural production. This has been so since before the implementation of the capitalist system, as in the case of the physiocrats,³⁷ who found an explanation to the generation and multiplication of wealth in agriculture. Smith (1976) describes the difference between agriculture in poor and rich countries, whereas Ricardo (1817) raises the Theory of Differential Rent of Land. Both proposals observe the importance of agriculture as a generating axis of wealth, just as those developed by the physiocrats. However, Smith and Ricardo gave rise to later critics on the origin of value in the Economy.

³⁶ Commodity futures contracts do not pay returns, so profits are derived from the increase in contract prices.

³⁷ School of thought postulating "the government of nature". They argued that human laws should be in harmony with natural laws. The most important representative was François Quesnay, whose *Tableau économique* (1759) contained the principles that the physiocrats would adopt as their line of thought.

Marx (1882) would later set forth a thorough criticism stating that neither land nor the agricultural sector generate wealth on themselves, as does the labor of wage-earning workers. He identifies a dichotomous social structure: a capitalist agriculture associated with land rent, and non-capitalist forms of production linked to smallholders and agricultural workers.

Towards the end of the 19th century, Kautsky (1903) highlighted the importance of agriculture under a capitalist production scheme which required the concentration of the most productive areas of those agents capable of applying greater technology; specialization schemes; and division of labor to the land. Consequently, Chayanov (1975) proposed the Theory of the Peasant Economic Unit³⁸. He stated that phenomena such as income, capital, prices, profits, and salaries in peasant economies do not always concur with classic economic schemes.

Anthropology³⁹ joined the analysis on the agricultural sector during the 19th century. It proposes that agricultural dynamics are not strictly driven by economic interests and highlights the need to incorporate cultural influences and social relationships such as “peasants’ kinship, mythology, values, attachment to land and cults, attitudes, beliefs and cognitive systems” (Flores, 2016, p. 9).

Redfield’s (1960) postulates laid the foundations for the creation of the Economic Commission for Latin America (ECLAC). Also, Heyning (1982) took up the neoclassical approach to analyze the traditional-modern⁴⁰ dichotomy. Later, the structuralist proposal criticized this dualist position and argued that both poles are the result of the same historical process. Warman’s theoretical proposal (1976) states that the business system keeps a symbiotic relationship with peasants even though this complementarity is asym-

³⁸ Wage-earning work is absent from peasant economic units, and exploitation comes from the family, peasants, and artisans (Aricó, 1981). The peasant mode of production differs from the capitalist industrial mode of production mainly because of the dynamics of family work units which explain the functioning and rationality of the peasant economy (Flores, 2016).

³⁹ Science that studies physical, social, and cultural aspects of human communities (Ramírez, 1994).

⁴⁰ He identified two figures: *i*) Capitalist and industrial sectors are receptive to change, oriented towards the market, seeking to maximize profits; *ii*) The traditional agricultural sector is based on subsistence production with scarce surpluses for commercialization; the goal of production is not necessarily to obtain profits.

metrical. Within this trend, it is important to highlight Gutelman (1974) and Bartra (1974).

As for the productive restructuring of the agricultural sector, it is understood as the global restructuring process suffered by the capitalist economy from the last few decades of the 20th century onwards. There have been several attempts to characterize this phenomenon, however, Contreras (2015) points out that there are multiple theoretical constructions, and the subject is addressed from different approaches and methodological points of view. Therefore, trying to understand the phenomenon entails identifying both the characteristics and determining factors of the restructuring; and the methodological approach from which the responses are constructed.

In this regard, Contreras (2015,) points out that there are at least four emblematic theoretical approaches: “*i*) Manuel Castells’ Theory of Post-industrial Society; *ii*) Alain Touraine’s Theory of Modernity; *iii*) Sergio Zermeno’s Thesis on the Theory of the Defeated Society; and *iv*) The concept of Neoliberalism” (p. 41).

In global terms, the visible face of agricultural restructuring is shown since the beginning of the 21st century, through the price volatility of the products that make up the sector, especially in cereals. In addition, Flores (2016) states:

The determining factors of the production chain in the agricultural sector are: social conflicts, political factors, the subsidy regime, physical and chemical conditions of arable land, diseases and pests in crops, infrastructure, technology, labor, the type of seeds cultivated and, especially, climate-frost, snow, drought, and rainfall regime (p. 1).

He also points out that these are some of the factors that impact international price mobility.

In the Mexican case, as of the last decades of the 20th century, there has been a series of structural reforms. It all started with the deregulation of the administrative rules that supposedly hindered the functioning of markets. Some of the high points of this process were: an economic opening; the entry in 1996 to the General Agreement on Tariffs and Trade (GATT); just

after NAFTA in 1994; the privatization of Mexican productive and industrial plants; and an overall decentralization, among others (Flores, 2016).

It should be noted that this process resulted in the abatement of most of the subsidies to the countryside. Therefore, the entrepreneurial sector, whose profitability was strongly linked to these subsidies, had to make internal and external adjustments in order to adapt to the new competitiveness conditions. In terms of the agricultural workforce and labor market, the signing of NAFTA and the opening of trade brought about a deep regional economic and social polarization throughout the countryside (Flores, 2016).

Rubio (2010) points out that speculation in agricultural prices resulted in a food crisis, as the aim of agricultural production is no longer human and animal food, since it has become a speculative commodity⁴¹. He identifies a relation between two main aspects during the capitalist crisis: *i*) the financial dimension and *ii*) the characteristics of energy requirements. Institutions such as the United Nations' Food and Agriculture Organization (FAO) also recognize that, during the past decades, the goal of agriculture has transitioned to become, not only the backbone of nations' food supply, but also a new possibility regarding energy production. This corresponds to two structural problems: food insecurity in countries with production deficits and the increasing demand for alternative energy sources (FAO, 2017).

One possible reason behind this restructuring process is the current fragility of global agri-food systems. Rubio (2010) states that these are currently undergoing an exhaustion phase due to the extreme concentration of world food production in just a few countries. In such countries prevails an elite of producers⁴² inclined to displace the domestic agricultural industries of other countries and decapitalize their production plant. This great concentration of markets weakens the stability of supply, and prices fluctuate in the face of any minimal provocation. Thus, the market becomes a "breeding ground" for speculation.

This restructuring production process has a direct influence on the pricing of agricultural products. This has induced scholars and government

⁴¹ As well as the production of energetics.

⁴² By 2008, 55 percent of world cereal exports were concentrated in four countries: USA, France, Canada, and Argentina (Rubio, 2010).

agencies worldwide to set forth a series of alternatives to industrialized and hyper-concentrated agricultural production. Flores (2016) points out some of the tasks that these new proposals for agricultural production need to work on: *i*) Decrease in food dependency; *ii*) Increase in agricultural borders, production, and productivity; *iii*) Efficient use of farming water; *iv*) Increased research on the effects of transgenic or improved seeds and on the preservation of the biological and genetic diversity of native seeds; *iv*) Procurement of agricultural subsidies and transfers; *v*) Greater protection and opening of the sector, resulting in better incomes and wages for agricultural producers and workers; *vi*) Investments in the infrastructure network of zones, production units, and rural housing; *vii*) Establishment of fees and final destinations of the agricultural production for human food, biofuel, and animal consumption; *viii*) Research and innovation of agroindustry at all production stages to stimulate productivity and creation of value.

General Financing and Agricultural Sector Financing

There are several analyses and approaches to the notion of financialization; many authors agree that it is one of the defining features of present-day capitalism. According to Mateo (2014), its roots can be traced back to authors such as Veblen (1904) and Keynes (1936), among others. However, Magdoff and Sweezy (1972) are pioneers in the use of the term. It was not until the 1990s that the use of financialization as a concept gained a generalized exposure.

From the mid-1970's and after the break-up of Bretton Woods, banking organizations reported their first signs of growth and expansion. Also, "new markets, such as Euro-currency and *off-shore*⁴³ financial centers began to be created. These revolutionized the dynamics of financial circulation [...]; it can be inferred that financial capital is determined on an international scale from the hegemonic points of the system" (Lichtensztein, 1984). Thus, the

⁴³ This term is usually applied to a company registered in a country (usually a tax haven) other than the country or countries where its financial activities take place. An offshore company is commonly used for activities such as captive insurance, offshore marketing, international shipping, or tax shelters (OECD, 2017).

effects on the economy are observable from at least two positions: those countries with the need to expand their capital and increase their accumulation margins; and those countries where the arrival of such international financial organizations has brought along financial capital growth.

Contemporary analyses of the financialization concept can be found in Galbraith's (2004) ideas. One way of characterizing the concept is based on Epstein (2005), who states: "financialization refers to the growing importance of financial interests, financial markets, and financial agents and institutions in the functioning of national and international economies" (p. 3).

Krippner (2005) defines it as "the accumulation pattern where profits are made through financial channels rather than through trade and production of goods" (p. 174). Other authors, such as Medialdea and Sanabria (2012), point out that financialization is a *new nature* in finance beyond the limits of quantitative growth, and that it "alters the economic operating procedures to a certain depth". Thus, it induces transformations in agents whose character is not financial in principle.

Financial globalization thus led to several changes in the financial systems (Soto, 2010) with Financial Deregulation being the main transformation. It was carried out during the Clinton administration in the USA, and it made possible the introduction of derivatives for risk diversification. This process is known as *Shadow banking*⁴⁴ and it was the boost required by speculative capital to take over the economy's physical markets, especially commodities (Rubio, 2010). It also prompted liquidity and profit for banks and for non-banking financial institutions (Soto, 2010).

Economies around the world soon began to keep pace with the transformations led by the United States. Subsequently, the deregulation and financial liberalization process gave rise to a relationship between deregulation-speculation and derivatives-crisis, which feed into each other (Soto, 2010).

The creation of futures markets laid the foundations for the prevalence of financial activities in the economy. However, it was the financial component of the 2008 crisis that gave formal birth to the process of financialization in the commodity sectors, mainly those of oil and basic grains (Rubio,

⁴⁴ Known in Spanish as "sistema financiero en la sombra" (Rubio, 2010).

2010). Thus, this major growth of financial markets and the massive use of derivative instruments had consequences on the stability of the economic system, impacting each of the productive sectors in its own way.

The Pricing Process

As for the behavior of futures contract prices, Mansell (1992) describes two fundamental reasons for the existing differences between financial futures prices and their spot prices on the one hand; and different prices between two different futures contracts on the other (*e. gr.* in monthly variations). Said reasons are: *i*) market expectations on spot futures prices; and *ii*) carrying costs⁴⁵. For Hull (2004), “the possibility of delivery [of what is stated in the contract] is what links the futures price to the spot price”.

There are several empirical studies aimed at assessing market efficiency. These studies describe the role of futures markets in the relation between spot prices and futures prices (Bekiros & Diks, 2008). Some of the authors who have addressed this issue are Garbade and Silver (1983), who proposed a model to discover the role of futures prices in establishing spot prices for commodity products. This model was later developed through the analysis of different commodities (Oellermann *et al.*, 1989; Schroeder & Goodwin, 1991; Silvapulle & Moosa, 1999).

Energy commodities, mainly oil, have shown faster progress in this type of analysis. In this regard, Bopp and Sitzer (1987) tested their hypothesis that futures prices have the possibility of predicting spot prices on the diesel market. In addition, there are other works that analyze market efficiency using cointegration tests (Serletis & Banack, 1990; Chen & Lin, 2004; Cologni & Manera, 2008).

Soto (2010) points out that derivative products, having the possibility of modifying relative prices of financial and non-financial assets, encourage and feed the formation of speculative bubbles that might result in waves of financial inflation, instability and crisis.

⁴⁵ It refers to the *cost of carrying the underlying asset in the futures contract to its maturity*; this can be positive or negative depending on whether futures prices are higher than spot prices and vice versa (Mansell, 1992).

Regarding Mexican corn, Ortiz and Montiel (2016) state that in the transmission process of corn futures prices from the CBOT market to the Mexican spot market, the price of corn futures market is not strongly related to the spot prices registered in some states of the country, so there is a disparity between both prices.

It is inferred that the relation between commodity speculation prices differs from that of fixed prices for many reasons. Said reasons become clear in the political and social factors that impact futures market prices. Above all, they are evident in the economic procedures of capitalism developed in recent decades, which will be discussed in the following chapter.

III. The Relation between Real Production and Speculation. Its Expression in the Agricultural Industry and the Futures Market

This chapter explains and develops the most important theoretical proposals used to analyze the relationship between real production and speculation in the agricultural industry. We go over several statements on the nature of futures instruments; the argument on the absence of arbitrage; and what Rubio (2010) points out about the “safe-haven effect”.

In the case of the agricultural industry, the creation of soybean futures in the CBOT in 1936 allowed the stability of futures markets as the USA became the largest producer and consumer of this grain (Mansell, 1992). It is documented that, at the beginning of the 1990s, the most advanced agro-industrial companies in Mexico were already using futures to cover coffee, orange juice and grain exports (Mansell, 1992).

During this period, risk managers were reported to have approximately 50% responsibility for the volume traded in the futures market, whereas only about 3% of the contracts resulted in physical delivery (Mansell, 1992).

From the beginning, futures trading presented a problem that Mansell (1992) identifies as follows:

If prices rose during the harvest season, farmers were faced with the enormous temptation to break their contract on arrival, as it required selling the grain at a lower price than they could expect on the spot market. Moreover, when the price hike was caused by drought or pests, many farmers did not

have the goods they had committed to deliver even if they were willing to comply with contract provisions. Also, when prices fell, buyers often did not fulfill the contract upon arrival, as they preferred to purchase the grain at lower prices on the spot market (p. 277).

These structural problems in financial futures, together with large margins in derivatives contracts, make it possible to obtain profits through speculation and create irregularities in the markets.

This situation opens the door to what Buffet (2002) called a dynamic that is easy to enter but almost impossible to leave. He stated that derivatives were like time bombs, both for the parties that deal in them as for the economic system⁴⁶. Years later, he would continue to make the same assertions,⁴⁷ which were finally confirmed by the 2008 crisis.

The derivatives market operates with overleverage, opacity, high risk and propensity for large speculative participations. Thus, it has been a key factor in motivating the economic bankruptcies and system crises of recent times (Soto, 2012). There is no comparison between the amounts of wealth managed in the financial market and the real or physical production market⁴⁸.

This is largely because a small amount of margin allows the investor to control a contract with a much larger nominal value and thus very substantial leverage (Mansell, 1992). The situation then allows investors to carry out speculative operations, generating high profit percentages with respect to the invested amount, and to manage high loss percentages as well (Díaz & Aguilera, 2013).

⁴⁶ Quoted as: "We view derivatives as time bombs, both for the parties that deal in them and the economic system" (Buffet, 2002).

⁴⁷ "Financial derivatives are indeed weapons of mass destruction [for the economy]. Since neither the people who created them nor the people who use them fully understand how they work, they are a threat. They have the power to get into debt the entire financial system as a whole, and magnify the effects of a crisis," said Warren Buffet in an interview with Lapetra (2008).

⁴⁸ "We are talking about a market (both organized and OTC) that went from 3.9 billion dollars in 1989, to 712 billion dollars in March 2012 at notional value. This means more than 10 times the world product" (Soto, 2012, pp. 60).

This idea opposes the statements of classical theory which posits a non-arbitrage⁴⁹ condition to keep markets in balance. Arbitrageurs⁵⁰ are supposed to exist only in as much as they can equalize the price of a given asset in the world financial markets where assets are traded. This behavior is called the “law of one price”⁵¹.

Empirical evidence shows that this does not happen in all cases and that there may be an incomplete price transmission. Some authors (Rapsomanikis, Hallam & Conforti, 2003) blame this on phenomena such as the trade policies and high transaction costs produced by deficient communication and transport infrastructures. Ultimately, this would lead agents to make inefficient decisions affecting the price level.

However, this is not the only contradiction identified in classical theory. According to the Theory of Market Efficiency, agents with rational expectations are supposed to use the best available information. Market prices should always reflect the fundamental values, and the social function of financial markets should be to correctly allocate capital among companies. This should be done in accordance with the information on expected future profit margins determined by market fundamentals.

Price formation has ceased to respond to agricultural market fundamentals and tends to reflect extra-sectoral factors. This is derived from the financial deregulation process and the growing wave of financial instruments utilization (Suarez, 2013). Spot prices are altered by transactions in the derivatives market, resulting in high levels of volatility and its subsequent effects. This phenomenon is contrary to the mechanisms explained by classical theory. There, market forces determine prices in a context of perfect competition and economic freedom (Wray, 2009; Soto, 2012).

There is an observed transfer of speculative capital from the agricultural industry to the futures market caused by lower profitability in the investment areas that traditionally generated the highest margins in the agricul-

⁴⁹ It is a strategy that seizes any profit opportunity arising from price differences (Feenstra & Taylor, 2012).

⁵⁰ “Operators who seek to acquire an asset in a given market in order to sell it immediately in another market at a higher price” (Aragonés & Mascareñas, 1994, p. 1).

⁵¹ “In the absence of friction [...] and on competitive terms [...] identical goods should be sold in different places at the same price if the prices are expressed in the same currency” (Feenstra & Taylor, 2011).

tural industry. This happened because risk managers considered that the behavior of commodities was not correlated with the behavior of stocks. Thus, commodities in general could be used to reduce portfolio risk, particularly those coming from the agricultural industry (Wray, 2008).

This phenomenon has been most visible since the 2007 financial crisis (Rubio, 2010). During this process, capital tends to migrate towards commodity futures, since food has served as a safe haven for speculative capital⁵²:

The “safe-haven effect” temporarily solves the speculative collapse but provokes an artificial increase in food prices [...] basic grains have become a safe haven for speculative capital and oil substitutes. However, these are fictitious ways out of the crisis, as commodities are profitable spaces for speculative investment; there is no real food shortage and stocks have been sufficient to meet world demand. So, once food uncertainty is overcome, capitals migrate again out of commodities in search of better investment spaces⁵³ (Rubio, 2010, pp. 6-7).

However, in the specific case of this industry, this process leaves behind food crises and price shocks. Rubio (2010) identifies the reasons why there is no real interest in regulating financial markets to settle the amounts of speculation on commodities, which are: the wide profit margins in countries like the United States⁵⁴ and the possibility for these countries to maintain and strengthen their geopolitical hegemony through agricultural products prices.

⁵² “Hoarding commodities would reduce volatility in portfolio returns [...] Money managers turn to commodity futures markets believing that commercial securities can be preserved better than commodities themselves. These money managers never want to take over the shipments. So, when the stipulated date arrives, contracts are moved on to other futures contracts with a more distant date” (Wray, 2008, p. 96).

⁵³ Rubio (2010) proposed a counterpart to the “safe-haven effect”: the “herd effect”. There, traditional hedge funds migrate to commodity futures if they lose profitability.

El País reported on 4th September 2011: “Drought in the financial markets pushes certain investors into raw materials. Hedge funds and banks now influence prices on Tunisia’s bread, Kenya’s flour, and Mexico’s corn. The World Bank is sounding the alarm for soaring food prices”.

⁵⁴ The companies that benefit most from large speculative profit margins are those with North American capital, some examples are Cargill, Monsanto, John Deere, Mosaic (Rubio, 2010).

It is worth noting that some companies have the possibility to manipulate raw material prices⁵⁵ either by “legal” means, through speculation, or by “illegal” means, such as stock or spot price monopolization. The argument is that contradictions occur in “legal” speculation. Although illegal means may sound more harmful, individual traders supposedly modify the prices of some base points illegally to make profits. By means of financial instruments, the futures market “could be quintupling prices through legal buy and hold strategies” (Wray, 2008, p. 91).

In addition to the financial crisis resulting from high speculation levels, this situation also creates a barrier to exit production crises. The prices of agricultural products have a direct impact on wages which, in turn, impact production costs⁵⁶. This generates an “economically perverse phenomenon” (Rubio, 2010). It is another contradiction to classical theory that consists of the incurrance of price hikes at the same time as production increases⁵⁷. It is a bubble on agricultural commodities that does not respond to the supply-demand assumption (Wray, 2008)⁵⁸. In macroeconomic terms, this generates inflation, higher commodity prices and higher import bills, among other things, in deficit countries. It has been pointed out that there is a wave of financialization of the agricultural industry, and it is not the only case; we can also add the metallurgical, construction, energy and other industries to the list, most of all being raw materials as well (Wray, 2008)⁵⁹.

⁵⁵ It has been stated that the most important markets, such as oil, soy, corn, and wheat, are too big to be manipulated beyond short periods.

⁵⁶ “High grain prices tend to raise the costs of industries and become an obstacle to wage reduction[...]high prices affect the demand of large population groups, reducing real wages and thus the power to purchase industrial goods” (Rubio, 2010, p. 9).

⁵⁷ As for agricultural commodities, the period between 2016 and 2017 registered record soybean crops (119 MT) and corn (385 MT) in the USA. In addition, there were historical levels of regional and global stocks of both products and wheat. Additionally, South America expected record soybean and corn crops for 2017, which would affect their price (Dejneka, 2017).

⁵⁸ “Contrary to what is taught in economics and business courses, markets generate perverse incentives for excessive risk. They punish those who resist with relatively low returns [...] and those who participate are rewarded; highly leveraged financing drives up underlying asset prices until the inevitable collapse occurs” (Wray, 2008, p. 82).

⁵⁹ “The price of eight raw materials had risen 500% or more by the end of June 2008: refined oil, nickel, crude oil, lead, copper, zinc, tin and wheat” (Wray, 2008, p. 87).

Having analyzed the existing relation between real production and speculation, it is necessary to land the argument on a defined geographical space and a specific product, to understand the process in practical terms. This will be discussed in the Referential Framework developed in the following chapters. Mexico's geographical, physical, and economic characteristics will be described together with the current situation of Mexican corn.

THIRD PART

REFERENTIAL FRAMEWORK

After having developed our research's theoretical bases, we need to define our specific area of study and key points, to understand the context of the phenomenon under study. The above will be reflected in the Reference Framework developed next. This framework is related to the Theoretical Framework as it links the theory with the analysis of reality, corresponding to a geographical and temporal context.

Two chapters are presented next. The first chapter describes Mexico's physical and economic geography, with special attention to the economic situation. In the second chapter, we discuss the recent data about Mexican corn.

IV. Mexico and Corn

This chapter presents four sections, each describing the region under study from a territorial, geographical, economic, and social point of view respectively. It also describes the agricultural industry: *i. e.* the perspectives of global agricultural industries and Mexico's agricultural industry.

Mexico's Location, Limits, and Borders

Mexico's official name, as stipulated in the Constitution, is The United Mexican States (E.U.M. by its acronym in Spanish). The country is located within the American continent, specifically in North America, between the extreme north latitude 32° 43' and the extreme south latitude 14° 32'. It has land borders to the north with the USA and to the south with Guatemala and Belize. As for the maritime borders, they are located in the East, with the Atlantic Ocean; the Gulf of Mexico; and the West Indian Sea, and in the West with the Pacific Ocean; and the Gulf of California (INEGI, 2017).

Article 42nd of the Political Constitution of the United Mexican States (CPEUM by its acronym in Spanish) stipulates that:

The national territory includes: the integral parts of the Federation; the islands, including reefs and capes in the adjacent seas; The Guadalupe Island and Revillagigedo Islands located in the Pacific Ocean; the continental plat-

form and the submarine bases of the islands, keys and reefs; waters of the territorial seas in the extension and terms established by international law and the internal maritime ones; and the space located over the national territory, with the extension and modalities established by international law (CPEUM, 2017).

It has a territorial extension of 758 451 mi², of which 756 469 mi² correspond to continental surface and 1 981 mi² to insular surface.

Figure 1. Mexico's Geographic division



Source: INEGI (2017).

Mexico is administratively organized as a federation consisting of 32 states and Mexico City (CDMX by its acronym in Spanish), which is the country's capital and the seat of the government (INEGI, 2017). All 32 entities make up the Mexican political division.

Table 4. *Federal entities, Their Capitals and Number of Municipalities*

<i>Federal Entity</i>	<i>Capital</i>	<i>Municipalities</i>
1. Aguascalientes	Aguascalientes	11
2. Baja California	Mexicali	5
3. Baja California Sur	La Paz	5
4. Campeche	Campeche	11
5. Chiapas	Tuxtla Gutiérrez	122
6. Chihuahua	Chihuahua	67
7. Coahuila de Zaragoza	Saltillo	38
8. Colima	Colima	10
9. Durango	Victoria de Durango	39
10. Guanajuato	Guanajuato	46
11. Guerrero	Chilpancingo de Bravo	81
12. Hidalgo	Pachuca de Soto	84
13. Jalisco	Guadalajara	125
14. Mexico City	—	16 (burroughs)
15. Mexico State	Toluca de Lerdo	125
16. Michoacán de Ocampo	Morelia	113
17. Morelos	Cuernavaca	33
18. Nayarit	Tepic	20
19. Nuevo León	Monterrey	51
20. Oaxaca	Oaxaca de Juárez	570
21. Puebla	Puebla de Zaragoza	217
22. Querétaro	Santiago de Querétaro	18
23. Quintana Roo	Chetumal	11
24. San Luis Potosí	San Luis Potosí	58
25. Sinaloa	Culiacán	18
26. Sonora	Hermosillo	72
27. Tabasco	Villa Hermosa	17
28. Tamaulipas	Ciudad Victoria	43
29. Tlaxcala	Tlaxcala	60
30. Veracruz	Xalapa-Enríquez	212
31. Yucatán	Mérida	106
32. Zacatecas	Zacatecas	58

Source: Author's own design, based on data from INEGI (2017).

Mexico's Economic Geography

Economic geography is understood as the set of effects that the geographic characteristic of a given territory have on its economy (Esquivel, 2000). In general terms, Mexico's economy is divided into three main sectors which

are largely determined by economic geography and by the features of the social sectors existing within the Mexican economy.

Economic sectors

1. **Primary or agricultural:** those referring to the exploitation of natural resources such as agriculture, forestry, livestock, mining, and fishing.

2. **Secondary or industrial sector:** which is characterized by the predominant use of machinery for the transformation of raw materials. It is divided between the extractive and transformation industries, both of which are, in turn, subdivided into specific sectors such as construction, manufacturing, energy production, etc.

3. **Tertiary:** which involves trading goods and providing services, as well as the communications and transport subsectors (INEGI, 2017).

Table 5. *Shaping of Mexico's Economic Sectors and Subsectors*

<i>Primary or Agricultural</i>	<i>Secondary or Industrial Sector</i>	<i>Services Sector</i>
<ul style="list-style-type: none"> • Agriculture • Cattle Raising • Silviculture • Fishing • Mining 	<p>Extraction Industry</p> <ul style="list-style-type: none"> • Mining • Coal and derivatives • Iron ore • Non-ferrous metallic minerals • Quarry sand, gravel and clay • Non-metallic minerals • Energy extraction • Petroleum • Gas <p>Manufacturing Industry</p> <ul style="list-style-type: none"> • Food, beverages, and tobacco • Textiles, clothing, and leather industry • Wood industry and wood products • Paper, paper products, printing, and publishing • Chemicals, petroleum products, rubber, and plastic • Non-metallic mining products, excluding petroleum products and coal • Basic metalworking industries • Metal products, materials, and equipment • Other manufacturing industries 	<ul style="list-style-type: none"> • Trade • Hotels and Restaurants • Transport • Communications • Financial Services • Real Estate Leasing • Professional Services • Education Services • Healthcare Services • Government Services • Other services

Source: Author's own design based on data from INEGI (2017).

The nature of economic relations prompts a necessary bond among economic sectors. This relationship is measurable in macroeconomic terms through the input-output⁶⁰ matrix proposed by Leontief in 1936. The most recent input-output matrix for Mexico was carried out by INEGI in 2012, based on the Mexican National Accounts System. It shows both intersectoral relations as well as those among national economic agents.

Table 6. 2012 Domestic Input-Output Matrix by Activity Type
(The amounts are listed in millions of pesos)

Activities	2012 Domestic Input-Output Matrix by Activity Type					
	Primary Activities	Secondary Activities	Tertiary Activities	Intermediate Demand	Final Demand	Final Use
Primary Activities	67,495	389,075	49	456,619	306,269	762,888
Secondary Activities	122,085	2,892,870	1,000,912	4,015,868	9,339,182	13,355,050
Tertiary Activities	43,736	1,404,873	1,673,097	3,121,706	9,070,021	12,191,727
National Intermediate Consumption	233,316	4,686,818	2,674,058	7,594,193	18,715,472	26,309,665
Imported Intermediate Consumption	53,992	3,208,380	499,909	3,762,280	1,513,889	5,276,169
Tax on Net Subsidies on Products	-3,517	-40,858	-108,791	-153,166	635,193	482,027
Total Uses at Buyer's Prices	283,791	7,854,340	3,065,176	11,203,307	20,864,555	32,067,862
Gross Value Added	479,097	5,500,710	9,126,552	15,106,359		
Total Production of the Economy	762,888	13,355,050	12,191,727	26,309,665		
GDP	475,580	5,459,852	9,017,760	14,953,192	635,193	15,588,386

Source: INEGI (2017).

Social Sectors

From the point of view of administrative and organizational sociology, economic organizations and institutions can be grouped into four main sectors: *i)* The Private Sector; *ii)* The Public Sector; *iii)* The External Sector; and *iv)* The Social Sector (Alcacer, 2000 and Velázquez, 2008). Together, they are called “Social Sectors” and they are composed of the economic agents involved in the economic process and in social development.

⁶⁰ It is an instrument to interpret the interdependence of the economy's various sectors. It describes the transactions between real economy sectors and analyzes the effect of final demand variations among sectors in a situation of equilibrium (Márquez, 2014).

Table 7. *Social Sectors*

<i>Private</i>	<i>Public</i>	<i>External</i>	<i>Social</i>
Private and professional organizations that provide services to the economy	Federal, municipal, and state government institutions	Companies of foreign origin	It is integrated by all forms of organization of social and civil origin focused on the production, distribution and consumption of socially necessary goods and services

Source: Authors' own design based on data from Velázquez (2019).

Some examples of the division of Mexico's social sector are: *i*) Companies with Mexican capital: Bimbo, Cementos Mexicanos, La Costeña, Teléfonos de México (Telmex), Fábrica de Jabón La Corona, Refrescos Pascual, among others; *ii*) State-owned companies: Pemex, Federal Electricity Commission, Mexican Institute of Social Security (IMSS by its acronym in Spanish), Institute of Security and Social Services for State Workers (ISSSTE by its acronym in Spanish), Bank of Mexico (BM), among others; *iii*) Foreign companies: Procter & Gamble, Citibank, General Motors, among others; *iv*) Social Organizations: *ejidos*, workers' organizations, communities, cooperatives outside the formal financial system, civil associations (Velázquez, 2008).

Retrospective of Mexico's Economic Indicators

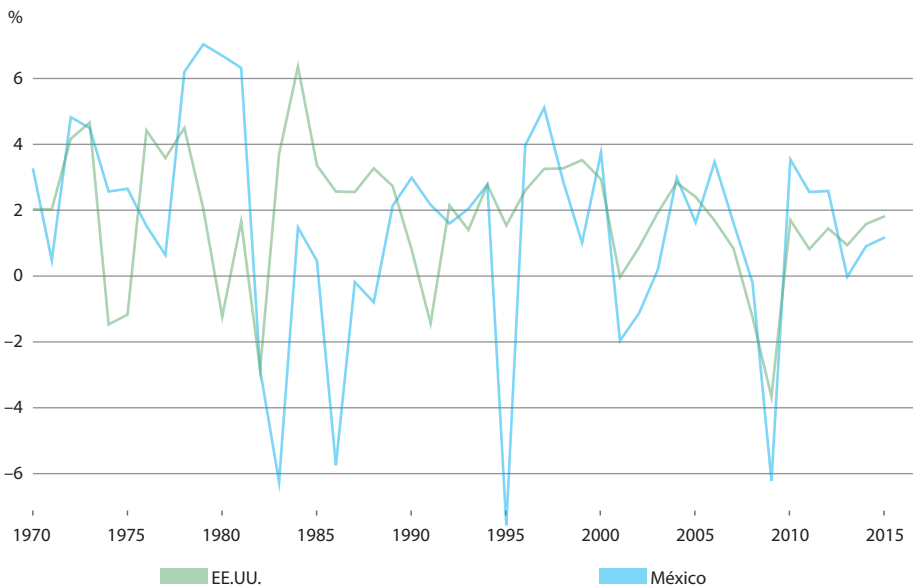
By 2016, the GDP had a 2.3 rate, registering a decline of two percentage points from the 2.6 recorded in 2015. WB reported that the factors driving annual growth in 2016 were: private consumption (mainly), low inflation, workers' remittances, credit expansion, higher real wages, and job creation in the formal sector (WB, 2017).

Under this scenario, the WB projects that Mexico's economy is undergoing a deceleration process due to the global growth and trade stagnation context. Other factors include the increase in fossil energy prices, mainly oil, and the decrease in capital flows (WB, 2017).

By the end of the year, improvements in national growth were reported because of the boost given to non-oil exports, while oil exports reported

highs. For 2016, the Center for the Study of Public Finances (CEFP by its acronym in Spanish) indicated the growth and decline percentages in the economic activity by sector: primary activities grew by 6.2 percent towards the fourth quarter; secondary activities deteriorated by falling 0.2 percent; and tertiary activities lost dynamism by rising 3.2 percent (CEFP, 2017).

Figure 2. Comparative of USA and Mexico GDP's Annual Percentage Growth Rate Per Capita in local Currency, at Constant Prices



Source: WB National Accounts Data and OECD National Accounts Data (2017).

Regarding the monetary and financial sector, the international markets showed high volatility⁶¹ due to the uncertainty caused by the USA presidential elections. In addition, Mexico's low economic growth and the challenges of stabilizing public debt posed serious risks. On December 9th, the rating

⁶¹ "A term describing the variability of a share price. The most common measure of volatility is the annualized standard deviation of returns, which is used in the Black-Scholes option pricing model. The volatility of the underlying instrument is generally favorable for an option because even in stock movements against the option holder, the loss on the option is limited unless a large movement in its favor leads to an extremely high return. Since it is impossible to know how volatile a stock will be in the future, historical volatility is often used as a reasonable estimate" (FIRA, 1995).

agency known as Fitch⁶² changed the economic outlook for Mexico from stable to negative, although the credit rating remained stable at BBB+⁶³. Later, Moody's and Standard & Poor's⁶⁴ followed the same trend by changing their ratings too (CEFP, 2017).

The Bank of Mexico (BANXICO by its acronym in Spanish) has proposed a systematic increase in the interest rate, in order to counteract inflationary pressures and keep inflation expectations anchored against the possible risks derived from Mexico's relationship with the USA. Therefore, in 2016, it stipulated the reference interest rate twice, once on November 17th at 4.75 percent, and the other one on December 15th at 5.75 percent (CEFP, 2017).

At the beginning of 2017, BANXICO planned to continue its policy of raising the interest rate. On February 9th, March 30th, and May 1st, it increased to 6.25 percent, 6.50 percent and 6.75 percent respectively (WB, 2017). By the end of 2017, it closed at a 7.06 rate, based on forecasts by the private sector (CEFP, 2017).

As for the Index of Prices and Quotes (IPC by its acronym in Spanish) of the Mexican Stock Exchange (BMV by its acronym in Spanish), it closed at 45 642.9 units at the end of the fourth quarter of 2016. It is understood that it operated under schemes of volatility and uncertainty from late 2016 to early 2017 due to the bilateral political process between the USA and Mexico. Other factors included the expectations for the normalization of the USA monetary policy by the Federal Reserve.

However, recovery was not long in coming, and by the end of January 2017, the IPC reached 47 001.06 units (CEFP, 2017). As of the fourth quar-

⁶² Also known as Fitch Group, Fitch Rating or Fitch Inc. It is an international credit rating agency based in New York and London that offers several products and services for the financial industry (Fitch Ratings, 2017).

⁶³ "It is the security level of the fund; it is derived from the evaluation of factors that include primarily: quality and diversification of the portfolio assets, strengths and weaknesses of management, and acceptable operating capacity" (Díaz & Aguilera, 2013).

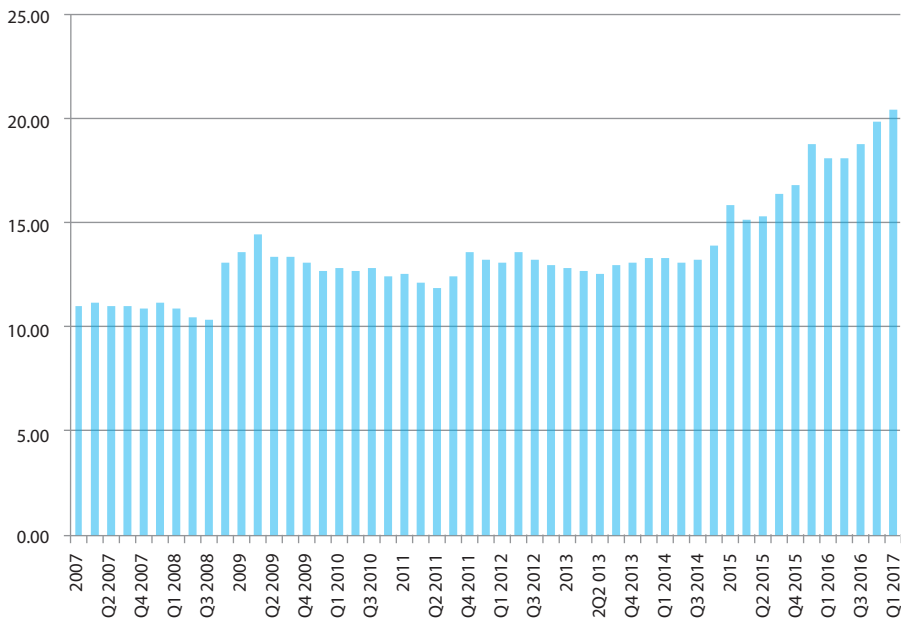
⁶⁴ Moody's is a securities rating institution authorized and supervised by the Banking and Securities Commission. It performs sector analyses for: corporate, financial institutions, public finance, insurance, investment companies, project finance and structured finance (Moody's, 2017).

Standard & Poor's or S&P Global Ratings is a rating agency that provides high quality market information through its credit ratings, analyzes and articles (S&P Global, 2017).

ter of 2016, the foreign exchange market showed signs of uncertainty and volatility, with the Mexican peso rising against the USA dollar in the first and second quarters of 2017.

The CEFP (2017) points out that this situation derives from four factors which, in turn, summarize the general economic unease: *i)* The USA presidential elections process and results; *ii)* The expectations on the bilateral relationship between Mexico and the USA; *iii)* The perceived strength of the USA dollar against other currencies due to the expectation of changes in the USA fiscal policy; *iv)* The prospects and evolution of international oil prices.

Graph 1. 2007 Annual and Quarterly MX/USD Exchange Rate Up to First Quarter 2017



Source: Author's own design based on data from the International Monetary Fund (IMF) (2017).

The private sector expected the exchange rate to be 21.21 by the end of 2017 (CEFP, 2017); Currency futures contracts consulted at the beginning of 2017 in the CME Group were quoted between 20.61 and 21.57 pesos per US dollar, according to the contracts to be delivered in March, June, September, and December 2017.

The Agricultural Industry

Global Agricultural Outlook

The agricultural industry is one of the world's economic pillars. Agricultural systems are crucial for the welfare of humanity as they meet a wide range of needs; they are at the center of food security while also providing vital supplies for the processing industry. Both the Organization for Economic Co-operation and Development (OECD) and the Food and Agriculture Organization of the United Nations (FAO), point out that "Agriculture is a key sector for the achievement of many of the goals set in the Sustainable Development Agenda 2030. This is oriented towards the end of poverty and hunger and the promotion of people's prosperity and well-being" (OECD, 2016). These international organizations analyze, from a global perspective, the central role of international trade in ensuring the food security of countries, due to the geographical dispersion of food supply and demand.

During the last decades of the 20th century and the first decade of the 21st, the whole agricultural industry was characterized by a strong demand, which together with low agricultural reserves, resulted in high prices. This situation encouraged agricultural sectors to find economic incentives and favorable conditions to increase their production capacity, which led to an increase in global agricultural production.

However, the phenomenon could not last. Data on agricultural crops at the global level, obtained in the past few years, reported reductions in the production of most crops by 2015, compared to the high levels reached in 2014. On the price side, a large number of products have suffered systematic reductions due to various factors *i)* slow increases in demand; *ii)* high inventory levels; *iii)* continuous and strengthened supply; *iv)* weak economic growth and abundant stocks (OECD, 2016). In this regard, many products, especially grains, reached historic lows⁶⁵ (OECD, 2016). The culmination of this decade and the beginning of the next is expected to pose different

⁶⁵ Products such as oil seeds (rapeseed, sunflower, peanuts), wheat (with lower price levels than ever since 2009), cotton, corn, among others. The exceptions were soybeans, which increased prices during 2015, and sugarcane (OECD and FAO, 2016).

challenges, largely because of the slowdown in economic growth. It is not possible to state that the price levels of agricultural products are on a full downward trend because each product features its own specificities. However, FAO does predict that the overall growth in global demand for agricultural products will be slower (FAO, 2017). The organization also added that “weakening agricultural markets make the sector less attractive for investment, limiting total growth in agricultural production to 1.6% per year on average” (OECD, 2016, p. 40).

It is also expected that yield improvements in terms of efficiency will be responsible for at least 80 percent of the total production growth. Also, the number and extension of crops will increase by 4 percent, with Brazil and Argentina being the countries with a greater expansion forecast. A regionally divided perspective proposes the following figures (FAO, 2017):

- **South and East Asia:** It is the world’s largest agricultural production region, with global yields of 40 percent for cereals and 60 percent for vegetable oils⁶⁶. Its production is expected to grow by almost 20 percent in the coming years, mainly through intensification policies and efficiency improvements.
- **North America, Latin America, and the Caribbean:** This region dominates the world’s oilseed production, with cereals as its second most important agricultural products, holding 90 percent and 30 percent of the world’s production respectively. Forecasts for the next few years indicate that both corn and soybean production will increase by 10 percent. Although surpassed by Asia, this region has a vast untapped agricultural area, making agricultural expansion possible. Latin America as a region is the most important source of agricultural area expansion in the world, with a 24 percent cultivation area.
- **Sub-Saharan Africa:** It is one of the poorest agricultural producing areas, and it is expected to have a growth slowdown in the coming years. However, it registered some expansion of arable land. Regional policies propose the implementation of a series of policies to improve

⁶⁶ Especially palm oil

productivity with the aim of expanding total agricultural production by 2.6 percent per year, over the next ten years.

- **Eastern Europe and Central Asia:** Over the past few years, this region has increased its agricultural production by 42 percent due to productivity gains, producing 10 percent of the world's cereals between 2013 and 2015. Agricultural activity is projected to expand by 13 percent during the next decade.
- **Western Europe:** This region produces 13 percent of the world's cereals, specializing mainly in individual mixed crops such as corn, sugar beets, oil seeds, roots, and tubers. The area under cultivation is expected to be reduced by 3 percent in the coming years.
- **North Africa and the Middle East:** Agricultural production in this region is limited mainly by two factors: an unstable political situation in several countries, and unfavorable natural conditions, which means that the region's share of world production is very low. As a result, production is based mainly on crops with low water requirements such as wheat (which accounts for 60% of the harvested area). Production is expected to remain low in the coming years, accounting only 4% of the world's production.
- **Oceania:** The region's world cereal production is minimal at 2%, yet its high export levels make it an important region in terms of international trade. It is expected to increase its production by 11% in the next decade, mainly in products such as sugar cane and cereals.

Agricultural Industry in Mexico

Regarding the agricultural industry, FAO has the objective of conceptually homogenizing its own methodology with the sectors' data recovery methodologies; thus, it points out the following:

a commodity or basic species is involved in many indicators needed to monitor and evaluate development policies, food security, and progress towards the achievement of the Millennium Development Goals. The products or species and their associated data must feed into the System of National Ac-

counts and the global balance of supply and demand for food, as well as other agricultural products. The basic data must be related to the crops or species that have the highest proportion in land use and contribute significantly to the well-being of production units and rural households (ENA, 2013, p. 8).

In order to achieve this, it is important to have a systematization and analysis scheme for agricultural data at the international and national levels. In this sense, several organizations and institutions dedicated to the agricultural sector⁶⁷ have set forth a series of proposals for our country.

Table 8. *Structure of Agriculture in Mexico According to Data from ENA 2012*

<i>Agricultural Cycles</i>	<i>Intercrop Farming</i>	<i>Protected Agriculture</i>	<i>Protected Agriculture Technology</i>	<i>Alternative Agriculture</i>	<i>Agricultural Technology</i>
<ul style="list-style-type: none"> • Spring-Summer • Autumn-Winter • Perennials 	<ul style="list-style-type: none"> • Mixed Crops • Associated Crops • Intercrop Farming • Per Sown Hectare 	<ul style="list-style-type: none"> • Nursery • Greenhouse • Shade House • Shade Net • Macro Tunnel • Plastic Film Mulching • Other 	<ul style="list-style-type: none"> • Thermal Screen • Cold Room • Wet Wall • Extractors • Fans • Irrigation Pumps • Agrochemicals Sprinklers • Drip Irrigation Systems • Sprinkler Irrigation Systems • Fogging Irrigation Systems • Fertigation Systems 	<ul style="list-style-type: none"> • Biodynamics • Hydroponics • Bioponics • Aquaponics 	<ul style="list-style-type: none"> • Fertilizers • Biofertilizers • Plant Food • Creole Seed • Improved or Certified Seed • Genetically Modified or Transgenic Seed • Herbicides • Insecticides • Moisture Sensors • Optical Crop Sensor • Drafts or Yoke Animals • Tractor • Seed Drills • Harvesters • Biological Pest Control • Tree Grafting • Crop Rotation • Pruning • Controlled Burns • Conservation Tillage • Technical Support • Organic Agriculture Certificate • Other

Source: Authors' own design based on data from ENA (2012).

⁶⁷ Some examples are INEGI, FND, FIRA, ASERCA, among others.

The National Agricultural Survey (ENA by its acronym in Spanish) (2012) describes agriculture as a part of the primary sector that “includes the sowing, cultivation and harvesting of plant species”, and features general forms of cultivation: annual (seasonal) or irrigation.

Figure 3. *Map of the Distribution of Irrigated and Seasonal Crops*

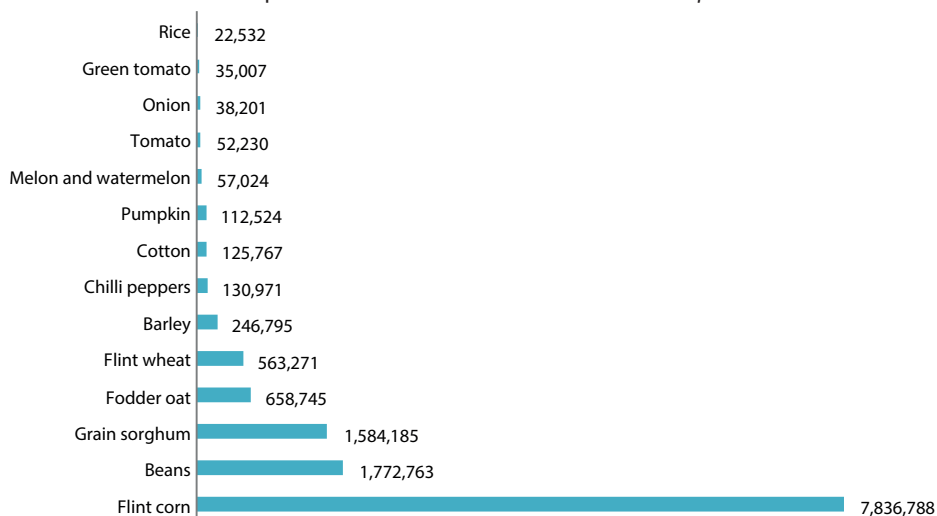


Source: INEGI (2017).

The INEGI (2017) lists the 29 agricultural products as the county’s main GDP contributors. Together, they represent 80% of the primary sector: corn grain, fodder corn, sugar cane, grasses, potatoes, melon and watermelon, coffee, oranges, grapes, bananas, lemons, wheat grain, avocado, sorghum grain, beans, grains, chilies, alfalfa, tomatoes, mango, onions, pumpkins, green tomatoes, cotton, apples, cocoa, barley and soybeans. Many of them also coincide with the agricultural products listed by the Mexican System of National Accounts (SCNM by its acronym in Spanish): corn, sugarcane, beans, coffee, wheat grain, rice, and sorghum grain.

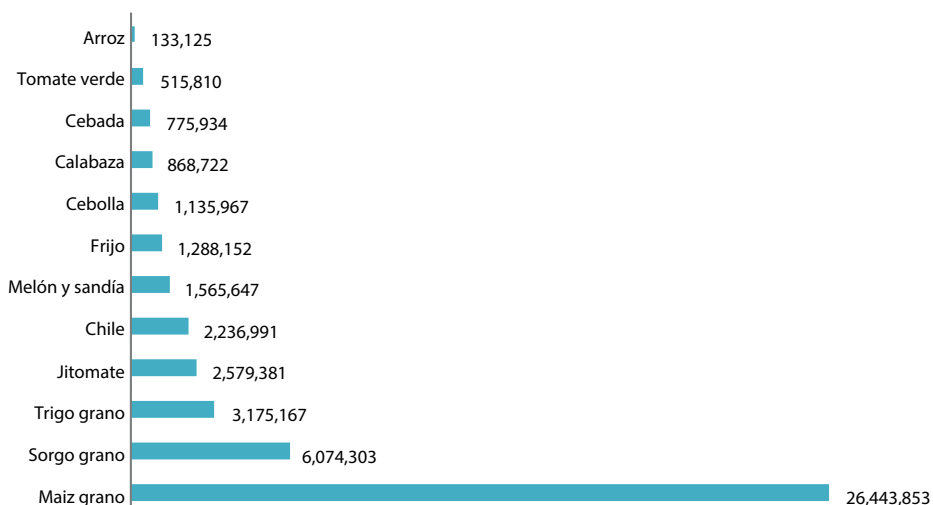
Corn grain is the most important annual crop, with 7.8 million hectares and 26.4 million tons of production, other crops worth highlighting are beans, with 1.9, and grain sorghum, with 1.6 million hectares (INEGI, 2017).

Graph 2. Number of Hectares of Main Annual Crops



Source: ENA (2012).

Graph 3. Amounts Produced of Main Annual Crops



Source: ENA (2012).

Having outlined a geographic, social, and economic description of Mexico in general terms, with special attention to the economic situation, the next chapter will address more specific data on the recent situation of Mexican corn.

V. The Situation of Mexican Corn

This chapter provides an overview of the situation of corn in the national context. It begins by describing its characteristics; then it describes its participation in financial markets as a preamble to describing the process by which corn futures are beginning to be used in Mexico.

Due to its unique characteristics, corn is the most important Mexican crop. All Mexican entities grow corn to a greater or lesser degree, but there are seven states that have historically concentrated more than half of the volume of the national production (SIAP, 2012). Sinaloa is at the top of that list as the main producer, in addition to being the state with the most placements in futures markets (Ochoa, 2011). There are three main uses for corn in Mexico: *i*) Human food; *ii*) Fodder; *iii*) Manufacture of starches, oils, and fuels such as ethanol.

Corn is also a very important element in the Mexican diet, and it makes it possible to ensure food availability all year round, not only in rural but also in urban areas. Corn is one of the most sensitive crops, since it directly affects the whole economy through prices. In this sense, Ortiz and Montiel (2016) point out that:

The cyclical nature of agriculture, its financial dependence and the behavior of the climate mean that grain production in Mexico takes place in an environment of uncertainty, which is reflected in the trend of grain prices and in producers' incomes (p. 3).

When international trade opened up to corn, producers' incomes were affected by the market saturation caused by foreign corn imports (Ochoa, 2011) at harvest time. The price tended to fluctuate, so corn producers were affected and sought alternatives that would allow them to reduce risk. One of the ways to deal with such price fluctuations was obtaining futures on agricultural products and thus guaranteeing some security.

The first yellow corn futures contract in Mexico was introduced by MexDer. At first, they listed the Chicago Mercantile Exchange Group (CME Group) corn futures contracts, and FIRA acted as the government's financial agent to use hedge contracts for the price of several agricultural commodities. This role would be later played by the Agency for Services for the Commercialization and Development of Agricultural Markets (ASERCA by its acronym in Spanish). This agency was created in 1991 as a decentralized administrative body of the then Secretariat of Agriculture and Hydraulic Resources (SARH by its acronym in Spanish) "with the purpose of promoting the commercialization of agricultural production for the benefit of producers, in the face of international openness and market liberalization" (ASERCA, 2017, "Historical Background" section, § 1) as well as to lessen the negative effects of the sector's financialization, foreseen by the implementation of risk coverage in Mexican agriculture.

This program began using a price hedging scheme that emerged in 1993, initially to cover the fall in cotton prices and later to cover the price of corn through *put* and *call* options (Ortiz & Montiel, 2016). The SAGARPA authorized the sale of futures on Mexican agricultural commodities as of 1993. This action derived from the public-private production partnership that made the 1992 agrarian reform possible, in addition to the liberation of Mexican finances in 1986.

During this period, and because of the 1994-1995 crisis, agricultural activity was seriously affected by the cyclical effect of demand and by climatic and natural factors; one of the most affected products was corn. Therefore, the State maintained a subsidy on corn prices and a controlled price regime through the National Company of Popular Subsistence (CONASUPO by its acronym in Spanish) until 1996. As of that year, the program began to be used for the acquisition of stock instruments in the CBOT, mostly by producers of white corn, the underlying product being yellow corn quality US#2.

Ramos (1996) states that as a result of the 1995 crisis in Mexico, agricultural activity as a whole was seriously affected by the cyclical effect of demand and also by climatic and natural factors, with corn being one of the most affected products.

Later, derived from the 2008 financial crisis, the decline in the domestic market in Latin American economies led to global lags in the consumption of agricultural products. Thus, producers began to lose income which ultimately limited their financing power. However, the main transmission effect of Mexico's crisis was seen in the manufacturing sector; the impact on the agricultural sector was not as drastic (Basurto & Escalante, 2009).

During this period, corn prices did rise because of an increase in ethanol production. This created great uncertainty and drove speculative capital to buy and sell assets on Mexican corn (Rubio, 2010).

As of 2012, the first ENA was carried out in Mexico, where the latest national data on Mexican crop production were collected. That same year, the MexDer was created, and SAGARPA presented the first yellow corn futures contract in Mexico. This was intended to benefit producers, traders, industrialists, and financial investors in the agricultural sector (SAGARPA, 2012).

By 2014, the FND reported that corn participated with 18% of the production value of the agricultural sector with an estimated value of \$88 billion pesos in 2012, and \$78 billion pesos in 2013; and that it concentrated 33% of the planted area in the country. By March 2016, a deficit in yellow corn production was reported in Mexico along with an increase in the price of the USA Dollar. This eventually influenced the prices of basic products.

Basurto and Escalante (2009) state that financial penetration in Mexico's agriculture is limited and heterogeneous as it depends on the agricultural structure; the product in question; land tenure; and productivity, among other factors.

In terms of financing, the availability of resources depends on the size of the producers within the sector and is mostly oriented towards small producers (Basurto & Escalante, 2009). The three main sources of access to credit in Mexico are commercial banking, development banking and the informal financial system.

This chapter offered the physical characteristics, production, and situation of corn during the past decades. It is now necessary to understand the

operational structure and normativity of the institutions through which futures on said product are traded both in MexDer and in the CBOT. This will be discussed in the following chapter.

Fourth part

NORMATIVE FRAMEWORK

After developing the variables under study and the situation of Mexican corn, we proceed to identify the existing laws, regulations and provisions at work in the futures market, since its legal functioning is a significant part of the current analysis.

To visualize the origin of speculation in futures markets in the countries under study, it is important to know the regulatory elements of futures at a global level, specifically those concerning yellow corn. This is based on references from both MexDer, in the case of Mexico, and the CBOT, in the case of the United States.

VI. Futures Market Structure

This chapter elaborates on the general structure of the futures market and describes the structure of the Mexican and the USA futures market. We also present a thorough description of MexDer's operation in Mexico, and CBOT's in the USA.

The historical origin of futures markets dates back to the Middle Ages; their fundamental objective was to provide the possibility of reinvestment in agriculture and to guarantee future trade prices (Hull, 2004). However, its generalization and organized birth took place in the city of Chicago, USA during the second half of the 19th century as this became the center of grain trade in the New World.

The goal was to face the risks resulting from the variations in the purchase and sale prices of grains. However, the issue of contract compliance soon arose due to the characteristics of the futures market creation process. Therefore, to standardize advance contracts, Grain Exchanges were created along with an institution called Clearing house which would act as an intermediary and legal seller to facilitate transactions and reduce risk (Mansell, 1992).

The operation of buying and selling contracts was initially carried out using the *open-outcry*⁶⁸ system, in which the agents were physically present

⁶⁸ Translated into Spanish as "*sistema de corros*".

at the time of the transactions. However, the sophistication of futures exchanges and the development of technology and communications opened the possibility of developing the market's activities electronically: *electronic trading*⁶⁹(Hull, 2004).

In the futures markets, the characteristics of each agreement must be specified in detail in every contract. Such characteristics are: the type of asset, the size of the contract (or the quantity to be delivered), the place and date of delivery, and the possible alternatives for the delivery procedure.

There are roughly three types of participants in the futures markets: *i)* Risk Managers; *ii)* Speculators; *iii)* Brokers (Mansell, 1992). They are integrated as follows:

Table 9. *Futures Market Participants*

Speculators		Risk Managers	Brokers
They buy and sell future instruments to take risks in exchange for profits		Institutions that buy and sell future instruments to manage risk	Divisions of firms providing international financial services, subsidiaries of commercial and/or investment banks, subsidiaries of firms specializing in spot markets, or independent individuals
Floor Traders / Locals	Off Floor Traders		
Scalper Traders	They pay	Firms	Futures Commission Merchants
Position Traders	commissions for	Financial Institutions	Floor Brokers
Spreader Traders	their operations	(Commercial Banks,	Futures Brokers employees
Intramarket Spread	Day Traders	Investment Banks, Securities	Freelancers or Floor
Intermarket Spread		Brokers, Insurance companies,	Commissioners
Intracommodity Spread		Central Banks, Government	
Financial Arbitrageurs		Agencies)	

Source: Authors' own design based on data from Mansell (1992).

However, not all transactions are carried out through organized markets. For instance, OTC markets consist of telephone and computer networks of agents who do not need to have physical presence in the market. Yet OTC transaction amounts are often "much larger than in organized markets" (Hull, 2004). This type of private trading is often used to hedge⁷⁰ goods without specific futures instruments. However, the risk of contract breach by either party is usually higher.

⁶⁹ Translated into Spanish as "*actividad comercial electrónica*".

⁷⁰ Hedging: Buying and selling securities to reduce risk; the goal is to achieve perfect protection for a risk-free portfolio (FIRA, 1995).

Mexico

Mansell (1992) points out that banks such as BANAMEX, Banca Cremi and Banca Serfín inaugurated divisions to handle futures on the USA and London stock exchanges from 1988 onwards.

Published on July 18, 1990, the Law to Regulate Financial Groups (LRAF by its acronym in Spanish) still applies to existing financial groups⁷¹. There are a wide range of organizations that can belong to these groups, such as stockbrokers or multiple banking institutions, among others. However, although these groups can form single organizations constituted by various credit institutions, they are integrated into a single entity in the form of a corporation offering a wide range of financial services (Díaz & Aguilera, 2013).

The Securities Market Law (LMV by its acronym in Spanish) has been in force since December 30th, 2005. Its very first article establishes that “Its general observance in Mexico is of public order, and it has the purpose of developing the stock market in an equitable, efficient and transparent way; it must protect the interests of the investing public, minimize systemic risks, and promote a healthy and regular competition” (LMV, 2014). Furthermore, according to the revised May 6th, 2009 bill, article 104 section VI bis was added by means of a decree, stating “the obligation of issuers to disclose information in order to present periodic reports on the positions they maintain in derivative financial instruments, as well as the possible contingencies on the financial situation” (LMV, 2014).

On May 26th, 1997, the “Provisions of a Prudential Nature to which Participants in the Exchange-Listed Futures and Options Market shall be Subject in their Operations” were published in the Federal Official Gazette (DOF by its acronym in Spanish). It stipulates: *i*) The preliminary provisions outlining the concepts to be used by the law; *ii*) The Stock Exchanges’ description; *iii*) The operators’ characteristics; *iv*) The description of the structure and functions of clearing houses; *v*) The characteristics of liquidity providers; *vi*) General provisions; among others (DOF, 1997). These provi-

⁷¹ Unions of financial institutions that operate as integrated groups prior authorization of the SHCP (Díaz & Aguilera, 2013, p. 21).

sions have undergone five amendments to date; the most recent was published in the November 23rd, 2011 DOF; It sought to harmonize provisions with the corresponding laws and to incorporate “the operations that traders and settlement partners conduct with derivative contracts in foreign markets, while complying with their responsibilities and obligations [...] the nomenclature of derivative contracts listed on Mexican market exchanges stands out from those listed on foreign markets” (DOF, 2011).

MexDer, Mercado Mexicano de Derivados, S.A. de C.V., was created on December 15th, 1998 as the Mexican Derivatives Exchange. It was created to satisfy specific requirements and functions for the management of derivatives markets, and it offers both futures and options contracts. It is constituted as a variable capital corporation, authorized by the Ministry of Finance and Public Credit (SHCP).

MexDer’s mission is defined as follows:

Contribute to strengthening and developing the Mexican Financial System through the consolidation of the Mexican derivatives market as a basis for risk management of the Financial Institutions in it, as well as of companies and investors in general; offer a wide range of derivative instruments listed or registered, managed, cleared and settled with the highest degree of security, efficiency, transparency and credit quality (MexDer, 2017, “The Derivatives Exchange” section, § 3).

Participants have three possible positions: traders, liquidity providers or market makers (see table 4). There are four institutions working together: *i*) MexDer as a set of derivatives; *ii*) Asigna Clearing and Settlement: the clearing house acting as a management and payment trust; *iii*) Liquidity providers; and *iv*) Trading members, which are not necessarily required to be shareholders in order to operate. Both MexDer and Asigna are self-regulated entities under the supervision of the SJCP, the Bank of Mexico and the National Banking and Securities Commission (CNBV by its acronym in Spanish), which provide the necessary facilities and services to carry out their activities.

Table 10. *Division of MexDer Participants*

<i>Traders</i>	<i>Liquidity Providers</i>	<i>Market Makers</i>
They trade contracts on MexDer's Electronic Trading System as commission agents for one or more liquidity providers.	They perform the following functions: <ul style="list-style-type: none"> • Assess counterparty risk • Segregate collateral • Avoid conflicts of interest 	Permanently maintain purchase or sale quotations of: <ul style="list-style-type: none"> • Futures contracts • Options contracts of the class in which they are registered to promote their negotiation.

Source: Dias and Aguilera (2013).

Brokerage contracts carried out by traders or liquidity providers on behalf of third parties subscribe to a second brokerage contract signed by each client. Each contract establishes four basic aspects: *i)* The description of risks to customers participating in the execution and acceptance of futures contracts quoted on MexDer; *ii)* The customer's recognition of MexDer and Asigna regulations in addition to the rules issued by financial institutions; *iii)* Specification of the communication means to be used in sending, receiving and confirming trade orders; *iv)* Acceptance and recognition of limit positions in derivative contracts; *v)* Acceptance and recognition of Asigna as counterparty in MexDer's derivative contracts (Diaz & Aguilera, 2013).

Asigna, as a clearing house, is an administration and payment trust established in 1998 by BBVA Bancomer. Its goal is to clear and settle the derivative product operations carried out at MexDer (MexDer, 2017b). It mainly acts as a counterparty and guarantor of all financial obligations arising from the operation of traded futures contracts.

Asigna's mission is defined as follows:

Offer clearing, settlement and risk management services for derivative financial operations, providing participants with the highest degree of security, transparency and credit quality at competitive prices. Ensure the orderly development of derivatives markets and contribute to the strengthening of the Mexican financial system with a self-sufficient operation and the highest standards of technology and staff qualification (Asigna, 2017, "Mission Vision" section, § 1).

Although it is a self-regulating entity⁷², Asigna is legally governed by the following financial authorities: SHCP, CNVB, BM, the regulations stipulated in the Mexican stock market, the aforementioned “Provisions of a Prudential Nature to which Participants in the Exchange-Listed Futures and Options Market shall be Subject in their Operations,” and the “Rules to which companies and trusts involved in the establishment and operation of an exchange-listed futures and options market shall be subject” (DOF, 2010). It has an internal regulation, a manual to which market participants adhere, and a set of decision-making collegiate entities. These are composed of a technical committee; an admission and risk management subcommittee; an administration subcommittee; an audit subcommittee; a disciplinary and arbitration subcommittee; and a regulatory and ethics sub-committee (MexDer, 2017b).

Asigna previously followed a system called INTRACS/400, through which it performed registration, clearing and settlement functions (Díaz & Aguilera, 2013). It currently operates through a system called CLEAR-MX⁷³, which performs novation, registration, clearing, collateralization, margining, market valuation, settlement, and risk management functions. This clearing house is made up of liquidity providers that act as management and payment trusts constituted by the eight main financial groups established in the country: *i*) Actinver; *ii*) Banamex; *iii*) HSBC; *iv*) BBVA Bancomer; *v*) GBM Stock Exchange; *vi*) J.P. Morgan; *vii*) Santander; and *viii*) Scotiabank Inverlat (Asigna, 2017).

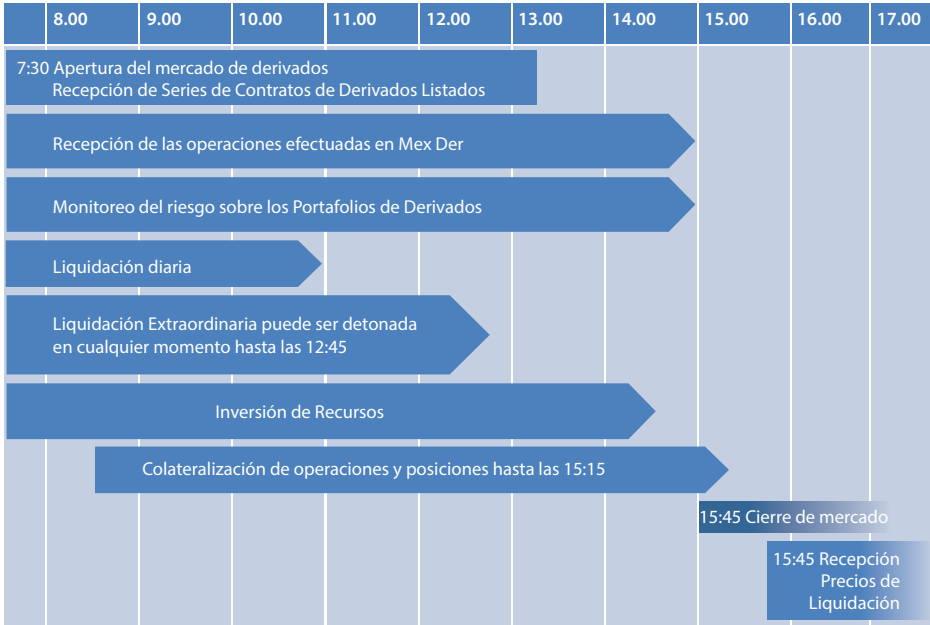
Asigna’s operations are linked to MexDer’s schedules and cleared in real time. Thus, Asigna instantly records class, series, purchase or sale contract number and all the activities agreed upon by the liquidity providers and traders at MexDer. Then, these are electronically validated by the central allocation system; in case of any inaccuracies, they are rejected, and the market is notified for possible correction. Finally, risk is assessed on the derivative portfolios that are updated with the operations agreed upon during trading sessions. Market prices of both derivative contracts and un-

⁷² It has powers of supervision, judgement, and sanction of entities (liquidity providers) with which it interacts (Asigna, 2017).

⁷³ CLEAR-MX, Spanish acronym for: Clearing, Settlement, Electronics and Risk Management.

derlying assets are analyzed, verifying the adequacy of monetary resources⁷⁴ to mitigate clearing house exposure (Asigna, 2017) (see figures 4 & 5).

Figure 4. *Asigna's Operational Scheme*

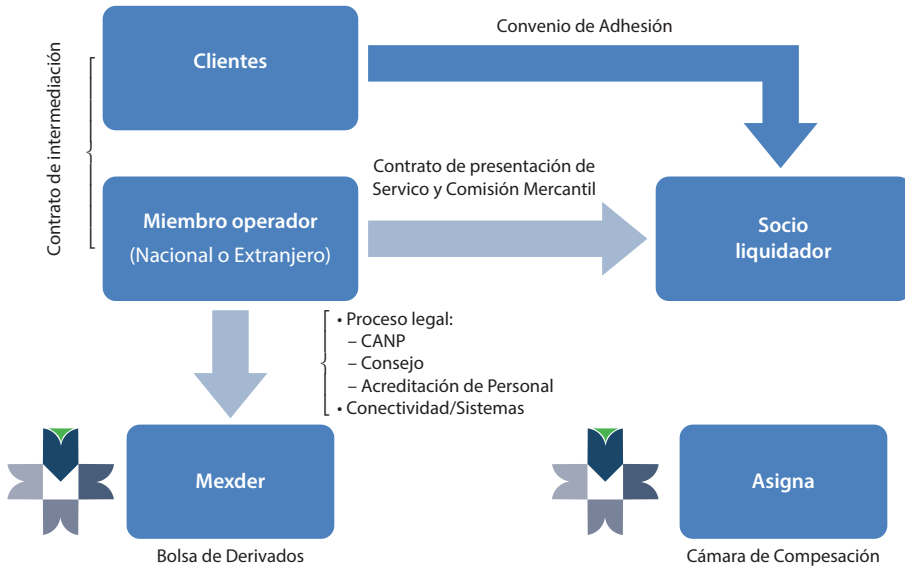


Source: Asigna (2017).

Although MexDer is part of the BMV group, it is independent and different from the BMV. However, the agreements entered by the BMV directly concern MexDer. For instance, an agreement signed in 2010 between the BMV and CME Group, in which electronic distribution networks were interconnected, allowed users to access both markets (MexDer, 2017b).

⁷⁴ Minimum initial contributions that participants deliver per open contract. These resources are used to cover price variations and are constituted in securities and/or cash in a Contribution Fund, managed and invested by Asigna (Asigna, 2017).

Figure 5. MexDer Participants Chart



Source: MexDer (2017).

The first yellow corn futures contract in Mexico was introduced by MexDer. CME Group’s corn futures contracts were initially listed, and FIRA served as the government’s financial agent to apply hedge contracts on the price of several agricultural products; this function was later performed by ASERCA (MexDer, 2017).

Table 11. Yellow Corn (MZ) Futures Trading Specifications
MexDer Yellow Corn (MZ) Futures Trading Agreement Specifications

Object	
Underlying asset	Yellow Corn quality US#2
Number of units of the underlying asset	25 metric tons
Series	MZ contract series: March, May, July, September, and December for up to three years MexDer can list new series for trading
Negotiating dynamics	
Symbol or ticker symbol	Identification of contract series by symbol or key
Estimation unit	Pesos per ton for Yellow Corn US#2 future price
Bid	Minimum fluctuation of \$5.00 MX pesos in bids to enter into contracts

Bidding value per futures contract	It will be \$125.00 MX pesos (bid by number of MZ tons covered by the contract)
Means of negotiation	Electronic procedures through MexDer's Electronic Trading System according to regulations

Negotiation Characteristics and Procedures

Maximum daily fluctuation of future price	There will be no maximum future price during the same trading session
Trading hours	Business Days: 7:30 to 14:00 Mexico City
Trading hours at Daily Settlement Price (PLD by its acronym in Spanish)	The PLD will be calculated by MexDer at the end of each trading session. This price will be used by MexDer's liquidity providers and traders for firm positions Schedule of firm positions: 14:25 to 14:35 Mexico City
Last trading day and expiration date	The last Friday at least 2 business days prior to the last business day of the month preceding the series expiration month (if it is not a business day, the day immediately preceding it)
Negotiation of new series	It will start on the business day following its announcement date through the MexDer Newsletter

Daily settlement and settlement on maturity

Daily settlement	According to the brokerage contract
Procedure for settlement on maturity	Subject to the terms and procedures under which the daily settlement is executed on due date
Calculation of daily settlement price	Calculated by MexDer according to the following formula:

$$PL_t = \frac{PFC_t \times TCF_t \times 5000}{127 \times 100}$$

Where:

PL_t = Settlement price of MZ futures contract on day t , rounded to the nearest bid

PFC_t = Settlement price of yellow corn futures contract traded on CBOT with the same expiration month on day t

TCF_t = Forward Exchange Rate Peso/Dollar on MZ settlement date provided by a price vendor hired by MexDer on day t

Settlement price at expiration	Calculated according to the following formula:
--------------------------------	--

$$PL_t = \frac{PFC_t \times TCF_t \times 5000}{127 \times 100}$$

Where:

PL_t = Settlement price at maturity of MZ on day t , rounded to the nearest bid

PFC_t = Settlement price of yellow corn futures contract traded on CBOT with the same expiration month on day t

Tfx_t = The 24-hour value date exchange rate provided by a price vendor hired by MexDer on day t

The "Market Disruption Event" rule from CBOT's Rulebook should also be considered

Limit positions in futures contracts on MZ	
Limit positions in short or long positions and in the opposite position	Maximum number of open contracts of the same kind that a customer may have; it is set by Asigna and will be announced on MexDer's Newsletter
Limit positions for hedge positions	Customers may open long and short positions that exceed the limit positions set and published by Asigna to create a hedge position
Extraordinary events	
Fortuitous case or force majeure	MexDer and Asigna may respectively suspend or cancel trading, clearing and settlement of contracts according to regulations
Contingency situations	Both the auction schedule and the operating mechanism may be modified according to MexDer's Business Continuity Plan and Asigna

Source: Authors' own design based on data from MexDer (2019).

United States of America

The birth of futures markets in the USA and the world happened just as the CBOT and the *Chicago Produce Exchange* (CPE) were established in 1874 and 1874 respectively; the latter would later change its name to *Chicago Mercantile Exchange*. The objective of both institutions was to handle cash-advance contract transactions and enter into *to-arrive* contracts, specifying the quantity and price of grains to be delivered on an invoicing date (Mansell, 1992).

The CBOT was founded to link farmers with traders, standardizing the quantity and quality of the traded cereals; the first few contracts were of the *to-arrive*⁷⁵ kind (Hull, 2004).

The 1950 constitution of the CBOT stipulated to: “promote just and equitable principles in trade; discover and correct abuses; and support regulations and measures to ensure the prosperity of the trade and business community” (CME Group, 2017e, “Founded with Common Goals” section, § 1).

The CPE sought to provide a market for perishable agricultural products such as butter, eggs, and poultry, among others. However, overtime, markets became specialized in just a few products; such was the case of the Butter and Egg Board, which would eventually change its name to CME and begin to offer futures contracts on perishable products. Its 1919 constitution stipulated to:

⁷⁵ Contracts in which buyers and sellers privately agree on the terms of the sales to be executed upon the arrival of goods at a future date (Hull, 2004).

promote uniformity in the customs and usages of exchange; collect and deliver general useful information; facilitate a quick solution to any business dispute arising among members, for the full benefit of cooperation in fostering their legitimate activities (CME Group, 2017e, “Founded with Common Goals” section, § 3).

The CME began offering currency futures in 1972 (Hull, 2004).

At the beginning of the 1980s, the CME’s business model became widespread along, with the development of futures exchanges around the world. One example is the *London International Financial Futures Exchange* (LIFFE), which was supported by the CME during its construction and development process. Furthermore, by 1984, the CME created the first global futures association agreement in the industry and developed a joint system with the *Singapore Monetary Exchange* (SIMEX). Years later, it would activate the CME Globex system, a pioneering model for electronic futures trading.

During the 1990s, the CME began the demutualization⁷⁶ and centralization of its decision-making procedures, due to a global increase in the futures markets competition. The purpose was to strengthen the competitiveness and assertiveness of the strategies employed, under a new international finance context and through the development of global electronic banking. By 2002, the CME became the first futures exchange to sell public shares through Public Offerings⁷⁷. Then, in 2006, the CBOT implemented this scheme as well (CME Group, 2017e).

After more than a century of rivalry, the CME and the CBOT merged in 2007. Also, the CME Group acquired NYMEX in 2008, adding energy

⁷⁶ “It is a worldwide trend where stock exchanges are converted from member-managed non-profit entities to shareholder-controlled for-profit companies (corporations). This demutualization is commonly carried out in three stages: -The first is to incorporate a corporation and assign a membership exchange value for a certain number of shares. -The second stage consists of giving more participants access to the operation, even if they are not shareholders of the stock exchange. Moreover, electronic operation systems make this access possible for both national and foreign entities. -The third and final stage consists of listing the shares of the stock exchange itself on the local stock exchange. Some of the stock exchanges that have carried out this complete process are Germany, Euronext (Paris, Brussels and Amsterdam), Australia and London” (BMV, 2017).

⁷⁷ T initial placement of securities among the investing audience (BMV, 2017).

commodities and precious metals to its previously listed products (CME Group, 2017e).

The CME Group currently offers contracts in five different DCM's: CME, CBOBMVT, NYMEX, COMEX and CME Europe. It trades futures and options based primarily on interest rates, stock indexes, energy, currencies, agricultural commodities, and metals. As for raw material derivatives, it offers contracts from all USA exchanges, making it possible to trade in a wide variety of commodities (CME Group, 2017).

Table 12. *Products Featured in the CME Group*

<i>Agriculture</i>	<i>Energy</i>	<i>Shares</i>	<i>Currencies</i>	<i>Interest Rates</i>	<i>Metals</i>
• Corn Futures	• Crude Oil Futures	• E-mini S&P 500 Futures	• Euro FX Futures	• Eurodollar Futures	• Gold Futures
• Soybean Oil Futures	• NY Harbor	• E-mini NASDAQ 100 Futures	• Japanese Yen Futures	• 2-Year T-Note Futures	• Silver Futures
• Soybean Futures	• Brent Last	• E-mini Dow (\$5) Futures	• Australian Dollar Futures	• 5-Year T-Note Futures	• Platinum Futures
• Chicago SRW Wheat Futures	• Day Financial Futures	• E-mini S&P MidCap Futures	• Sterling Pound Futures	• 10-Year T-Note Futures	• Palladium Futures
• Livestock Futures		• Nikkei/Yen Futures	• Canadian Dollar Futures	• USA Treasury Bond Futures	
• Pork Meat Futures		• Nikkei/USD Futures	• Swiss Franc Futures	• Ultra USA Treasury Bond Futures	
			• Mexican Peso Futures	• 30-Day Federal Funds Futures	

Source: CME Group (2017c).

Each one of the DCMs that make up the CME Group has specific regulations due to the fact that each one carries out different kinds of trades. They are regulated by the Commodity Futures Trading Commission (CFTC), where they are registered with self-regulatory responsibilities. Each of the regulations of the DCMs that make up the group has been designed to provide a common regulatory framework for market users along with a standardized legal, numbering, and language structure (CME Group, 2017d).

As for Globex, it is the largest electronic derivatives trading market in the world; its connectivity allows access to a wide range of futures products and options, available on any exchange in the world, 24 hours a day. Cur-

rently, it can be directly accessed from more than 150 countries and territories through internet connection and telecommunication centers. This platform allows direct connection (through services managed directly by the client or by the CME Group) and indirect connection (through private brokers, clearing firms, data centers or financial service providers). It has its own risk management interface and a series of tools to make transactions more efficient (CME Group, 2017a).

Figure 6. CME Globex Network Structure



Source: CME Group (2013).

The CME Group has a clearing house called CME Clearing. It is the most important central counterparty in the world, and it offers several services such as the stipulation of listed derivative contracts and the transaction of OTC contracts. CME Clearing holds twice-daily settlements to efficiently estimate the market price of each derivative and prevent the accumulation of losses and debt. It is responsible for settling exchange accounts, clearing exchanges, regulating delivery, and reporting accumulated data on daily transactions (CME Group, 2017).

The following section elaborates on the research methodology and on the development of a regression model using the OLS method, which allowed us to analyze the prices of the product under study.

Fifth part

RESEARCH METHODOLOGY

Method is essential to the process of scientific research. The employment of the appropriate method is key to the fulfillment of the outlined objectives. For this reason, the scientific method will be used as a central guide for this research. As Bunge (1975) points out, the scientific method is a procedure applied to the whole cycle of research in the frame of every knowledge related problem, it is the only way of practicing proper science.

The method used in this work constitutes a synthetic analysis. First, we separate the elements of the phenomenon described in the problem statement. Then, these elements will be brought together under a logical relationship, allowing for the achievement of the research objectives.

In the next part of the research, the empirical study carried out will be further developed. We will go through the definition of the variables and the econometric model. This model will be used to test the research hypothesis.

VII. Linear Regression Model for Time Series Data Design

This chapter consists of four sections. The first three correspond to the review of previous empirical studies from different points of view; the definition of variables; and the definition of the model, respectively. Together, these chapters set forth the design of the tools to be used in the empirical research. The last section consists of a simple linear regression model for time series data, corresponding to the series of physical prices of Mexican corn and the prices of futures traded in the CBOT during the time frame assigned to this research.

The goal of economic science is to understand the nature and functioning of economic systems. From the results of observation, analysis and information gathering processes, we move towards establishing theoretical models and empirical analysis tools that allow us to synthesize reality. In this sense, econometrics is proposed as a tool that allows for quantitative analysis of real economic phenomena based on a simultaneous development of observation and theory. These are related by inference methods as proposed by Samuelson, Koopmans, and Stone (1945) (Gujarati, 2010).

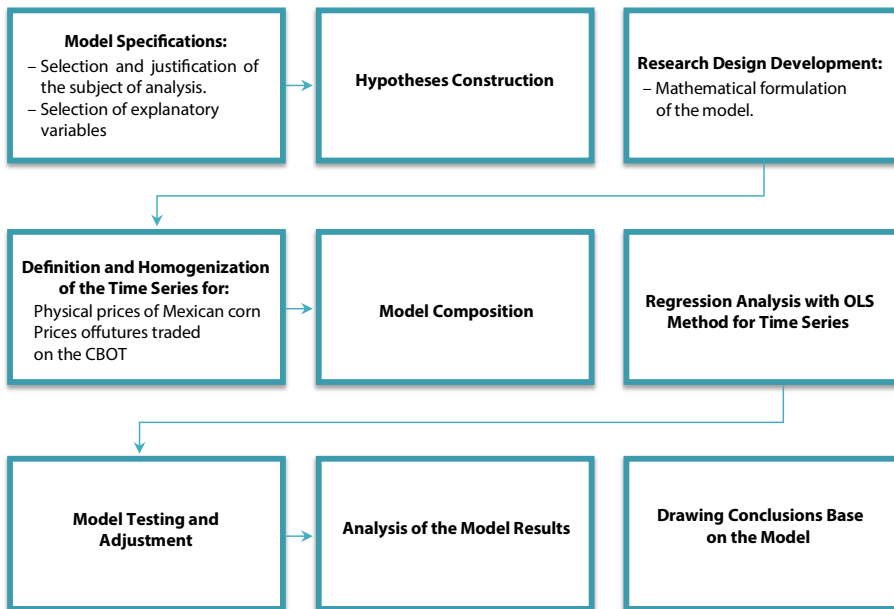
The term “econometrics” was introduced by Ragnar Frisch to refer to the economic analyses that made use of statistical methods during the late 19th and early 20th centuries. Since then, econometrics has been in constant development. However, some authors, such as Epstein (1987), suggest the existence of a modern econometrics, arising in the second decade of the 20th

century, based on proposals of Henry Ludwell Moore (Fernández & Adalid, 2000). Within econometrics, the OLS method contains statistical properties that have made it one of the most efficient and popular methods for regression analysis (Gujarati, 2010).

For the present research, we will use regression analysis along with the OLS method for time series data. This is a necessary and adequate tool to carry out correlations between the proposed variables and to test the general hypothesis according to the available information. Time series models take into consideration the scheme of past movements of a given variable and make it possible to identify any correlation with other variables over time.

For the purposes of data analysis in this paper, we set forth a specific critical path, which we used to carry out the research process and the model application in an orderly manner.

Figure 7. Research Critical Path and Model Application



Source: Authors' own design (2019).

Variables Definition

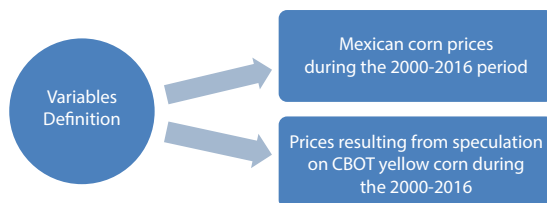
Two variables were used corresponding to two product prices from different markets: the physical market that handles spot prices and the financial market that handles stock prices resulting from speculation. The two series totaled 408 monthly observations.

The data series, consisting of the bulk of data totaled for both series, were requested from and provided directly by FIRA. This institution had the largest number of condensed periods for the series. The series consist of years 2002 to 2016 for the average monthly price in yellow corn distribution centers in Mexico, and years 1996 to 2016 for the closing prices of yellow corn #2 in the Gulf.

However, a complete and condensed series for the speculative prices does not exist, so it was constructed using the averages from the daily data obtained from secondary sources such as the National Information and Market Integration System (SNIIM by its acronym in Spanish) of the Ministry of Economy (SE by its acronym in Spanish). The series was compared with some of FIRA's data included in the databases provided; these contain both Reuters and CBOT sources. Both series were unified and made as consistent with each other as possible by reviewing their trends.

Data from both series were valued in nominal terms, so they show alterations over time between periods that do not allow comparisons between them. Thus, they were deflated in order to reflect constant prices taking 2010 as the base year, specifically the month of December, as indicated by INEGI (2017) in their database on the consumer price index and its components.

Figure 8. *Variables Definition*

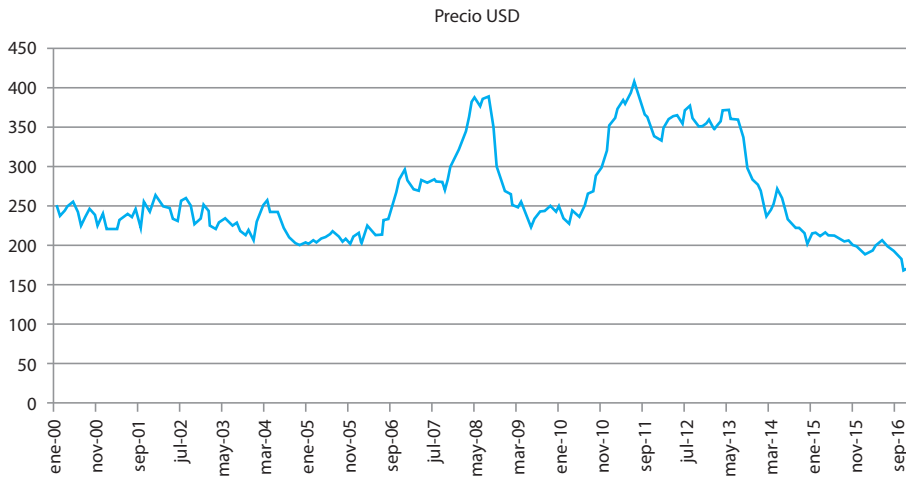


Source: Authors' own design (2019).

Mexican Yellow Corn Spot Prices (PS by its acronym in Spanish)

In order to construct this variable, we took into account the Mexican yellow corn monthly national average prices in distribution centers in Mexico, with data from the series provided by FIRA, which in turn averages the prices sourced from the SNIIM and the SE. Prices are registered in Mexican pesos (MXN), and the USD/MXN exchange rate was considered with monthly average quotes per publication date in the DOF, published by the Mexican Central Bank (BM). This made the study consistent with MexDer’s “Methodology for the estimation of bases and indifference prices”.

Graph 4. Variation in the price of Mexican yellow corn at constant prices 2000-2016



Source: Authors’ own design (2019).

Prices Resulting from CBOT Yellow Corn Speculation (PE)

This variable was estimated similarly to the previous one. However, the data series was constructed entirely based on the CBOT’s daily prices⁷⁸ of

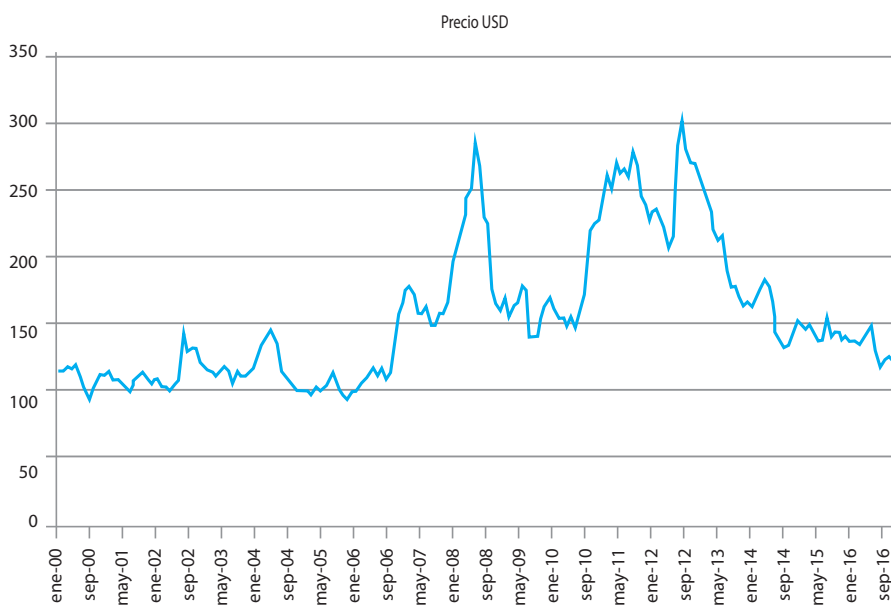
⁷⁸ Weekdays and non-holidays.

yellow corn #2 futures contracts in the Gulf. These can be found on SNIIM's website in the Foreign Markets, Grains and Seeds sub-section (SIIM, 2017).

The data from the contract series were used according to MexDer's "MZ yellow corn futures contract specifications", stated in Table 10, chapter 6 of this document. They correspond to the months of March, May, July, September, and December. Subsequently, simple averages were calculated to approximate the monthly prices of the entire series, because in one month there may be several contracts in force and there is no single reference price. It should be noted that the quality of the data obtained was not optimal, since no data were recorded for several months.

As indicated in MexDer's contracts, the unit of measurement is one dollar per metric ton; however, the original CBOT prices published by the CME Group come in bushels. To make the conversion, MexDer takes the conversion factor of 39.36825 metric tons per US dollar in its contracts, as stated in their "Methodology for the estimation of bases and indifference prices".

Graph 5. *Yellow Corn Price Variation Due to CBOT Speculation at Constant Prices 2000-2016*



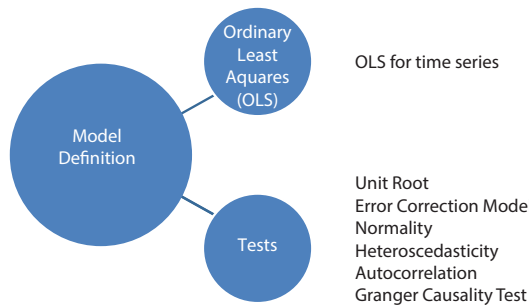
Source: Authors' own design (2019).

Model Definition

The model was chosen based on the characteristics of the data to be used; it was defined as a time series data regression model because of its periodicity.

For the purposes of this research, the law of one price is taken into account. As in the rest of the markets, arbitrage is expected to ensure the existence of one single equilibrium price (Godinez, 2006). However, the law of one price states that markets have a complete spatial and temporal integration and therefore, prices are determined instantly in all markets. Comparing two markets located in different spatial regions, this integration would cause the price differences to equal the transaction costs. Therefore, the expected value of the deviations from the price parity would be zero (Godinez, 2006). However, this relation is not perfect in reality; the relation models between spot and future prices seek to analyze the causality between them.

Figure 9. Model Definition



Source: Authors' own design (2019).

OLS Model

In econometric literature, the development of the OLS method is attributed to Carl Friedrich Gauss. It is one of the most widely used methods of statistical analysis due to its intuitive and mathematically simple features (Gujarati, 2010). This model allows estimations based on dependent and independent variables in such a way that the latter are explained (Núñez, 2007).

The model used was a single-equation statistical dependence regression model, so the mathematical notation of its stochastic sample regression function (SRF) corresponds to the following formula:

$$Y_t = \hat{\beta}_1 + \hat{\beta}_2 X_t + \hat{u}_t$$

Where Y_t represents the dependent variable, X_t the independent variable, \hat{u}_t the residual sample term or stochastic error, $\hat{\beta}_1$ the intercept and $\hat{\beta}_2$ the regression line slope, both betas are also known as least-squares estimators.

In the case of the analysis, if Y_t represents the price of Mexican yellow corn, for the data indicated above, we have $Y_1, Y_2, Y_3, \dots, Y_n$, where sub-index 1 denotes the month of January 2000 as the first observation and so on until December 2016.

The OLS method consists of selecting the SRF line in a way that the sum of residuals is the smallest possible. It is based on several assumptions: *i)* Linearity of the parameters; *ii)* Assuming X to be non-stochastic; *iii)* The mean value of disturbance u_t is zero; *iv)* Homoscedasticity or equal variance of u_t ; *v)* No autocorrelation between the disturbances; *vi)* The covariance between u_t and X must be zero; *vii)* The number of observations must be greater than the number of explanatory variables; *viii)* Variability in the values of X ; *ix)* The regression model is correctly specified; *x)* There is no perfect multicollinearity (Gujarati, 2010).

Gujarati (2010) states that compliance with these assumptions constitutes a checklist to guide the research, so they are the basis on which the OLS proof lies.

OLS Model for Time Series

Regarding time series, it is understood as a set of observations on the values shown by a variable at different periods of time. This information can be qualitative as in the case of dichotomous or categorical variables, or quantitative as in the case of data temporality (Gujarati, 2010). Empirical works based on time series are also based on the assumption of stationarity. If the series are not stationary, several complications can follow such as autocor-

relation, spurious regression problems and the random walk phenomenon in the case of financial time series (Gujarati, 2010).

In all econometric processes based on time series, several tests must be carried out to validate the assumptions and rule out the presence of any situation that could invalidate the analysis. This way, the structure of the model is developed according to the explanatory needs defined by the researcher.

Structure of the OLS Model for the Mexican Corn Spot Price Series and the Futures Prices Traded on the CBOT

This section will denote the explanation and the mathematical notation of each of the tests to be performed, based on Gujarati (2010).

Applied Tests

Stationarity

In the present analysis, we are looking for a stationary stochastic process⁷⁹, that is, one that has the following properties:

- Mean: $E(Y_t) = \mu$
- Variance: $var(Y_t) = E(Y_t - \mu)^2 = \sigma^2$
- Covariance: $Cov(Y_t, Y_{t+k}) = E[(Y_t - \mu)(Y_{t+k} - \mu)]$

That is, the mean, variance and covariance remain unchanged over time, but this is not possible for most economic series as is the case of the series under analysis. Since prices are involved, there are enough arguments to think that they are non-stationary and random as is the case with random walk models (RWM).

⁷⁹ "It is said that a stochastic process is stationary if its mean and variance are constant in time, and if the value of the covariance between two periods depends only on the distance or lag between these two time periods, not on the time in which the covariance has been calculated" (Gujarati, 2010, p. 772).

a) Graphic test

This test consists of graphing the series in search of possible patterns that intuitively describe the nature of the data. This is done prior to the formal tests to have initial clues to guide the data analysis.

b) Unit Root

Stationarity is one of the necessary elements in a price data series. It allows invariance over time as the mean, variance and covariance remain the same. If the time series is not stationary, the possibility of fully studying its behavior is lost, since it is not possible to generalize the data analysis (Gujarati, 2010). In order to verify this, we used a unit-root test.

The RWMs are described as follows:

$$Y_t = \rho Y_{t-1} + u \quad -1 \leq \rho \leq 1$$

It is specified that if ρ equals 1, it is known as a unitary root problem; therefore, it is non-stationary. The use of identifying a unitary root is to transform the series so that they present themselves as stationary. This is possible through the treatment of data and the differentiation of the series.

One of the most widely used tests to identify the presence of a unitary root is the Tau statistic test. It is known in the literature as the Dickey-Fuller test, which evolved over time into another more complete test known as the Augmented Dickey-Fuller test (ADF). In addition to containing the criteria of its older similar, the ADF integrates the possibility of analysis when the error term u_t is correlated.

The ADF is developed by “adding” the lagged values of the dependent variable to the equation. Analysis decisions are determined based on the following hypotheses:

$$H_0 = \text{Unit root}$$

$$H_a = \text{No presence of unitary root}$$

Cointegration

It is when two variables have a long-term or equilibrium relation. Granger (1986, p. 226) points out that “A test for cointegration can be considered as a pre-test to avoid situations of spurious regressions”.

a) Graphic test

In this test, the regression residuals are plotted in search of possible patterns that intuitively describe the nature of errors. This is done prior to the formal tests to have initial clues to guide the data analysis.

b) Regression Residuals ADF

This test is known as Engle-Granger test (EG), augmented Engle-Granger test or two-stage Engle-Granger estimation test. It was developed in 1987 based on the ADF statistic, but it has its own table of critical values (Engle and Granger, 1987). The Engle-Granger time-series cointegration hypothesis test is set out as follows:

$$H_0 = \text{No causality}$$

$$H_a = \text{There is causality}$$

Error Correction Model (ECM)

The ECM is a mechanism by which the error term is used to tie the behavior of short-term variables to their long-term value. It has its basis in Granger’s representation theorem, which states that if two variables are cointegrated, the relation between them is expressed as an ECM.

That is,

- Short-term behavior: $\hat{U}_t = Y - a_0 - a_1 X_t$
- Long-term behavior: $Y_t = a_0 + a_1 Y_t + \varepsilon_t$

Normality

It refers to the fact that each one of the stochastic error terms u_i has a probability distribution. So, they are normally distributed, that is, their mean is $E(u_i) = 0$ and can be shortly expressed as follows:

$$u_i \sim N(0, \sigma^2)$$

Under the assumption of normality, OLS estimators have the following statistical properties: *i)* They are unbiased; *ii)* They have minimal variance, which means that as n increases, the estimators converge to their true population values; and *iii)* $\hat{\beta}_1$ and $\hat{\beta}_2$ are normally distributed.

The existence of normality is sought because a distribution of this type allows the majority of data to be grouped in a confidence interval that corresponds to 90%, and it allows for the evaluation of data analysis based on t , F and X^2 tests (Núñez, 2007).

a) Histogram and Jarque-Bera Test (JB)

It is a graphic way to understand the population density of residuals by intervals. The way to evaluate it is to imagine the normal distribution curve in the shape of a bell on the histogram; this gives an idea about the normality of residuals.

The JB test is an asymptotic test based on OLS residuals. In this test, both symmetry and kurtosis are calculated through the following equation:

$$JB = n \left[\frac{S^2}{6} - \frac{(K-3)^2}{24} \right]$$

And the following hypothesis test:

H_0 = The residuals are normally distributed

H_a = The residuals are not normally distributed

b) Quantile-quantile or Q-Q plot

It is a graphic test that indicates the normal distribution of residuals. If there is normality in the residuals, it should display points along the line if the points are very dispersed and most of them are outside the line, there is no normality.

c) Boxplot

It is a graphic test based on quartiles. It is aimed at visualizing the data distribution of the residuals of the estimation, in case of normality. This graph shows the minimum and maximum values as well as the median and the position of outliers.

Autocorrelation

We define the term as the “correlation between members of a series of observations ordered in time [as in time-series data] or in space [as cross-sectional data]” (Gujarati, 2010). The OLS model assumes no autocorrelation for X given the u_i perturbations, expressed symbolically as follows:

$$E(u_i u_j) \neq 0 \quad i \neq j$$

It shows how the disturbance term related to any observation is not influenced by the disturbance term related to any other observation. Contrary to heteroscedasticity, time series are more likely to be self-correlating, since they are structured in a specific time order and are successive, and thus there may be relations between data (Gujarati, 2010).

a) Durbin-Watson's d Test

It is one of the most used and known tests to detect correlation; it is mathematically defined as:

$$d = \frac{\sum_{t=2}^{t=n} (\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=1}^{t=n} \hat{u}_t^2}$$

And it is the ratio of the sum of squared differences of the sum of squares of the regression. It has the following hypothesis test:

H_0 = No positive autocorrelation

H_a = No negative autocorrelation

Generally, if the DW test coefficient is around 2, H_0 is not rejected. For the purposes of this research, the range between 1.85 and 2.15 will be considered.

b) Breushch-Godfrey

It is considered as a general autocorrelation test; it allows: *i)* The existence of non-stochastic regressors; *ii)* Autoregressive schemes greater than 1; *iii)* Simple moving averages or higher than white noise error terms. It is mathematically developed as:

$$Y_t = x'_t \beta + \varepsilon_t$$

$$\varepsilon_t = \rho_1 \varepsilon_{t-1} + \rho_2 \varepsilon_{t-2} + \dots + \rho_r \varepsilon_{t-r} + u_t$$

It has the following hypothesis test:

$H_0 = \rho_1 = \rho_2 = \dots = \rho_r = 0$ (Absence of autocorrelation)

$H_a = \rho_1 \neq \rho_2 \neq \dots \neq \rho_r \neq 0$ (AR(r) or MA(r))

c) Correlogram

This graphic test helps identify autocorrelation; it consists of a series of ordered bars that correspond to the lag and to the division between the lag covariance and the variance.

Heteroscedasticity

This test is based on the verification of one of the OLS's most important assumptions, which is that disturbances u_i are homoscedastic. If this is not the case, then there is heteroscedasticity and it is expressed as follows.

$$E(u_i^2) = \sigma^2$$

Where σ^2 indicates that the conditional variances of u_i are no longer constant. It is important to note that heteroscedasticity is usually a more recurrent problem in cross-sectional data⁸⁰ than in time series information, since the latter tend to be of similar magnitude (Gujarati, 2010).

Since this is an essentially economic analysis, it is not possible to know the exact σ^2 . It is an SRF, so there are no specific rules to know if there is heteroscedasticity. However, we applied the following method proposed in Gujarati (2010).

a) Graphic Method

It is used when there is no *a priori* or empirical information regarding the existence of heteroscedasticity in a model. In order to do this, a regression and a *post-mortem* examination of the squared residuals need to be performed. This way, \hat{u}_i^2 are plotted in contrast to \hat{Y}_t and the data distribution is observed in search of a systematic pattern.

b) White

This is a general test seeking the existence of heteroscedasticity; it may also be a test of pure heteroscedasticity or specification error or both.

Its hypothesis test is:

$$H_0 = \sigma_i^2 = \sigma^2 \quad (\text{No heteroscedasticity})$$

$$H_1 = H_0 \quad \text{is not verified}$$

⁸⁰ Information collected at one point in time (Gujarati, 2010).

c) White's Correction

The estimation can be made based on corrected errors with White's proposal in the case of large samples; this transforms them into robust standard errors. Thus, the standard errors corrected through heteroscedasticity by White's method are larger than the errors that had been estimated through the ECM. Therefore, the estimated t-values will be much lower than those obtained at the beginning (Gujarati, 2010).

Granger Causality Test

The term *causality* refers to the relation between a factor or group of factors that are assumed to be the cause, and a given result, which is assumed to be the caused element (Godínez, 2006).

One of the most widely used causality tests is Granger's; it is based on the question whether variable x causes variable y .

The hypothesis test for Granger's causality test is outlined as follows:

H_0 = No causality

H_a = There is causality

VIII. Results

This chapter develops and examines the model tests selected to analyze the relationship between the spot prices of Mexican yellow corn and the future prices traded on the CBOT. It ends with a set of conclusions resulting from contrasting the reviewed literature with the results of the empirical analysis.

Analysis of the OLS Model for the Mexican Corn Spot Price Series and the Futures Prices Traded on the CBOT

Applied Tests

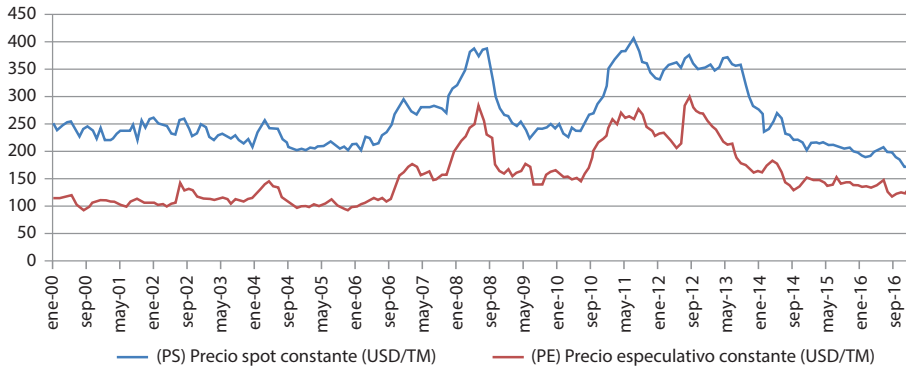
Stationarity

a) Graphic Test

By plotting both series we can observe the possible nature of the time series. It does not follow a definite trend; as it is about price variations, the series is expected to be non-stationary with random walk⁸¹. Therefore, the formal tests described below are carried out based on an intuitive examination of graph 6.

⁸¹ "The prices of securities, such as stock or exchange rates follow a random walk; that is, they are not stationary" (Gujarati, 2010, p. 741).

Graph 6. Comparison Between Spot and Speculative Price Variations, at Constant 2000-2016 Prices



Source: Authors' own design (2019).

b) Unit Root

The ADF test was individually performed on raw data, and unit roots were found in both variables, based on the fact that the Prob values are very high and the ADF *tau* values are not negative enough compared to the critical values pointed out by *e-views* at 1, 5 and 10 percent. The H_0 is not rejected, and the data on the plotted test regarding the non-stationarity of the series is rejected.

Figure 10. Unit Root Test for PE and PS Variables on Raw Data

Augmented Dickey-Fuller Unit Root Test on PE					Augmented Dickey-Fuller Unit Root Test on PS				
Null Hypothesis: PE has a unit root					Null Hypothesis: PS has a unit root				
Exogenous: Constant					Exogenous: Constant				
Lag Length: 1 (Automatic- based on SIC, maxlag=14)					Lag Length: 1 (Automatic- based on SIC, maxlag=14)				
			t-Statistic	Prob.*			t-Statistic	Prob.*	
Augmented Dickey-Fuller test statistic					Augmented Dickey-Fuller test statistic				
Test critical values: 1% level					Test critical values: 1% level				
5% level					5% level				
10% level					10% level				
*MacKinnon (1996) one-sided p-values.					*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation					Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(PE)					Dependent Variable: D(PS)				
Method: Least Squares					Method: Least Squares				
Date: 10/29/17 Time: 20: 11					Date: 10/29/17 Time: 20:06				
Sample (adjusted): 2000M03 2016M12					Sample (adjusted): 2000M03 2016M12				
Included observations: 202 after adjustments					Included observations: 202 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Variable	Coefficient	Std. Error	t-Statistic	Prob.
PE(-1)	-0.034451	0.016005	-2.152517	0.0326	PS(-1)	-0.026844	0.015944	-1.683674	0.0938
D(PE(-1))	0.234201	0.069063	3.391112	0.0008	D(PS(-1))	0.203497	0.069743	2.917832	0.0039
C	5.470971	2.626879	2.082688	0.0386	C	6.809075	4.297236	1.584524	0.1147
R-squared	0.068681	Mean dependent var	0.116936		R-squared	0.048567	Mean dependent var	-0.336309	
Adjusted R-squared	0.059321	S.D. dependent var	12.13852		Adjusted R-squared	0.039005	S.O. dependent var	13.18417	
S.E. of regression	11.77298	Akaike info criterion	7.784232		S.E. of regression	12.92448	Akaike info criterion	7.970864	
Sum squared resid	27582.03	Schwarz criterion	7.783365		Sum squared resid	33241.41	Schwarz criterion	8.019997	
Log likelihood	-783.2074	Hannan-Quinn criter.	7.804111		Log likelihood	-802.0573	Hannan-Quinn criter.	7.990743	
F-statistic	7.337728	Durbin-Watson stat	2.009915		F-statistic	5.079120	Durbin-Watson stat	1.995324	
Prob(F-statistic)	0.000842				Prob(F-statistic)	0.007057			

Source: Authors' own design (2019).

As indicated in the literature (Gujarati, 2010), we applied first differences to both series⁸², and performed the unit-root test again. We decided not to include the trend because we do not consider the analyzed series to be deterministic in nature.

Since they were in first differences $I(1)$, the data were treated with log to ensure the stationarity of both series at the time of making the relevant estimations.

Figure 11. Unit Root Test for PE and PS Variables on First Difference Logarithmic Data

Augmented Dickey-Fuller Unit Root Test on D(PE01)					Augmented Dickey-Fuller Unit Root Test on D(PS01)				
Null Hypothesis: D(PE01) has a unit root					Null Hypothesis: D(PS01) has a unit root				
Exogenous: Constant					Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=14)					Lag Length: 0 (Automatic - based on SIC, maxlag=14)				
			t-Statistic	Prob.*			t-Statistic	Prob.*	
Augmented --Fuller test statistic					Augmented Dickey-Fuller test statistic				
Test critical values:					Test critical values:				
1% level					1% level				
5% level					5% level				
10% level					10% level				
-11.45140					-12.93304				
-3.462737					-3.462737				
-2.875680					-2.875680				
-2.574385					-2.574385				
*MacKinnon (1996) one-sided p-values.					*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation					Augmented Dickey-Fuller Test Equation				
Dependent Variable: O(PE01,2)					Dependent Variable: D(PS01,2)				
Method: Least Squares					Method: Least Squares				
Date: 10/27/17 Time: 21:44					Date: 10/27/17 Time: 21:43				
Sample (adjusted): 2000M03 2016M12					Sample (adjusted): 2000M03 2016M12				
Included observations: 202 after adjustments					Included observations: 202 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PE01(-1))	-0.797754	0.069664	-11.45140	0.0000	D(PS01(-1))	-0.909022	0.070287	-12.93304	0.0000
C	0.000843	0.004756	0.177230	0.8595	C	-0.001477	0.003441	-0.429120	0.6683
R-squared	0.396016	Mean dependent var	0.000473		R-squared	0.455432	Mean dependent var	0.000261	
Adjusted R-squared	0.392996	S.D. dependent var	0.086754		Adjusted R-squared	0.452709	S.D. dependent var	0.066058	
S.E. of regression	0.067590	Akaike info criterion	-2.540860		S.E. of regression	0.048869	Akaike info criterion	-3.189496	
Sum squared resid	0.913683	Schwarz criterion	-2.508105		Sum squared resid	0.477635	Schwarz criterion	-3.156741	
Lag likelihood	258.6269	Hannan-Quinn criter.	-2.527607		Log likelihood	324.1391	Hannan-Quinn criter.	-3.176243	
F-statistic	131.1346	Durbin-Watson stat	2.002748		F-statistic	167.2634	Durbin-Watson stat	1.991112	
Prob(F-statistic)	0.000000				Prob(F-statistic)	0.000000			

Source: Authors' own design (2019).

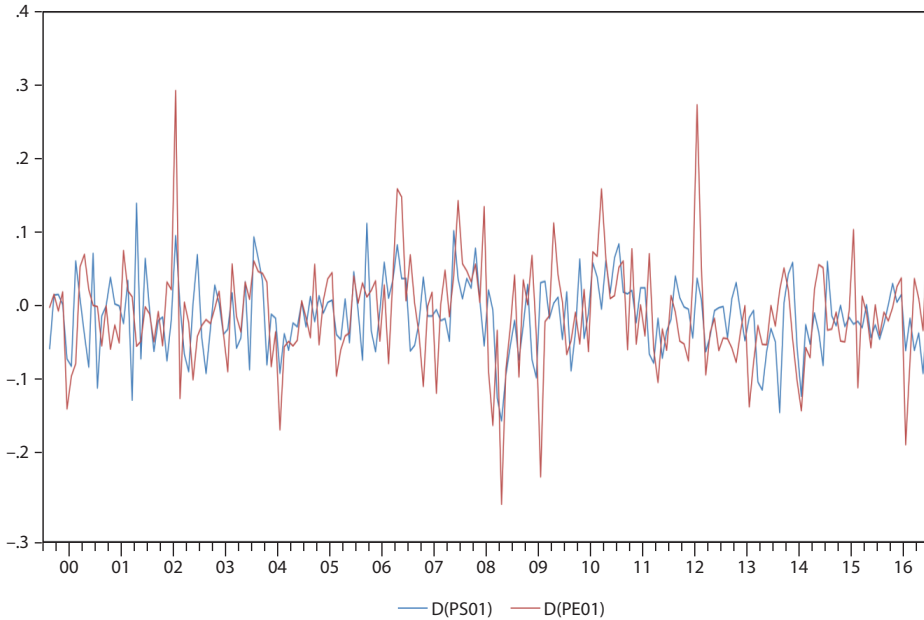
Here, the ADF statistic result for both series is “sufficiently negative” with values -11.45140 and -12.93304 for $D(PE01)$ and $D(PS01)$ ⁸³ respectively. Therefore, the null hypothesis in favor of stationarity is rejected since these values are greater in absolute terms than any of the critical values indicated by Mackinnon at 1, 5, 10 percent.

⁸² “The first differences of the random walk time series are stationary [...] Most economic time series are $I(1)$; that is, they usually become stationary only after taking their first differences” (Gujarati, 2010, pp. 742, 747).

⁸³ D will hereinafter denote that the series are in first differences, i. e. $I(1)$ and $O(1)$, which are logarithmic.

Likewise, the probability associated with the *tau* statistic recorded in Prob values is lower than level 0.05, as confirmed by the rejection of the null hypothesis. The DW value indicating no autocorrelation should also be noted at the time of testing.

Graph 7. Graphic Representation of the D (PE01) and D (PS01) Series in First Differences



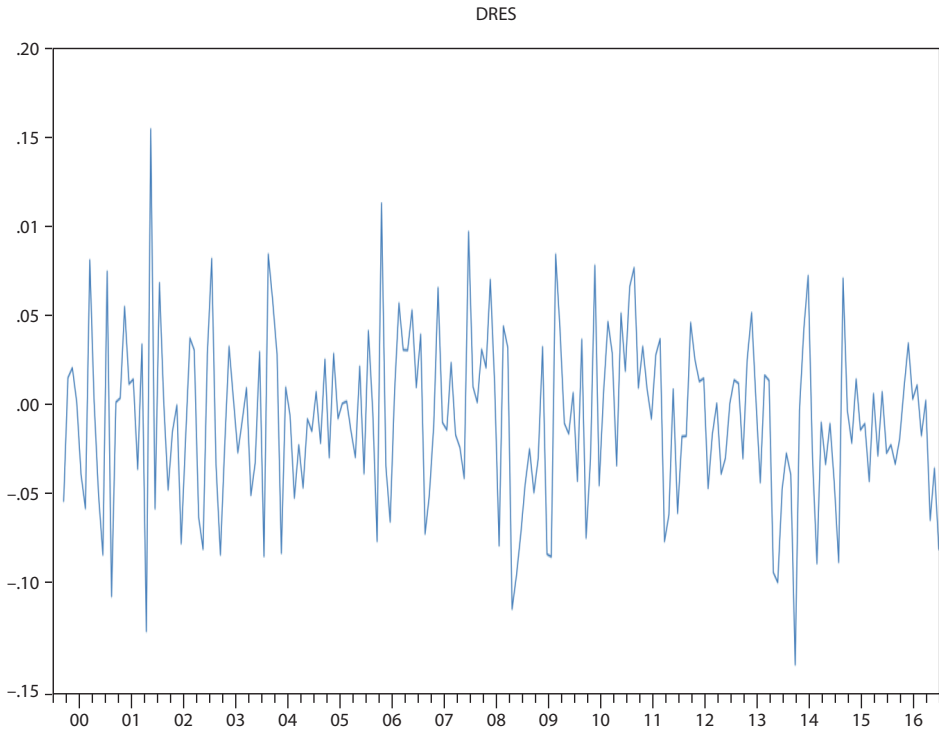
Source: Authors' own design (2019).

When plotting both series in first differences, it can be noticed that they seem to move not around time but around their means, variances and covariances. This indicates that they are stationary.

Cointegration

a) Graphic Test

It consists of a graphic inspection of residuals to informally test the co-integration of the series. This can be a first indication of cointegration since residuals seem to vary around the mean, the variance and covariance.

Graph 8. *Residuals Cointegration Graphic Test*

Source: Authors' own design (2019).

b) Regression Residuals ADF

Following the structure proposed by Engle and Granger (1987) on the two-stage cointegration test, the ADF unit root test was performed on the regression residuals between variables D (PS01) and D (PE01); Schwartz's automatic lagging criterion was used with 0 lagging of 14.

The results confirm that both series are cointegrated. The ADF value of -14.60913 is "negative enough" and it is higher in absolute terms than any of the critical values of Mackinnon at 1, 5 and 10 percent. Therefore, the H_0 can be rejected as it stipulates that there is no cointegration. We concluded that the residuals are cointegrated in $I(1)$ order, and thus, the tests show a stable long-term relation between D (PS01) and D (PE01). As for the DW value, it ranges between 1.85 and 2.15, and therefore, it is considered acceptable, indicating no autocorrelation.

Figure 12. Regression Residuals ADF

Augmented Dickey-Fuller Unit Root Test on RESID01				
Null Hypothesis: RESID01 has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=14)				
		t-Statistic	Prob.*	
Augmented Dickey-Fuller test statistic		-14.60913	0.0000	
Test critical values:	1% level	-3.462737		
	5% level	-2.875680		
	10% level	-2.574385		
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(RESID01)				
Method: Least Squares				
Date: 10/29/17 Time: 22:37				
Sample (adjusted): 2000M03 2016M12				
Included observations: 202 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID01(-1)	-1.030345	0.070527	-14.60913	0.0000
C	0.000224	0.003295	0.068119	0.9458
R-squared	0.516238	Mean dependent var		0.000161
Adjusted R-squared	0.513820	S.D.dependentvar		0.067171
S.E. of regression	0.046836	Akaike info criterion		-3.274461
Sum squared resid	0.438730	Schwarz criterion		-3.241706
Log likelihood	332.7205	Hannan-Quinn criter.		-3.261208
F-statistic	213.4268	Durbin-Watson stat		1.998459
Prob(F-statistic)	0.000000			

Source: Authors' own design (2019).

Error Correction Model (ECM)

An error correction model was carried out including a delay⁸⁴. The latter was used to link the short-term with the long-term behaviors of variables $D(PS01)$ and $D(PE01)$. According to the cointegration of the tested series, there is a stable relation of long-term equilibrium between both, even when there is imbalance in the short term.

The estimated function reads as follows:

$$D(PS01) = a_0 + a_1 D(PE01)_t + a_2 \hat{U}_{t-1} + \varepsilon_t$$

Where:

D = denotes that the variables are in first differences

\hat{U}_{t-1} = error correction mechanism used to correct the imbalance between the series in the short term

a_2 = short-term adjustment parameter

⁸⁴ Based on the use of two lags when comparing spot prices and future prices in ECMs. This can be found in Durán (2011).

So, the statistical significance of a_2 indicates the proportion of the imbalance in D (PE01).

For this reason, we can read the equation written in first differences in the results of the estimation:

$$D(PS01) = 0.0018551 + 0.215686 \cdot D(PE01) - 0.031793 \cdot \hat{u}_{t-1}$$

Value -0.031793 is interpreted as the error correction mechanism in the ECM. It appears as negative because it must act as a reducer of the unbalance. It is indicated by $t - 1$ in the following period, which is monthly-based in the present case, and thus it gradually restores the variables until reaching equilibrium in period t .

Figure 13. ECM Estimation Results

Dependent Variable: DPS				
Method: Least Squares				
Date: 10/27/17 Time: 21:53				
Sample (adjusted): 2000M03 2016M12				
Included observations: 202 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001851	0.003304	-0.560117	0.5760
DPE	0.215686	0.049151	4.388200	0.0000
DRES	-0.031793	0.072222	-0.440217	0.6603
R-squared	0.089130	Mean dependent var		-0.001650
Adjusted R-squared	0.079976	S.D. dependent var		0.048951
S.E. of regression	0.046953	Akaike info criterion		-3.264608
Sum squared resid	0.438708	Schwarz criterion		-3.215476
Log likelihood	332.7254	Hannan-Quinn criter.		-3.244729
F-statistic	9.736251	Durbin-Watson stat		2.000896
Prob(F-statistic)	0.000092			

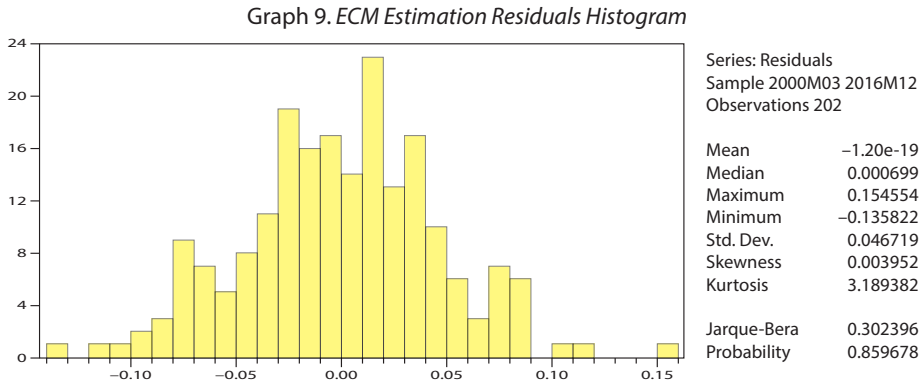
Source: Authors' own design (2019).

Normality

a) Histogram

The histogram graphic test was performed to identify the existence of normality in the ECM estimation residuals. The graph bars are arranged in such a way that they seem to have a normal distribution or bell curve, so that the residuals seem normal at first glance. By analyzing the coefficients attached to the test, the normality of residuals is confirmed by the following arguments: *i)* The Jarque-Bera value of 0.302696 is less than 5.99, so the null hypothesis is not rejected; *ii)* The probability value of 0.859678 reflects high

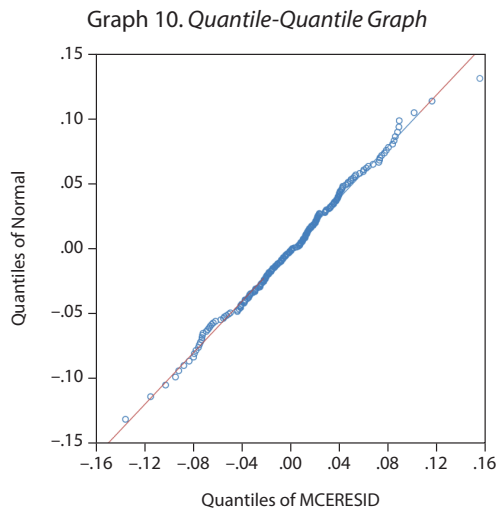
reasons for not rejecting the null hypothesis of normality; *iii*) The asymmetry coefficient value of 0.003952 tends to zero, which is an indication of normality; *iv*) The Kurtosis value of 3.189382 tends to 3, which indicates that the residuals have a normal distribution.



Source: Authors' own design (2019).

b) Quantile-Quantile:

This visual test requires most of the points to be located along the line. This is the case of the applied ECM residuals; therefore, normality is confirmed.

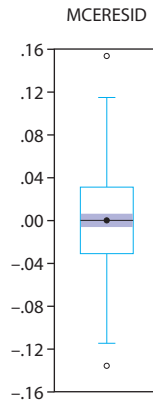


Source: Authors' own design (2019).

c) Boxplot

The residuals average is represented by a black dot in the center of the box at the 0.00 level. Both lines emerging from the center oscillate between levels -0.12 and 0.12 at a practically equal distance on both sides of the box. It is therefore concluded that the residuals pass the normality tests.

Graph 11. *ECM Estimation Residuals Boxplot*



Source: Authors' own design (2019).

Autocorrelation

a) DW Value

This statistic tests first order autocorrelations. It is considered an acceptable no autocorrelation proof when it is between 1.85 and 2.15. Based on the result of the ECM regression for DW, it showed a non-autocorrelation value of 2.000896.

b) Breushch-Godfrey (BG)

To evaluate the existence of a higher order autocorrelation, this test (BG) was performed from 1 to 12 lags, taking into account that the data are monthly-based. No evidence of autocorrelation was found in any of the tests applied for any of the orders tested as they had probabilities greater than 0.05.

Figure 14. *BG Tests for Lags One and Twelve*

Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	0.052128	Prob. F(1,198)	0.8196	
Obs*R-squared	0.053167	Prob. Chi-Square(1)	0.8176	

Test Equation:
 Dependent Variable: RESID
 Method: Least Squares
 Date: 10/30/17 Time: 21:53
 Sample: 2000M03 2016M12
 Included observations: 202
 Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.66E-06	0.003312	0.000803	0.9994
DPE	0.000710	0.049367	0.014383	0.9885
DRES	0.216690	0.951840	0.227654	0.8202
RESID(-1)	-0.218138	0.955425	-0.228315	0.8196
R-squared	0.000263	Mean dependent var	-1.20E-19	
Adjusted R-squared	-0.014884	S.D. dependent var	0.046719	
S.E. of regression	0.047065	Akaike info criterion	-3.254970	
Sum squared resid	0.438593	Schwarz criterion	-3.189460	
Log likelihood	332.7520	Hannan-Quinn criter.	-3.228465	
F-statistic	0.017376	Durbin-Watson stat	1.996603	
Prob(F-statistic)	0.996873			

Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	1.417661	Prob. F(12, 187)	0.1608	
Obs*R-squared	16.84416	Prob. Chi-Square(12)	0.1556	

Test Equation:
 Dependent Variable: RESID
 Method: Least Squares
 Date: 10/30/17 Time: 22:16
 Sample: 2000M03 2016M12
 Included observations: 202
 Presample missing value lagged residuals set to zero.

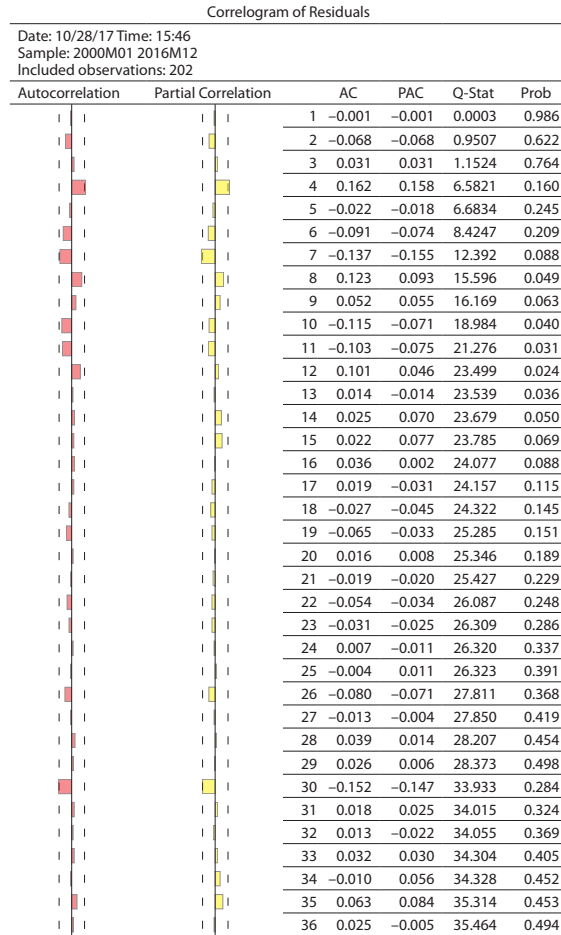
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.04E-05	0.003267	0.003169	0.9975
DPE	-0.004091	0.049711	-0.082285	0.9345
ORES	-0.220203	1.023233	-0.215203	0.8298
RESID(-1)	0.218842	1.026117	0.213272	0.8313
RESID(-2)	-0.022274	0.080117	-0.278017	0.7813
RESID(-3)	0.058933	0.073193	0.805171	0.4217
RESID(-4)	0.127349	0.073532	1.731892	0.0849
RESID(-5)	-0.039517	0.073834	-0.535218	0.5931
RESID(-6)	-0.064002	0.073353	-0.872520	0.3840
RESID(-7)	-0.137384	0.073651	-1.865343	0.0637
RESID(-8)	0.087815	0.074023	1.186318	0.2370
RESID(-9)	0.048211	0.073972	0.651744	0.5154
RESID(-10)	-0.071838	0.074081	-0.969724	0.3334
RESID(-11)	-0.077225	0.074288	-1.039534	0.2999
RESID(-12)	0.046832	0.074181	0.631322	0.5286
R-squared	0.083387	Mean dependent var	-1.20E-19	
Adjusted R-squared	0.014764	S.D. dependent var	0.046719	
S.E. of regression	0.046372	Akaike info criterion	-3.232866	
Sum squared resid	0.402126	Schwarz criterion	-2.98720	
Log likelihood	341.5195	Hannan-Quinn criter.	-3.13347	
F-statistic	1.215138	Durbin-Watson stat	1.99689	
Prob(F-statistic)	0.267153			

Source: Authors' own design (2019).

c) Correlogram

It is observed that none of the bars exceed the dotted line of the second partial correlation column, which is evidence of no correlation. This is confirmed by the fact that none of the Prob values is less than 0.05.

Figure 15. ECM Estimation Residuals Correlogram



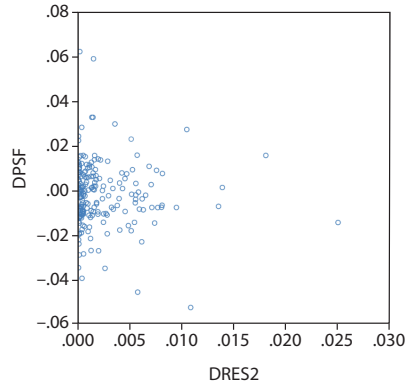
Source: Authors' own design (2019).

Heteroscedasticity

a) Graphic Method

The squared residuals series was plotted with the dependent variable forecast in search of a systematic pattern. The set of points do not show a systemic pattern at first sight. However, they seem to be grouped around zero, so it is necessary to perform formal tests to rule out heteroscedasticity.

Figure 16. *Estimated Squared Residuals Patterns*



Source: Authors’ own design (2019).

b) Breushch-Pagan-Godfrey (BPG) Test

Under the assumptions of the BPG test, which asymptotically follows the chi-square distribution with two degrees of freedom, the estimated values are compared with the critical values in the tables. The result for the critical value of chi-square at 5% is 5.99147, and 9.21034 at 1%. Therefore, the observed chi-square value of 6.128297 is significant at the 5% significance level, but not at the 1% level. However, it should also be considered that the Prob value is less than 0.05 but greater than 0.01. Thus, if the assumption of homoscedasticity is accepted, the conclusion would not be sufficiently clear.

Figure 17. *BPG Test*

Heteroskedasticity Test: Breusch-Pagan-Godfrey				
F-statistic	3.113087	Prob. F(2, 199)	0.0466	
Obs*R-squared	6.128297	Prob. Chi-Square(2)	0.0467	
Scaled explained SS	6.510808	Prob. Chi-Square(2)	0.0386	
Test Equation:				
Dependent Variable: RESIDA2				
Method: Least Squares				
Date: 10/31/17 Time: 02:08				
Sample: 2000M03 2016M12				
Included observations: 202				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.002173	0.000224	9.684778	0.0000
DPE	-0.000150	0.003337	-0.045028	0.9641
DRES	-0.011932	0.004904	-2.433146	0.0159
R-squared	0.030338	Mean dependent var	0.002172	
Adjusted R-squared	0.020593	S.D. dependent var	0.003222	
S.E. of regression	0.003188	Akaike info criterion	-8.643985	
Sum squared resid	0.002023	Schwarz criterion	-8.594852	
Log likelihood	876.0425	Hannan-Quinn criter.	-8.624106	
F-statistic	3.113087	Durbin-Watson stat	1.591702	
Prob(F-statistic)	0.046636			

Source: Authors’ own design (2019).

c) White's Test

Applying White's heteroscedasticity test to the ECM regression residuals, the observed chi-square value of 7.467226 was obtained multiplying r^2 by the number of observations (202). If it is compared with the chi-square critical values (5.99147 at 5% and 9.21034 at 1%), we see that it is significant at 5% but not at 1% because it is higher than 5.99147 but lower than 9.21034. As in the case of the BPG test, the observed Prob values are very low, less than 0.05 but greater than 0.01. Therefore, if the assumption of homoscedasticity is accepted, the conclusion would still not be sufficiently clear.

Figure 18. *White's Test*

Heteroskedasticity Test: White				
F-statistic	3.819351	Prob. F(2, 199)		0.0236
Obs*R-squared	7.467226	Prob. Chi-Square(2)		0.0239
Scaled explained SS	7.933309	Prob. Chi-Square(2)		0.0189
Test Equation:				
Dependent Variable: RESID*2				
Method: Least Squares				
Date: 10/28/17 Time: 18:15				
Sample: 2000M03 2016M12				
Included observations: 202				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001733	0.000284	6.111259	0.0000
DPE*2	0.006556	0.020791	0.315304	0.7529
DRES*2	0.186885	0.068597	2.724386	0.0070
R-squared	0.036966	Mean dependent var		0.002172
Adjusted R-squared	0.027288	S.D.dependentvar		0.003222
S.E. of regression	0.003177	Akaike info criterion		-8.650844
Sum squared resid	0.002009	Schwarz criterion		-8.601711
Log likelihood	876.7352	Hannan-Quinn criter.		-8.630965
F-statistic	3.819351	Durbin-Watson stat		2.005551
Prob(F-statistic)	0.023568			

Source: Authors' own design (2019).

d) Correction on White's test

Since the model's homoscedasticity could not be comfortably concluded, we proceeded to correct the variances or standard errors consistent with White's heteroscedasticity⁸⁵. This process reinforces the ECM standard errors. Thus, standard errors⁸⁶ are considerably larger than the EMC's standard errors without this correction. However, this also causes the observed esti-

⁸⁵ As Wallace and Silver comment on Gujarati (2010), "In general terms, it is probably a good idea to use the WHITE option [available in regression programs] systematically, perhaps comparing these results with regular OLS results as a way of checking whether heteroscedasticity is a serious problem in a particular data set" (p. 403).

⁸⁶ Marked as Std. Error by e-views.

mated t-values to be smaller; based on these values, we concluded that the regression is statistically significant at 5% with a value of 0.049949 which is reinforced by the Prob value.

Figure 19. Estimation of the ECM with the Heteroscedasticity Correction of White's Test

Dependent Variable: DPS				
Method: Least Squares				
Date: 10/28/17 Time: 18:46				
Sample (adjusted): 2000M03 2016M12				
Included observations: 202 after adjustments				
White heteroskedasticity-consistent standard errors & covariance				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001851	0.003305	-0.559888	0.5762
DPE	0.215686	0.049949	4.318098	0.0000
DRES	-0.031793	0.083758	-0.379585	0.7047
R-squared	0.089130	Mean dependent var		-0.001650
Adjusted R-squared	0.079976	S.D. dependent var		0.048951
S.E. of regression	0.046953	Akaike info criterion		-3.264608
Sum squared resid	0.438708	Schwarz criterion		-3.215476
Lag likelihood	332.7254	Hannan-Quinn criter.		-3.244729
F-statistic	9.736251	Durbin-Watson stat		2.000896
Prob(F-statistic)	0.000092	Wald F-statistic		9.336430
Prob(Wald F-statistic)	0.00133			

Source: Authors' own design (2019).

In this final ECM regression, the observed R^2 value is very low for what is expected in the relationship between the two series. So, we reviewed the literature to justify its relevance. Although the model's goodness-of-fit is very low (0.089130 or 8.913%), we see that the relation between the two variables exists although at a very low level.

Gujarati (2010) sustains that a low R^2 could mean that the proposed model should not be considered reliable for long term forecasts. However, it is important to point out that the price level forecast is not the objective sought by the model; other econometric proposals are known to exist for this purpose.

Regarding the errors of discarding a model based on the R^2 value, Martinez (2005) mentions:

if a high R^2 value is obtained in this process, fine, but this is not evidence in favor of the model. If this value is small, it does not mean that the model is necessarily wrong [...] the practice of selecting a model based on higher R^2 may result in the introduction into the model of what is known as *pre-test bias*; this may destroy some of the properties of the model's minimum square estimators (Martínez, 2005).

As for the other regression parameters, they denote significant values. The Prob value of the independent variable D (PE01) is 0.0000. Therefore, we concluded that it linearly influences the independent variable D (PS) at any level; and the DW statistic at 2.000896 is in an acceptable range, so we concluded that there is no autocorrelation.

Conclusions

Some theoretical proposals assure that financial instability and an increasingly dominant financial intervention in industries should not be considered anomalies in an uncertain globalized world. On the contrary, they claim that these should be expected as possible results of the international markets operations. This has caused an increasing interest in understanding how such effects, caused by the development of the system in different markets, appear and develop.

This is important to the extent that both the academia and the institutions maintain constant proposals to avoid crises. From the government's point of view, burying in mind the role of this growing financial presence in the agricultural industry allows for the correct creation of public policies. These policies make it possible to revise the financial market institutional design and to regulate the financial institutions responsible for creating those financial instruments that directly impact the agricultural industry. It is important to acknowledge the need to restrict the level of speculation and contain the effects that global financial movements have on the Mexican economy, specifically within the analysis field of the present research.

Since volatility is a consequence of speculation, it is important that markets get organized to limit price fluctuations, in this case, of yellow corn prices. This could be made possible by establishing rules for those financial market participants that inhibit speculative effects.

Other points to be highlighted are food sovereignty and price sovereignty. The analyzed phenomenon limits the producers' decision-making power and increases the tendency to continue importing yellow corn from the US; in the long run, this creates a great dependency on the US market. This situation, framed in the renegotiations of international treaties, could en-

danger the sector, and generate a scenario in which Mexico might need to start fearing food insufficiency.

As for Mexican prices, they tend to follow the United States pricing dynamics; producers are forced to set prices on their production, not based on their own characteristics, but following the logic of international markets, specifically that of speculation.

Finally, it is necessary to rethink the terms in which Mexico's agricultural industry should be fostered, especially the production of yellow corn. This is only one of the axes of a much more complex problem.

Appendixes. Theoretical Framework Bibliographic Review

International Trade Theories

<i>Name / Theory / Article</i>	<i>Authors / Representatives</i>	<i>Description</i>
Mercantilism	Mun (1621, 1644) Petty (1899)	Mun: Trade is the only way to increase wealth (Frugal consumption to increase the amount of exportable goods; Increase of the use of domestic land and natural resources to reduce imports; Reduction of export tariffs and export of goods with elastic demand).
Price-Specie Flow Mechanism	Hume (1752)	Quantity Theory of Money Price-Specie Mechanism "The accumulation of gold through a trade surplus would increase money supply and, consequently, prices and wages. This would reduce the competitiveness of the country in surplus".
Market Freedom Specialization of Countries Absolute Advantage	Smith (1776)	One of the central points of the economy should be specialization and exchange between countries. Countries should specialize and export those goods in which they have an absolute advantage, and they should import those goods in which the trading partner has an absolute advantage.
The Principles of Political Economy and Taxation Comparative Advantage	Ricardo (1817)	The Theory of Comparative Advantage states that countries show a tendency to competitively specialize, produce and export those goods whose production costs are relatively lower with respect to the rest of the world; these goods are therefore comparatively more efficient than others. On the other hand, countries tend to import those goods in which they are less efficient.
Trading Capital	Marx (1892)	He describes the world market and the existing international division of labor. He lays the foundations for understanding how international markets are created and shaped.
Pure and Monetary Theories of International Trade	Several authors	<i>i)</i> The Pure Theory refers to value analysis applied to international exchange; <i>ii)</i> The Monetary Theory mainly contemplates two aspects: one is the application of monetary principles to international exchange; the second is an analysis of adjustment processes through the use of monetary, exchange and financial instruments to counteract the asymmetric effects of the balance of payments.
Factor Proportions Theory	Leontief (1953) Heckscher (1919) Ohlin (1933)	Nations differ in their total factors of production even when their applied technology is equivalent. Leontief's paradox The Heckscher–Ohlin theorem studies the effects of factor endowments on international trade and attempts to demonstrate whether the differences between relative factor endowments are enough to form a basis for international trade. This model implies that factor prices between trading countries tend to be equalized through trade.
Equilibrium Theory and International Trade	Monje (2001)	Observes an unequal distribution of natural resources, which eventually causes a difference in exchange conditions among world regions based on unbalanced endowments of natural resources (Monje, 2001).
Theory on the Origin of Unequal Exchange	Arghiri (1964) Marini (1974)	Arghiri (1964) tries to show that unequal exchange is not due to the different types of products; it rather depends on the type of country of origin. On the other hand, Mauro (1974) guides his analysis from the viewpoint of the countries' productivity.

Source: Authors' own design (2019).

International Finances

<i>Name / Theory / Article</i>	<i>Authors / Representatives</i>	<i>Description</i>
The Financial Policy of Corporation	Dewing (1920)	Foundations of the classic vision of a company's financial management
General Theory of Employment, Interest and Money	Keynes (1939)	Answers to the economic crisis unleashed all over the world from the New York stock exchange crash of 1929
Methodology For Investment Analysis	Schneider (1944)	Criteria on financial decisions
Complex Analytical Tools Financial Asset Balance Model	Markowitz (1958) Modigliani & Merton (1958)	Development of complex analytical tools
Financial Markets	Merton (1973)	Performance of financial markets
Black-Scholes Model	Merton, Black & Scholes	Determines the price of financial assets
Financial Theory	Merton (1973) Sharpe (1976)	Modeling the behavior of financial theory
Arbitrage Pricing Theory (APT)	Ross (1976)	Linear modeling of the expected return of a financial asset; the return rate derived from the model is used to estimate the price of the asset.
Investment Selection Theory and The Capital Asset Pricing Model	Markowitz & Sharp (1990)	Linear relationship between expected return and risk
Finance	Buffet (1998)	Development through the practice of finance
History of Finance	Hagstrom (1998)	Historical description of finances
Modern Financial Theory	Black	Contributions to financial economics
Financial Economics	Marín & Rubio (2001)	Reveals consistent economic forecasts by observing financial asset prices.
Financial Capitalism	Chiavenato (2006)	The development of new forms of capitalist organization, enterprises with solidary partners, typical forms of commercial organization -whose capital comes from the obtained profits (industrial capitalism)- and who play an active role in the direction of the business, gave rise to the so-called financial capitalism.
Financial Theory, Corporate Finance, Public Finance, International Finance, Financial Management <i>et al.</i>	Parada (2005)	Contemporary finance
Behavioral Finance	Kahneman (1974, 1979)	Theories based on the psychology of individuals to explain market anomalies such as price fluctuations.
Social Finance	Yunus (1996)	Set of Financial Institutions whose objectives are not necessarily conditioned by the Formal Financial System and do not meet the criteria of maximum profit and speculation.

Source: Authors' own design (2019).

Definition of Futures and Commodities

<i>Name / Theory / Article</i>	<i>Authors / Representatives</i>	<i>Description</i>
Financial Theory	Merton (1973) Sharpe (1976)	Modeling the behavior of financial theory
Financial Markets	Merton (1973)	Performance of financial markets
Finance	Buffet (1998)	Development through the practice of finance
History of Finance	Hagstrom (1998)	Historical description of finances
Modern Financial Theory	Black	Contributions to financial economics
Financial Economics	Marín and Rubio (2001)	Reveal consistent economic forecasts by observing financial asset prices
Financial Theory, Corporate Finance, Public Finance, International Finance, Financial Management <i>et al.</i>	Parada (2005)	Contemporary finance
Review of the Black-Scholes Model	Scholes Merton	Derivative assets valuation
Commodities	Desireé (2008)	“Primary products, such as coffee, sugar cane, wheat, corn, rice, beans, and sorghum, do not differ in their production phase, and their commercialization is generic, without brands that add specific value. Therefore, they are considered within the group of products known as agricultural commodities. But there are also non-agricultural commodities such as petroleum, gold, silver, copper, among others”.
Futures	Dunsby, Eckstein, Gaspar, and Mulholland (2008)	The investment is made not on physical goods but on the future of commodities.
Futures	Mansell (1992)	Explanation of how futures work in general and in Mexico
Futures	Aguilera (2013)	“Contracts whose price derives [...] from the value of an asset, which is known as the underlying asset of said contract. These underlying assets can also be financial instruments, [...] they can be physical goods such as gold, corn or oil”.

Source: Authors' own design (2019).

Speculation

Name / Theory / Article	Authors / Representatives	Description
Fictitious Capital	Marx (1894)	Assets whose value does not correspond to any real capital
Theory of Speculation	Bachelier (1990)	Basic mathematical modeling of efficient markets and valuation of options
Financial Markets Objective	Mansell (1992)	"They are developed for the purpose of meeting the needs of risk managers, not those of speculators".
Financial Economics	Marín and Rubio (2001)	Economic organizations are divided into 1) companies with real assets; and 2) financial asset intermediaries.
Views on Speculation	Soto (2010)	1) The orthodox view states that derivative financial instruments were created solely to reduce financial risks and improve financial efficiency through maintaining price stability; 2) The heterodox view sustains that derivatives also serve as a means to carry out speculative activities with the aim of generating profits.

Source: Authors' own design (2019).

Productive Restructuring in the Agricultural Sector

Proposal / Theory	Authors / Representatives	Description
Tableau économique	Quesnay (1759)	"Agriculture is the source of all wealth, both of the State and of the citizens".
Agriculture as a Generator of Wealth	Smith, A. (1776)	It is the beginning of the criticism against the physiocrats belief that the land is the source of all wealth. It raises the importance of division of labor in manufacturing, and the difference between agriculture in rich and poor countries.
Theory of Differential Rent of Land	Ricardo (1817)	The rent of land is differentiated by fertility and by geographical location; this gives rise to the law of diminishing returns.
Theory of Value	Marx (1882)	Value does not come from the land if it is not a product of labor.
Importance of Agriculture within a Capitalist Economy	Kautsky (1903)	It elaborates on agrarian issues under the scheme of capitalist production, which requires the concentration of the most productive extensions in capitalist property.
Theory of the Peasant Economic Unit	Chayanov (1975)	Economic usufruct of a peasant or artisan family that does not employ paid workers but uses only the work of its own members. A Family Economic Labor Unit (UEFT, by its acronym in Spanish) is the unit where wage-earning work is absent and the usufruct stays within the family of peasants or artisans.

Anthropological Approach to the Agricultural Sector Typology of Agricultural Communities	Redfield (1960)	It highlights the relationships of kinship and patronage. The difference between the <i>peasant</i> (control over the land in a traditional way) and the <i>farmer</i> (agricultural production as a business).
Structural Heterogeneity; the Mexican Case	Gutelman (1974)	Agriculture is sustained by the small market economy.
Agricultural Structure as a Class Structure	Bartra (1976)	Three sectors: 1) developed capitalist; 2) simple mercantile; 3) pauperized peasants
Symbiotic but Asymmetrical Relationship Between the Business Sector and Peasants	Warman (1976)	It criticizes the dualistic proposal of agricultural production. It considers that both poles are the result of a single historical process.
Peasant Socioeconomic Unit (USC, by its acronym in Spanish) and Three Sectors of the Agrarian Structure	Bartra (1982)	USC is a production and consumption cell, constituted by the organic unit of labor force and the means of production.
Neoclassical Trend: Traditional-Modern Dichotomy	Heyning (1982)	Two figures are identified: 1) Capitalist and industrial sectors are receptive to change, oriented towards the market, and seeking to maximize profits; 2) The traditional agricultural sector is based on subsistence production with scarce surpluses for commercialization; the goal of production is not necessarily to obtain profits.
Theory of Post-Industrial Society	Castells (1997)	Deep restructuring of the capitalist system characterized by flexibility in management, decentralization and interconnection of enterprises, individualization and diversification of labor relations, massive incorporation of women into paid work, selective deregulation of markets and the dismantling of the welfare state. Special importance is given to the revolution of technology and information.
Theory of Dismodernism	Touraine (2001)	Process of globalization following the restructuring of capitalism after the seventies that is characterized by dismodernization: world market vs. fragmentation of national identities.
Theory of the Defeated Society	Zermeño (2001)	In the Latin American context, the countries that adopted neoliberal policies early (Chile, Argentina, Uruguay) are different from those that adopted them late (Mexico). The latter suffer from a process of dismantling social actors and the social fabric that underpins their criticism of NAFTA and integration into the globalization process.
Capitalist Crisis / Food Crisis Changing the Focus of Agricultural Production	Rubio (2010)	The aim of agricultural production is no longer human and animal food only, it has become a speculative commodity. He identifies a relation between two main aspects during the capitalist crisis: 1) the financial dimension and 2) the characteristics of energy needs.
Economy and Agriculture	Flores (2016)	Factors that produce fluctuation in agricultural prices and challenges of the new proposals for agricultural production.

Source: Author's own design, (2017).

General Financing and Agricultural Sector Financing

<i>Proposal / Theory</i>	<i>Authors / Representatives</i>	<i>Description</i>
Financing	Veblen (1904) Keynes (1936)	Background
Financing	Magdoff & Sweezy (1972)	Creation of the Term
Growth and Expansion Based on Hegemonic Economies	Lichtensztejn (1984)	Growth and expansion of banking organizations and "creation of new markets, such as the Euro-currency and off-shore financial centers, which revolutionized the dynamics of financial circulation [...]; it can be inferred that financial capital is determined on an international scale from the hegemonic points of the system".
Financing Process	Galbraith (2004) Epstein (2005) Krippner (2005) Medialdea & Sanabria (2012)	Contemporary analysis of the term
Financial Globalization	Soto (2010)	Transformations in financial systems (especially deregulation)
The New Phase of the Global Food Crisis	Rubio (2010)	Financing within a food crisis scenario

Source: Authors' own design (2019).

The Pricing Process

<i>Name / Theory / Article</i>	<i>Authors / Representatives</i>	<i>Description</i>
Theory of Market Microstructure	Demsetz (1980) Bagehot (1971) Garman (1976)	The internal market organization type is not neutral to the process of price formation and resource allocation. Study of the processes and results that occur in the exchange of assets under explicit trading rules.
Price Formation Theory	Within the microeconomic theory	Mechanisms through which prices are formed for a certain product or service There are two methods: according to the expenses, and according to the market.
Arbitrage Pricing Theory	Ross (1976)	
Derivative valuation models	Black and Scholes (1973)	
Transmission of CBOT Corn Futures Prices to the Mexican Spot Market	Ortiz & Montiel (2016)	Analysis with multivariate stochastic volatility during the 2007-2012 period; it shows that the price of the corn futures market is not strongly related to the prices registered in some states of the country.

Source: Authors' own design (2019).

Review of Econometric Models Applied to Finance

<i>Name / Model / Article</i>	<i>Authors / Representatives</i>	<i>Description</i>
OLS (Ordinary Least Squares)		Method for finding population parameters in a linear regression model
APT (Arbitrage Pricing Theory)	Ross (1974)	Linear modeling of expected returns of a financial asset. The return rate derived from the model is used to estimate the price of the asset.
Game Theory	Nash (1940 and 1950)	Price analysis based on game theory assumptions
CAPM (Capital Asset Pricing Model)	Markowitz and Sharp (1990)	Linear relationship between expected return and risk
ARCH (Autoregressive Conditional Heteroscedastic) and GARCH (Generalized Autoregressive Conditional Heteroscedastic) Tests	Engle (1982) Bollerslev (1986) Nelson (1990) Harvey, Ruiz & Shephard (1994)	Conditional variance Auto-regressive conditional heteroscedastic models They are used in stationary time series of high frequency financial and environmental data
Causality of the Chicago Exchange Future Price on Mexican Yellow Corn Physical Prices	Godínez (2006)	Econometric procedures of the auto-regression vector (impulse-response function, variance decomposition and Granger's causality)
Causal Relation between the Mexican Stock Market Index and the Spot Exchange Rate	Plata, Leyva, and Cárdenas (2007)	Cointegration, Granger's causality and VAR techniques are used with the error correction method
Hedge Theories with Futures Contracts	Aragó (2009)	Review of the main theories and models for hedging futures contracts
Calculating the Cost of an Insurance Premium Against a Fall in the Price of White Corn: the Sinaloa Sase	Rivera & Martínez (2010)	Comparison between the cost of an insurance premium against the fall of white corn price for Sinaloa versus the cost of the ASERCA simple coverage premium based on an auto-regressive model and time series OLS for white corn and a Monte Carlo simulation for price prediction
Use of Financial Derivatives in Uruguayan Soybean Production	Orsaetti, Bessonart & Marroni (2011)	Minimization of the variance of price performance of futures contracts, estimation of the minimum variance hedge ratio (MVHR) through bivariate models with error correction vector
Econometric Analysis of Prices in Agricultural and Energy Markets	Riotorto (2014)	Time series analysis with univariate and bivariate GARCH models
Transmission Effect of Corn Market Prices to the Tortilla Market in Mexico	González & Martínez (2015)	Relation between weighted average price of corn and weighted average price of tortilla based on a unit root test, Aikake's data criteria and Johansen's cointegration test
Alterations in the Stock Market Behavior of Technology Companies Induced by the Maturity of Derivatives	Amigo & Rodríguez (2016)	Detection of behavioral differences in the prices of underlying assets due to arbitrage and/or speculation operations Employment of the ARCH methodology on daily data
Transmission of CBOT Corn Futures Prices to the Mexican Spot Market	Ortiz & Montiel (2016)	Analysis through multivariate stochastic volatility

Source: Authors' own design (2019).

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Acronyms and Abbreviations

ASERCA	Agency for Services to the Commercialization and Development of Agricultural Markets
BM	Bank of Mexico
BMV	Mexican Stock Exchange
BG	Breushch-Godfrey
BPG	Breushch-Pagan-Godfrey
CBOT	Chicago Board of Trade
CDMX	Mexico City
CEFP	Center for the Study of Public Finances
CFTC	Commodity Futures Trading Commission
CME	Chicago Mercantile Exchange
CME Group	Chicago Mercantile Exchange Group
CNBV	National Banking and Securities Commission
COMEX	Commodity Exchange, Inc.
CONASUPO	National Company of Popular Subsistence
CPE	Chicago Produce Exchange
CPEUM	Political Constitution of the United States of Mexico
DCM	Designated Contract Market
DOF	Federal Official Gazette
DW	Durbin Watson
ECM	Error Correction Model
ECLAC	Economic Commission for Latin America
EF	Financial Economics
EG	Engle-Granger
ENA	National Agricultural Survey
FAO	United Nations' Food and Agriculture Organization
FE	Financial Engineering
FIRA	Trusts Established in Relation to Agriculture
FND	National Fund for the Development of Livestock, Rural, Forestry and Fisheries
FOB	Free on Board

GATT	General Agreement on Tariffs and Trade
IMF	International Monetary Fund
IMSS	Mexican Institute of Social Security
INEGI	National Institute of Statistics and Geography
INPC	National Consumer Price Index
IPC	Index of Prices and Quotes
ISSSTE	Institute of Security and Social Services for State Workers
JB	Jarque-Bera
LIFFE	London International Financial Futures Exchange
LMV	Securities Market Law
LRAF	Law to Regulate Financial Groups
MexDer	Mexican Derivatives Exchange
MT	Metric Tons
MXN	Mexican Peso
MZ	Yellow Corn Futures
NAFTA	North American Free Trade Agreement
NYMEX	New York Mercantile Exchange
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Squares
OTC	Over the Counter
RWM	Random Walk Models
SAGARPA	Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food
SCNM	Mexican System of National Accounts
SE	Ministry of Economy
SHCP	Ministry of Finance and Public Credit
SIMEX	Singapore Monetary Exchange
SNIIM	National Information and Market Integration System
Telmex	Teléfonos de México
USA	United States of America
USD	United States Dollars
USC	Peasant Socioeconomic Unit
WB	World Bank

Glossary

Anthropology. Science that studies the physical, social and cultural aspects of human communities (Ramírez, 1994).

Arbitrage. A strategy that seizes any profit opportunity arising from price differences (Feenstra & Taylor, 2012).

Bonds. “Certificate issued by a State or corporation that earns interest, promising to repay a sum of money (the principal) plus interest at a specified date in the future” (Samuelson *et al.*, 2006, p. 704).

Brownian movement. Random process to describe the behavior of variables that move in time. They are inserted into mathematical financial models to find answers to the problem of having large numbers of factors that influence the valuation of underlying assets. The pioneers in its use were Merton (1973), for the study of finance, and Itô (1944), in the development of the stochastic calculation required in such models (Pérez, 2015).

Carrying cost. “The cost of carrying the underlying asset in the futures contract to its maturity; this can be positive or negative depending on whether futures prices are higher than spot prices and vice versa” (Mansell, 1992, p. 300).

Commodities. Products underlying a futures contract on an established commodities exchange. These are physical goods that constitute basic components for more complex products. They are classified into grains, softs, energies, metals, meats, financial, indexes and currencies. As Dunsby, Eckstein, Gaspar and Mulholland (2008, p. 5) point out, investors do not actually invest in physical commodities themselves [merchandise], but in the future of commodities. Thus, when we talk about investment in commodities, we are talking about investment in the futures market; at the same time, the commodities index is the commodities futures index. Desireé (2008, p. 1), sustains that “Primary products, such as coffee, sugar cane, wheat, corn, rice, beans, and sorghum, do not differ in their production phase, and their commercialization is generic, without brands that add specific value. Therefore, they are considered within the group of products known as agricultural commodities. But there are also non-agricultural commodities such as petroleum, gold, silver, copper, among others” (Berdugo, 2014, p. 164).

Competitiveness. In its oldest and most common meaning, the term competitiveness refers to the extent to which prices of a country's goods and services can compete with those of other nations (Berdugo, 2014).

Credit risk. "When an investor grants a credit to a debtor, there is the possibility that a loss will occur if the debtor does not fully comply with the financial obligations agreed in the contract in relation to the time, form, or amount to be paid" as well as the "Decrease in the value of the assets due to the deterioration of the credit quality of the counterparty, even in the case that the counterparty fully complies with what was agreed" (Pérez, 2013, p. 24).

Demutualization. "It is a worldwide trend where stock exchanges are converted from member-managed non-profit entities to shareholder-controlled for-profit companies (corporations). This demutualization is commonly carried out in three stages: *i*) The first is to incorporate a corporation and assign a membership exchange value for a certain number of shares. *ii*) The second stage consists of giving more participants access to the operation, even if they are not shareholders of the stock exchange. Moreover, electronic operation systems make this access possible for both national and foreign entities. *iii*) The third and final stage consists of listing the shares of the stock exchange itself on the local stock exchange. Some of the stock exchanges that have carried out this complete process are Germany, Euronext (Paris, Brussels and Amsterdam), Australia and London" (BMV, 2017, D section, § 3).

Elasticity. A term widely used in economics to denote the response of one variable to variations in the other. The elasticity of X with respect to Y is the percentual variation in X for each 1% variation in Y .

Fictitious capital. This is an economic concept explained by the literature as a phenomenon alien to the process of real capital reproduction, and it is used together with the concept of speculation to explain financial phenomena that take place in contemporary capitalism. As Pacheco points out (2006) "The formal identity between speculation and fictitious capital is manifested in the widely extended concept of speculative capital. Speculative capital is generally understood as capital that is valued from the differences of interest rates produced between different countries. However, what is relevant at this stage of so-called global capitalism is not the existence of a

particular form of capital valued on speculation, but the transnational character of speculation itself” (p. 25).

Financial capital. Financial capital is understood, in general terms, as capital loaned at interest, such as bank capital, and capital applied to different investment funds, as pointed out by Sweezy (1994), Amin (2008), Foster (2010), among others. However, it should be noted that for the Marxist theory, financial capital is composed in part of money capital and the portion of mercantile capital that specializes in the handling of money, banks, and all institutions that carry out monetary operations (Astarita, 2012).

Financial groups. “Unions of financial institutions that operate as integrated groups prior authorization of the SHCP” (Díaz & Aguilera, 2013, p. 21).

Free on Board. A condition of sale in an international transaction that includes the cost of the goods to be shipped and the loading of the vessel but not the transport costs. The seller has the obligation to load the goods on board the vessel at the port of shipment specified in the sales contract. The buyer selects the vessel and pays the sea freight. The transfer of risks and costs occurs when the goods pass the ship’s rail. The seller takes care of the export formalities (ICC, 2010).

Geopolitics. Geopolitics, as first defined by Kjellén in 1916, “is the influence of geographical factors, in the broadest sense of the word, on political development in the life of peoples and States” (Atencio, 1982, p. 24).

Hedging. Buying and selling securities to reduce risk; the goal is to achieve perfect protection for a risk-free portfolio (FIRA, 1995).

Inflation. Also known as inflation rate, “it is the percentage of the annual increase in a general price level” (Samuelson *et al.*, 2006, p. 714).

Input-output Matrix. It is an instrument to interpret the interdependence of the economy’s various sectors. It describes the transactions between sectors of the real economy and analyzes the effect of final demand variations among sectors in a situation of equilibrium (Márquez, 2014).

International markets. The markets where residents from different countries exchange assets. (Krugman, Obstfeld & Melitz, 2012).

Law of one price. “In the absence of friction [...] and on competitive terms [...] identical goods should be sold in different places at the same price if the prices are expressed in the same currency” (Feenstra & Taylor, 2011).

Liquidity. It is the ability to buy or sell quickly (Mansell, 1992).

Money supply. “In a strict definition [...] M1 includes coins, cash and all direct or check deposits; this is money for transactions. Broadly, [...] M2 comprises all that is included in M1 plus certain liquid or quasi-money assets, such as savings deposits, money market funds and the like” (Samuelson *et al.*, 2006, p. 718).

No street territories. Term used to refer to poor and mostly rural areas in low-income countries (Songwe, 2011).

Notional value. It is the amount of the underlying asset in a derivative instrument where the underlying asset is generally not deliverable. They serve as a basis for calculating the final spot settlement or for calculating the sequential cash flows in the case of a multi-period instrument such as a swap.

Off-Shore. This is a term usually applied to a company registered in a country (usually a tax haven) other than the country or countries where its financial activities take place. An offshore company is commonly used for activities such as captive insurance, offshore marketing, international shipping, or tax shelters (OECD, 2017).

Options. It is the right to buy or sell a stock at a particular price at a specific future date. An Option will only conclude a transaction on the specified date when it is favorable to its owner (Wei, 2014).

Over the Counter. Over the Counter (OTC) is a type of off-exchange market that is not organized institutionally. It is composed of private and bilateral contracts between financial intermediary companies and the client.

Peasant socioeconomic unit. “They are those peasant units in our country that develop production to a certain extent on a commercial basis without abandoning self-supply and are based on family labor. However, in many cases they resort to the eventual aid of extra labor and have control over or ownership of a small land property” (Bartra, 1982, p. 26).

Physiocrats. School of thought that postulated “the government of nature”. It argued that human laws should be in harmony with natural laws. The most important representative was François Quesnay, whose publication of the *Tableau économique* (1758) contained the principles that physiocrats would adopt as their line of thought.

Productive capital. Productive capital is one of the specific functional forms of capital value within the global cycle of industrial capital (“industrial, in the sense that it includes all branches of production exploited on capitalist

bases” [Marx, 1885]). It also refers to capital that is occupied in the production sphere; its function is to create more value from already existing value.

Public offering. It is the initial placement of securities among the investing audience (BMV, 2017).

Put-Call parity. The put-call parity refers to the relation between the value of a call and the put registered in the same stock market with the same strike price and the same maturity term. Specifically, the parity indicates that the sum of the put value and the stock market price is equal to the sum of the call value and the actual value of the strike price. This relation is independent of any price model. (Wei, 2014).

Risk management. Process by which risk exposure is identified, measured, and controlled. It is an essential element for the solvency of any business. Risk management ensures compliance with the policies defined by the risk committees, reinforces the capacity for analysis, defines valuation methodology, measures risks and establishes homogeneous procedures and controls (BMV, 2017).

Shares. “Financial instrument that represents ownership and voting rights in general within a corporation. A given stake in the shares of a company provides ownership of that fraction of votes, net profits and corporate assets” (Samuelson & Nordhaus, 2006, p. 703).

Softs. Agricultural commodities originated from raw materials with a certain transformation process; these include products such as sugar, coffee, cotton, cocoa, and orange juice (Index Mundi, 2017).

Speculation. “Financial speculation is a global phenomenon that has behaved dramatically since the explosion of international liquidity in the 1970’s and the policies aimed at liberating capital markets. Said liquidity remains constant today in a system that began developing after the disappearance of the gold dollar pattern and the widespread establishment of flexible exchange rates” (Zapata, 2003, p. 100).

Spot. Market of delivery and immediate payment of a product (FIRA, 1995).

Spot price. The spot price is the cash price of the product. Same as “cash price” (FIRA, 1995).

Stationary stochastic process. “It is said that a stochastic process is stationary if its mean and variance are constant in time, and if the value of the covariance between two periods depends only on the distance or lag be-

tween these two time periods, not on the time in which the covariance has been calculated” (Gujarati, 2010, p. 772).

Swaps. It is a derivative financial instrument that consists of a bilateral exchange of money or future financial instruments. They are interest rate swap, currency swap, commodity swap and equity swaps. They are generally used to hedge risk or take advantage of certain market conditions (Wei, 2014).

To-arrive. Contracts in which buyers and sellers privately agree on the terms of sales to be executed upon arrival of goods at a future date (Hull, 2004).

Trade surplus. It refers to the moment when the total value of exports is higher than the total value of imports of a country based on its balance of trade (Samuelson *et al.*, 2006).

Uncertainty. Uncertainty occurs when an individual in the decision-making situation makes decisions based on his or her own expectations about market imperfections rather than on probability and statistical calculation on actual historical data (Knight, 1921).

Volatility. “A term describing the variability of a share price. The most common measure of volatility is the annualized standard deviation of returns, which is used in the Black-Scholes option pricing model. The volatility of the underlying instrument is generally favorable for an option. Even in stock movements against the option holder, the loss on the option is limited unless a large movement in its favor leads to an extremely high return. Since it is impossible to know how volatile a stock will be in the future, historical volatility is often used as a reasonable estimate” (FIRA, 1995).

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*Analysis of Mexican Corn Prices in the Chicago
Board of Trade Futures Market, period 2000-2016,*
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This work outlines an analysis of the relationship between real prices of real production and prices resulting from speculation in the period 2000-2016. The specific agricultural commodity selected to carry out this study is Mexican yellow corn, whose prices are analyzed based on the spot market, on the real or physical goods market, and on the results of speculation within the Chicago Board of Trade (CBOT) of the CME Group, located in the United States of America. To achieve the above, a linear regression analysis using the ordinary least squares (OLS) method and time series data has been applied. We consider that this tool is the most appropriate to test the hypothesis planted based on currently available data.

Among the main findings of the analysis is that the growing speculation in agricultural commodity markets (in this case Mexican yellow corn) brings with it a series of structural problems in the Mexican agricultural sector, such as the agrifood crisis, the lack of food sovereignty and a highly speculative pricing process coming from abroad. In this sense, this work shows evidence of the need to put forward proposals in terms of public policy, whose axis is the effective regulation of the national and international financial system.



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