UNIVERSITÀ CATTOLICA DEL SACRO CUORE

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Traders Behaviour in Agricultural Commodity Markets in View of Recent Global Developments

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Se cammino sento che
Vado avanti
E allora, la notte non si ferma e passa
Mentre il giorno mi viene incontro
Cammino... Io cammino
Tutti devono camminare
L'importante è camminare
Non importa se si è lenti o veloci
Basta camminare...
Se cammini... vai avanti
Camminare non vuol dire soltanto muovere le gambe
E fare dei passi...
Se la tua mente pensa... e pensa...
Nel modo giusto...
E allora vuol dire che tu cammini... e in te tutto si muove”

Abstract

The purpose of this thesis is to determine whether better risk management strategies, particularly hedging with futures contracts, can be utilized in the Italian market. We approach this by looking at the agricultural commodities market, defining its aspects and ramifications, and figuring out the optimal strategies for grain storage and price protection. We discuss the multinational corporations that dominate and have a significant influence on the global trade in commodities in the first chapter. The second chapter explains commodity trading, or the trade of various commodities, with an emphasis on futures contracts as a means of reducing the risks associated with keeping and storing commodities because they allow market participants to "hedge." In the third chapter, we compare the spot prices for the Italian market from the Borsa Merci Bologna to the futures prices for contracts traded on the EURONEXT and CBOT exchange. The value-at-risk of hedging with a diverse portfolio of commodities is then presented, along with an explanation on the reason why hedging influences the final selling price of the commodity.

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List of Abbreviations

Archer Daniels Midland

(ADM), 10

Chicago Board of Trade

(CBOT), 10

Chicago Mercantile Exchange

(CME), 11

Commodity Futures Trading Commission

(CFTC), 25

European Union

(EU), 10

Food Agriculture Organization

(FAO), 16

Hirschman-Herfindahl Index

(HHI), 14

Historical Value at Risk

(HVAR), 38

London Metal Exchange

(LME), 10

New York Stock Exchange

(NYSE), 24

Oxford Committee for Famine Relief

(OXFAM), 12

Structure Conduct Performance

1. Background and previous studies: Industrial Organization

1.1. Overview Of the Major Agricultural Commodity Traders

According to authors, a commodity trader is “an individual or a business that invests in physical substances, like oil, gold or agricultural products” (Chen, 2022). Commodities traded can be sorted in four categories: metal, energy, livestock, and meat and agricultural. Dedicated markets, or exchanges exist for cotton, wheat, corn, sugar, coffee, cattle, oil and many more items. Delivery of the goods can either be immediate “on the spot”, deferred with forward contracts or via futures contracts. Major exchanges in the world by geographical area are the Chicago Board of Trade (CBOT) and the Chicago Mercantile Exchange (CME) in the United States (US), the London Metal Exchange (LME) in the European Union (EU) and the Tokyo Commodity Exchange (TOCOM) in Japan. Within the subsector of agricultural commodities there are four big commodity traders, collectively known as “ABCD” – Archer Daniels Midland (ADM), Bunge, Cargill, and Louis Dreyfus. With the oldest of them being funded 120 years ago, they exert a strong influence on the market and according to some authors, they control around 90% of global grain trade (Holt-Gimenez, 2012). They operate across the whole supply chain as input suppliers, landowners to providing the infrastructure for transporting and buying the outputs while storing them in their facilities. Their value-added activities are particularly relevant on logistical and delivery challenges. In fact, the planning

and transportation of products on vessels, barges and rails requires extensive expertise and the ownership of global storage points and dedicated delivery systems is an indispensable ingredient for success in agricultural trade.

1.2. Market power: The Case of Agribusiness Firms

The major agribusiness firms are privately held and answers to a board of family members, employees, and private investors. Their global reach, undoubted access to capital and power exerted over producers who sell them their crops has led to several suspicions on their operations. The bankruptcy of the Switzerland-based global grain giant Andre & Cie SA, once considered one of the five top traders in the world by operating across 70 countries with a revenue of over 10$ billion a year, was caused by the exceedance of dealing limiting in soybeans trading on the CBOT and has urged their competitors to adapt their market presence (Behrmann, 2001) in view of the growth of the “supermarket revolution” where global retailers like Tesco, Wal-Mart, Carrefour and consumer companies like Unilever and Nestlé shifted the trade of food commodities on value-added products rather than bulk. From the 1980’s, the trade of bulk and intermediate processed products has steadily decreased (Figure 1.1), thus the use of bulk commodities trade can no longer be considered a valid indicator for measuring agricultural trade growth. The fastest growth is represented by consumers differentiated product like pastry, chocolate and wine that carry unique brand names (Gehlhar, 2001).

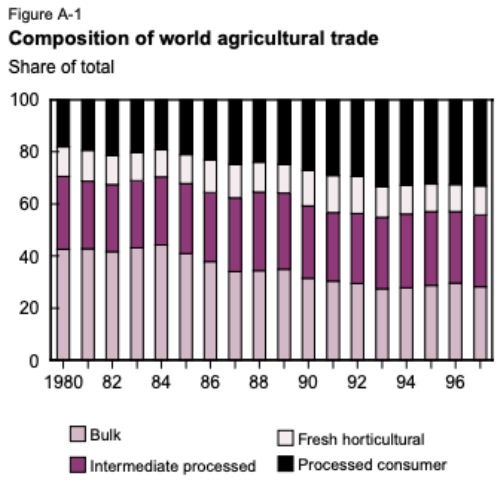

Figure 1.1 – Changes in the global agricultural trade composition from 1980 to 1998.

In response to these changes in the composition of agricultural trade, the expansion of these companies comes mainly from trading new products and ingredients and acquiring competitors. In 2021, ADM bought Deerland Probiotics & Enzymes with the aim of tapping onto the health and well-being market, whose demand is estimated in the hundreds of billions (Archer-Daniels-Midland, 2021) and Viterra (former Glencore Agriculture) entered in a stock purchase agreement with Marubeni to acquire Gavilon for 1.125$ billion dollars (Viterra, 2022). Concerns on the abuse of oligopolistic market have been raised by several organizations. The Oxford Committee for Famine Relief (OXFAM) reports on the leverage exerted by trading houses when dealing with farmers, since bulk agricultural trade purchasers are relatively few and this can lead to setting prices with relative ease (Murphy, 2012). The barrier to entry is also very high due to informational asymmetry – Something that commodity trading companies can

easily gather with respect to producers and consumers. They also have better access to capital that partly offset the fixed costs deriving from maintenance and storage of grains.

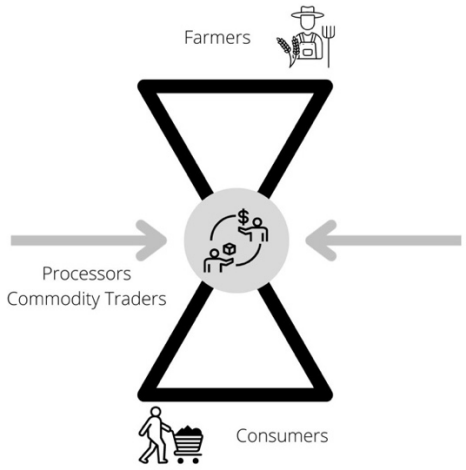

Figure 1.2 - Visual representation of vertical market power in the agricultural value chain.

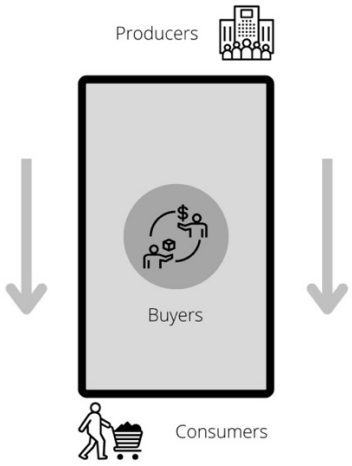

Figure 1.3 - Visual representation of a market where buyers do not exert market power.

Finally, the financial trades movement involving large amount of money are often accompanied by expensive margin requirements. There are two dimensions to this market power: horizontal and vertical. Horizontally we have an agricultural value chain composed by thousands of producers, hundreds of elevators and few processors or exporters that sell to millions of customers. Vertical market power is exerted as part of their value chain. Commodity trading companies buy grain from the elevator and process most of it. Their subsidiaries consume their processed grain, either for biofuels or as feed for livestock. The commodities become an

internal cost from operations and aren't sold in the open market. This reduces the price discovery mechanisms which is an inherent characteristic of futures markets.

1.3. Market Behavior of Commodity Trading Firms

Examining the behavior of commodity trading firms regarding changes in the agri-food industry can let us understand whether "bad" concentration, deriving from rising market power or strategic creation of barriers of entry may be present. Assessing competitions is possible through empirical approaches. The first approach is based on the Structure Conduct Performance (SCP). Developed from the 1930 to the 1960s for the purpose of providing a guide for competition policies. It considers a relationship between structure of a market, which then determines market conduct (prices and investments) and performance. Its main drawback is that it does not measure strategic interaction between firms and their behavior. For example, we could use combined sales of the largest firm in an industry. On this approach is based the Hirschman-Herfindahl Index (HHI), upon which several studies for estimating the level of competition in the agricultural industry have been based (Van Dam, 2021) (Piet, 2021) (Mary Hendrickson, 2007). Other indicators are the Lerner Index, based on revenue and the Boone indicator, or profit elasticity indicator. These last two methods consider market contestability from regulatory parameters, and they are considered broader in the sense that they consider the number of remaining competitors, their market share and imports and turnovers as factors that can change the market landscape. (Claessens, 2009). The third

approach is called H-statistics and measures the reaction of the output to input prices. With each indicator providing limited information, authors agree in their helpful estimation on the degree of market concentration, but there's a need of using multiple measures and other factors in our analysis as well. One drawback of current studies is that when constructing these measures on a national basis, we need to consider the multinational approach of commodity trading companies in which the relevant market may be larger (OECD, 2021). Oftentimes, the conduct of a firm buying products is a more reliable indicator of a possible dominant approach. It is important to discern if the concentration in the market is "good" and if it exists as a manifestation of efficient and superior technologies or adoption of innovative processes. Some countries like China are trying to defend from strong oligopolies structure by weighing the price benefits of foreign owned companies over their nationalistic ambitions. In China, over the last 20 years, import of soybeans have increased more than 10 times, from 28 million up to an estimated 100 million tons in 2022-23, according to USDA (Reidy, 2022).

1.4. Revenue Analysis of main Commodity Trading Firms

Commodity trading companies seems to defend well in periods of price. Despite some drawbacks after the financial crisis of 2008 and the Russian export ban, opportunities were created from profit due to shifts in food prices and changes in normal trading routes for commodities.Their revenue was analyzed using net income as an indicator of choice, as it takes into consideration operating

efficiencies, rather than the ability of generating sales and the Food Agriculture Organization (FAO) Price Index as a measure of changes in food prices[1] (Figure 1.5). The data for net Income was extracted from Thomson Reuter Refinitiv Eikon platform[2] with some additions from private press publications on Cargill for the last two years, since they halted public reporting of its quarterly and annual financial data (Blas, 2021). Louis Dreyfus does not publish their results to the public at all, thus it was excluded from our analysis. Overall, it seems there's a correlation between periods of high volatility and variations in net income, except for 2019 when Bunge posted a loss (Figure 1.4).

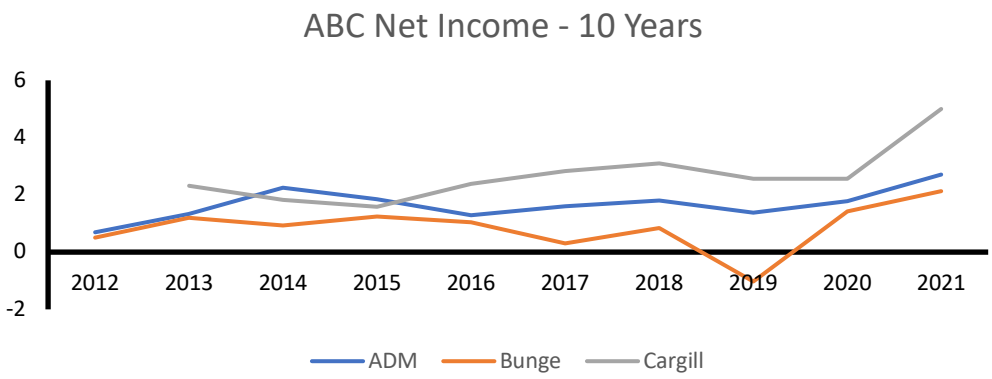

Figure 1.4 – Income of three major commodity traders over the last decade.

[1] The FAO Food Price Index consists of an average between five commodity group prices: meat, dairy, cereals, vegetable oils and sugar and is weighted with the average export shares of each group. To represent international prices, 95 price quotations are taken into consideration in the overall index (Food and Agriculture Organization of the United Nations, 2022).

[2] Eikon Financial Analysis & Trading Software | Refinitiv |

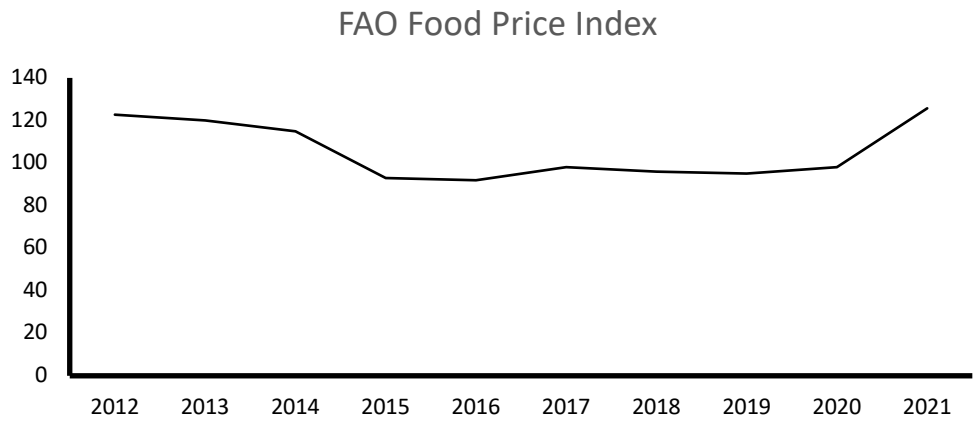

Figure 1.5 FAO Food Price Index over the last decade.

A seemingly positive response to food price volatility indicates that the differentiation strategies proved their worth, especially having places where to store grains and hedge from negative positions. The volatility in futures and options prices created new opportunities for large traders, that capitalized on these opportunities through their positions and participation in investment funds. With their profits raising along with food prices, the problem of food security arises and is questionable whether traders are merely hedging their positions or speculating on them. It remains complex to distinguish a commercial need for a commodity from an arbitrage opportunity. If an excessive speculation is present in the market, also futures markets may experience unneeded price spikes as a result, which will directly raise the cost of hedging.

1.5. Welfare Loss and the role of Information Asymmetry

The consequences of an excess of market power result in lower allocative inefficiency, higher costs due to product inefficiency and rent seeking activities, where companies spend their resources on trying to influence public policies. Agricultural commodities offer near to identical product, although with slight differences on quality. When this happens, companies tend to become concentrated and form oligopolies, a market structure where “a small number of organizations has control of an area of business” (Cambridge University Press, 2022) and consumers view the product sold by different firms as the same. An excess of market power reduces social welfare, as it’s transferred from consumers to firms. In many transactions happening every day, information between parties is *asymmetric*, meaning that an economic agent can take advantage of information not available to the other party. Although the problem of information asymmetry has been recognized since the antiquity by Greek Stoics[3] (Farnam Street Blog, s.d.), it wasn’t until the 20th century that this phenomenon was acknowledged. In traditional economics, price is believed to transmit all the necessary information about a product, but the way through which this information is exchanged varies.

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[3] The tale of a merchant who transported a sizable shipment of goods from Alexandria to Rhodes is told in Cicero's "De Officiis III." The trader can reach the island before his rivals who were transporting similar products. The merchant must decide whether to tell the islanders that there is a bigger quantity of commodities available or whether to "fake" a shortage to raise the price at which he sells his own products.

The problem of perfect allocation of resources isn't only a logic problem given certain preferences. Every individual possesses different amount of data and solving this problem means to rebuild the scattered and incomplete bits of knowledge that individuals possess. We can then redefine this problem in the utilization of the knowledge available, which is never concentrated equally in every individual (Hayek, 1945). The simplest example is perhaps the "Market for Lemons", that describes the relationship between car salesman and their clients. When buyers cannot distinguish between "peach" (good cars) priced at P_{peach} and "lemons" bad cars priced at P_{lemon}, their willingness to pay will be equal to the average between the value of the two, or P_{avg}. The only party that knows the real value of the car is the seller, that given the fixed price from the buyer will keep the good cars and sell the "lemons" at a higher price. Akerlof's (Akerlof, 1978) intuition was that asymmetry of information leads markets to inefficiency and resolving in a sub-optimal outcome, where "market failure" occurs. When not satisfied, sellers of "peaches" will leave the market due to their inability of selling their cars, and the average willingness-to-pay will decrease causing high-quality cars to disappear from the market. The issue of prices determining quality of goods traded on the market has been well studied and applied in futures market as well. Commodity traders exploit arbitrage opportunities coming from situations of non-competitive equilibrium and where informational asymmetry is present. The arbitrage opportunity is costly, but a compensation is received from those who pay for it, as it allows them to anticipate returns as it allows the price to reflect more information

than to uninformed market participants. Speculators are assumed to have different information regarding the realized value of certain random variables. In 1980, Grossman (Grossman, 1980) described this phenomenon with a model where there are two assets: R, safe and yielding a return and a risky asset whose return u varies randomly and consists of two parts, $u = \theta + \varepsilon$. Both are random variables, θ is observable at cost $\mathcal{C}$ while ε is unobservable. Equilibrium for this system is defined when $P_{\lambda}(\theta, x) = S$ where λ is the percentage of hedgers (informed traders) and x represent the supply of u, the risky asset. Informed traders, or speculators will observe θ whereas uninformed traders only observe the price. Since both parties are rational, hedgers will learn the distribution of price regarding returns and will use this in their demand for u. Additionally, when the expected utility of informed individuals is higher than the uninformed, there will be a shift towards acquiring information. As this shift happens, the expected utility of the informed individuals will be lower than their counterpart for two reasons: the first being that the price system will become more informative when higher quality of information is available, the second being that an increase in ratio between uniformed and informed traders will translate in a lower per capita gain from trading with uninformed individuals. Commodity trading firms utilize this information in their processes of risk measurements. Their deep involvement with buyers and producers of agricultural raw materials allows them to obtain information otherwise inaccessible to average consumers.

1.6. Collusion and Defection

Imperfect competition exists in agricultural markets to some extent. There are numerous farmers and few processors and most of the times information is not completely shared among parties as discussed before. When few companies enter in rivalry, they tend to generate non-cooperative oligopolies in which competition is made on quantities or prices. Cournot competition causes firms to overproduce, whereas Bertrand competition causes a price war. Both results are undesirable, and enterprises would be better off coordinating their efforts by limiting their market output and artificially increasing the market price, in structures called cartels. Having frequent interaction in the market leads companies to identify solutions that involve cooperation. Lack of manufacturing differentiation and market product uniformity are factors that tend to establish cartels. A greater number of market contacts can reduce the costs of maintaining cartel agreements by shortening the time for probable cheating and its subsequent identification and punishment. Exchange of information is crucial for monitoring potential detection, and stable market circumstances help with this. This formula for favorable circumstances works particularly well for raw materials with qualities that are extremely similar and that are often traded throughout the world in the agricultural sector. Empirical demonstration of collusive markets is trivial, and results have been varied. To determine the level of rivalry in rural agricultural markets, experimental data based on models of market competitions was evaluated. To lower the marginal costs for traders in a market for agricultural products in Kenia, model-based randomized

trials were performed. Consumer costs were reduced by 22% because of a one-month subsidy program, which is less than the ideal 100% decrease that would indicate a market with perfect competition. The rate of pass through is comparable to Cournot market structures with either a completely collusive market or a collusive demand curve. A subsequent welfare study revealed a 14.6% decrease in overall surpluses, of which 79% were captured by intermediaries and 21% by consumers (Bergquist, 2017).

1.7. Asian-American Lysine Price-Fixing

In the 1990s, five companies—American Archer Daniels Midland (ADM), Japanese Ajinomoto, Korean Sewon America Inc., and Japanese Kyowa Hakko Kogio (now known as Kyowa Kirin Co. Ltd) and Korean Ajinomoto and Kyowa Hakko Kogio—were found guilty of conspiring to fix the price of lysine, a crucial amino acid for animal diets. This was the U.S. Department of Justice's first international cartel case, which sparked global cooperation on price-fixing issues. As the guiltiest party, ADM consented to pay a fine of $70 million. The two Japanese businesses controlled 60% and 20%, respectively, of global sales on the lysine market (White, 2001). ADM made the decision to construct a lysine production facility in Decatur, Illinois, in 1989. As a result, lysine output would double globally. ADM's top executives ultimately made the decision to travel to Japan to collaborate with representatives from the two Japanese businesses to form the "amino acids trade association," an entity that would make decisions

about prices, sales, share distribution, and production levels for the product. When Mark Whitacre, a member of the ADM committee, turned informant to the FBI, investigations officially began, aided by a large amount of evidence that included recordings of the meetings, audio, and video. Once there was enough information, the Department of Justice decided to conduct a raid on ADM's offices to seize papers and reveal their ongoing lysine price-fixing investigations. The size and sum of the fine also became a sensitive issue. Price fixing is a felony under American law, punishable by both jail time and economic penalties. If the Sherman Act has been violated, the subjects who were damaged by the price fixers may demand repayment of their damages up to three times. (Sherman Antitrust Act, 2022). Connor (Connor, 1998) recognized several elements that might have helped in the formation of this cartel. First, the product was quite homogeneous, and the lysine market sales were highly concentrated (four producers provided 95% of the world's feed-grade lysine). There were high technical barriers preventing new businesses from entering the market and highly specialized plants needed significant capital expenditures and were not reproducible due to patents and technological secrecy. Additionally, lysine prices were kept secret from the public, were not traded on any commodity exchanges, and were only purchased occasionally in sized amounts. This made them more difficult to track than if they were small and frequent transactions.

1.8. The Ferruzzi-Montedison Case

Gruppo Ferruzzi was an agricultural trading company that moved around two million tons of goods and was Italy's first importer of soybeans, cereals, oilseeds, and cement. By 1983, after an Italian entrepreneur named Raul Gardini took over the company reems, it had grown to become one of the world's largest agro-industrial conglomerates. Their new market strategy was to establish a global company that could combine value-added chemicals with the agroindustry, thus providing a leadership role in what was then defined as “green chemicals”. This vision concretized by purchasing Eridania and Sugar Beghin Say, Italy's and France’s largest sugar producers, Central Soya and Leiseur Koipe, that processed soy from Argentina’s fields and later Montedison, with the goal of producing green chemicals from agricultural raw materials. Gruppo Ferruzzi was listed on the New York Stock Exchange (NYSE) and owned over 70 facilities in the United States, 1.8 million acres of land in Europe, the United States, Brazil, and Argentina, making them the largest soybean processor and starch and sugar producer. They were also market leaders in vegetable oils (45% of 1988 sales), soy protein (20% of market share), refined lecithin (50% of market share), first producer of pre-mixed feed and number two producer in the United States of animal feed (Goldberg, 1989). Due to a drought in Argentina that caused low yields, Gruppo Ferruzzi started to accumulate precautional stocks, resulting in the possession of 30 millions of bushels at the end of 1988. Concurrently, the group was actively participating in the futures market and owned many contracts with May delivery.

The group was asked by the Commodity Futures Trading Commission (CFTC) to clarify its position and liquidate their contract by the end of the month. As a response, Gruppo Ferruzzi said that that they had indeed accumulated positions in the market to guarantee operations in place in the Soviet Union and there were contracts in place that they needed to fulfill contractual obligation. The group still held contracts totaling 23.8 million bushels the following month, accounting for approximately 40.8% of total CBOT open positions. At the end of July, open positions totaled 6943 contracts, with each contract worth 5000 bushels of wheat (one bushel of wheat is around 27.21 kgs). If those positions were to be filled, physical product delivery would be nearly impossible, as the CBOT's warehouse only held "just" 13 million bushels. In response, the CFTC ordered all traders to reduce positions totaling more than one million bushels in order to reduce the risk that the amount of soybeans would not be able to meet the delivery obligations imposed on traders. Gruppo Ferruzzi's special hedging privileges, which allowed them to hold a larger amount of contract, had been revoked. As a result, by July 18th, 1989, their position had been reduced from 23 to 3 million bushels. Former CBOT chairman Karsten Mahlmann justified the organization's actions by saying, "The Board of Trade will not stand for a single party pushing the marketplace around" (Atlas, 1989). Due to the losses incurred because of these decisions, Gruppo Ferruzzi decided to respond to CBOT accusations of market manipulation and allegedly "cornering" the market through their cash and deferred contracts positions. The analysis of whether this was an act of price manipulation rejected

the null hypothesis that market participants in Summer 1989 were merely price takers in favor of the hypothesis that Gruppo Ferruzzi was acting as a monopolist with high confidence (Pirrong, Detecting Manipulation in Futures Markets: The Ferruzzi Soybean Episode, 2004).

2. Background and previous studies: Commodity Trading

2.1. Taxonomy Of Markets for Agricultural Commodities

There are two types of pricing in commodity markets: cash markets and futures markets. Cash markets are market channels in which the price is negotiated between participants. Quality specifications, timing, and location of delivery, as well as credit and payment terms, can all be negotiated between parties. The spot price can be for an immediate buyout or a deferred one, when the price can be set at delivery of a physical asset at a specific time in the future (forward contract), which is useful when the asset's production or procurement has yet to occur. The futures markets are the second pricing method. They differ from forward contracts in that they provide standardized contract terms through a centralized entity known as a clearing house. A clearing house's main goal is to act as a third-party guarantor for all transactions, to protect market participants from any form of manipulation, and to ensure performance by administering margin processes. The rules that are enforced apply to the pricing mechanism, delivery mechanism, and margin systems. They also include daily price movement limits and trading rules

such as position limits. Futures markets have two participants: Hedgers are individuals who hold an underlying cash position, either long or short. This means that they may own or require a specific asset. They participate in the market to reduce risk, which they accomplish by "hedging," or taking an opposite position to their current situation. When they have an asset, they will buy cash and short futures, and when they do not have an asset, they will buy long futures. Each of these two positions' movements will counterbalance and offset the losses in the other. Hedgers can be:

- *Farmers and livestock producers*: They produce an unlimited number of bushels of a certain product (long cash) and wish to guard against falling prices in the cash market. To do this, they will short future contracts related to their chosen commodity. They also require protection against rising costs for purchased inputs such as feed and fertilizers.
- *Merchandisers and elevators*: Need insurance against price drops between the time they buy grain from farmers or have a contract to do so and the time it is sold.
- *Manufacturers of food and feed*: Want to be protected from rising raw material costs or falling inventory values.
- *Exporters:* Require protection from rising grain prices for future deliveries that have not yet been made.

- *Importers:* They want to benefit from decreasing grain prices already contracted for delivery but not yet received.

Let's contextualize with an example of a short hedge: when a farmer has a certain inventory of maize after an harvest, he can long hedge by taking an opposite position in the futures markets by shorting a contract in the same amount of the owned crop and hedge until he needs to sell that specific commodity. The difference between its futures position and the change in the futures price will provide its payoff (Figure 2.1). With an opposite behaviour, an exporter who sold grain to a foreign buyer but has not yet purchased it could make a long hedge by purchasing a contract to protect against a price increase in the cash market until the purchase is completed and the sale is completed.

Date	Cash Position	Futures Position	Basis (b=c-f)
Sept 1	Long 10,000 bu @ 650	Short 2 Dec @ 700	-50
Nov 25	Sell @670	Buy 2 Dec @705	-35
Results	+20	-5	+15

Selling Price: P_{sell} = 670 -5 = 665

Margin: (= 665 - 650 = +15

Figure 2.1 – A short hedging example.

Speculators are the other participant in the market. As their primary objective is to make money from their higher risk positions, they supply liquidity and assume more risk than hedgers. Hedge funds, commodities pools, position traders,

spreaders or scalpers, and algorithmic traders are frequently involved in speculation. The purpose of the futures market is to capture and reflect market players' expectations, with prices expressing many individuals' perspectives. There would be no discrepancy between current prices and market expectations if there were no bias in participants' expectations. If it doesn't occur and bias is present, the market may exhibit either an upward or a negative bias. Although the primary function of futures markets is hedging, the emergence of hedge funds as active investors in agricultural commodities may have aided in the financialization of these markets. Position restrictions must be followed by index funds, hedge funds, pension funds, university endowments, and more generally non-commercial traders. Although similar restrictions exist for trades on public exchanges, they do not apply to swap transactions because they are derivative contracts traded over-the-counter (OTC) in private marketplaces. Due to the swaps loopholes, banks and other businesses can be treated as commercial entities and are therefore exempt from position restrictions. The quantity of long and short positions held by hedge funds is regularly disclosed in a CFTC report on Friday, and these positions are considered a catalyst for price movements during the day. In the last two years, swaps and managed positions have consistently been long, whereas producer holdings have consistently been short, or negative (Figure 2.2). Futures contracts have regulations that must be followed when taking positions, and there are two ways the contract might be fulfilled. The most popular method is contract offsetting when the position is either bought or sold asymmetrically. This eliminates any

contract obligation by bringing the net position to zero. The second procedure involves physically delivering the item to a designated warehouse and informing the clearing house that a physical cash settlement has occurred.

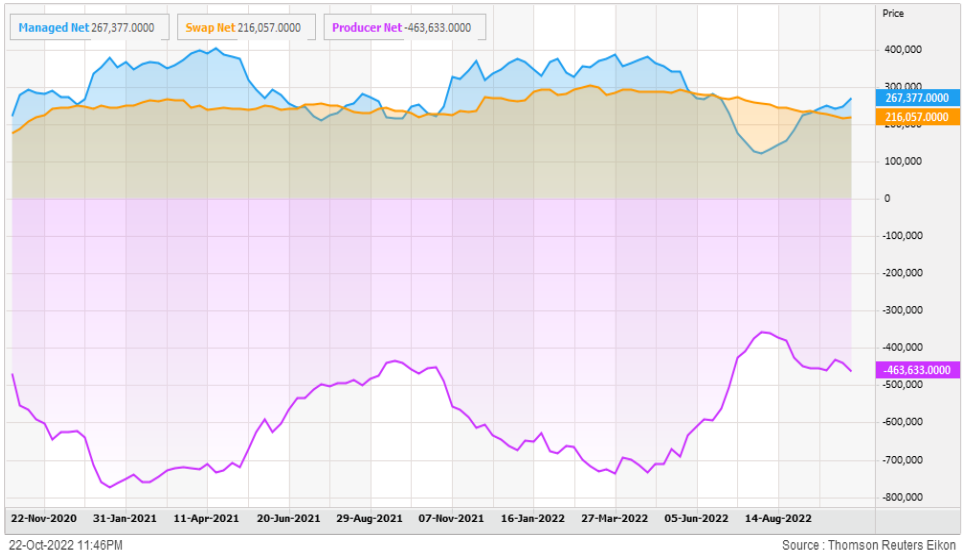

Figure 2.2 – Aggregated positions by commercial and non-commercial entities. Producers positions are represented in purple and are short, whereas blue and orange position are the ones of non-commercial entities.

2.2. Basis

The difference between cash and futures prices is defined as basis. Cash prices are regularly published by grain originators and purchasers. In Italy, cash prices are disclosed weekly in the “Listino settimanale” published by Borsa Merci, an institution that allows the negotiations of various commodity prices, negotiated by producers and buyers. In countries like the US, there are various tools available now to access basis information, such as MyDTN: HRS Basis, which shows the

basis difference across many different geographical areas (Figure 2.3). Four key factors influence the basis: the location due to transit costs, the time due to carrying and storage expenses, the presence of premiums or discounts for qualities that differ from the standard parameters, and the local supply. Only the supply remains difficult to estimate since it's the less predictable than the first three components. Because basis is less volatile than cash and futures prices, any hedging technique monitors it frequently. Although not always the case, basis is often more negative before harvest and increases as delivery approaches due to the accumulation of storage costs, which are typically around $.02 - $.04/ bushel/day. This behavior will be explained more in depth in the next sections with the theory of storage. When the basis is lower than the storage costs, a common trading strategy is to encourage storage, and vice versa.

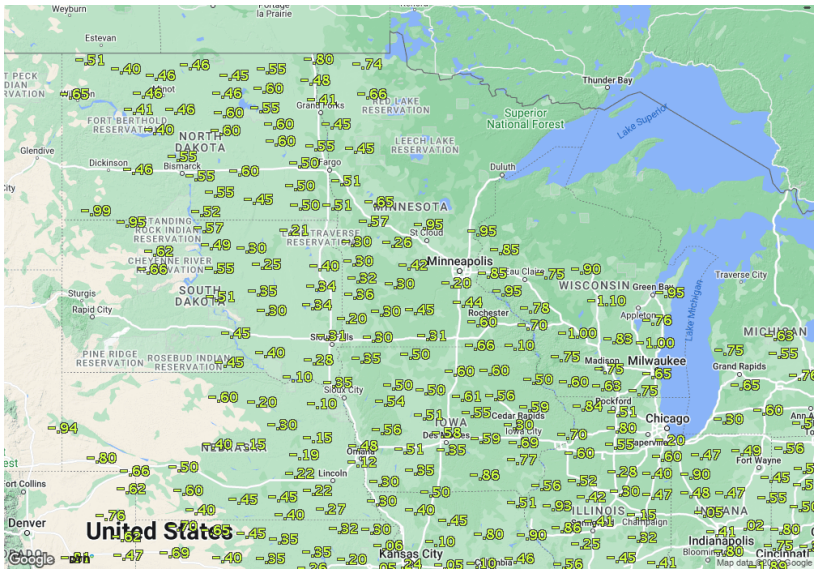

Figure 2.3 - Basis values in the US Midwest region in October 2022.

2.3. The Theory of Storage

When there are enough storage facilities in the market, storing can act as a buffer by absorbing price fluctuations. Storage also allows for the prevention of disruptions in goods and services and capitalization on price movements. Changes in spread or "carry" can influence a storer's incentive to sell or store grains because they determine whether a market is inverted or normal. The market is said to be normal when the intermonth spread between two futures contracts is positive for two or more consecutive months, and vice versa. The storer has less incentive to store the grains as the carry decreases. This will occur because the basis will rise over time as the positive market structure raises the basis. When the basis falls, more grains are available on the market. When the intermonth spread widens, a new incentive to store grain emerges. The EURONEXT Futures Contract intermonth spread is positive, indicating a normal market. Storers are encouraged to store their grains (Figure 2.4). This intermonth spread can determine the market price for storage P_s, making it easy to perform a storage hedge when it exceeds the storage costs S. When it is not, it is more convenient to sell the commodity. On the necessity and the risks of carrying inventories of agricultural products, Keynes first theorized the notion of “backwardation” (Keynes, 1930), suggesting that futures market exist to facilitate hedgers in avoiding risk, by selling their current inventory for a future delivery date, at a price that covers their opportunity costs for storage and by doing so, they naturally show a downward biased estimation of forthcoming spot prices. Since the futures market is not a reliable estimate,

hedgers are paying a premium, or a “fee” to speculators to use these markets as insurance (Carter, 1983).

PRICES - 13 NOV 2022

DELIVERY	BID	ASK	LAST	TIME	+/-	DAY VOL.	OPEN	HIGH	LOW	SETTL.	O.I
Dec 22	-	510.00	-	-	0.00	-	-	-	-	513.00	0
Mar 23	-	509.00	-	-	0.00	-	-	-	-	514.50	0
May 23	-	508.00	-	-	0.00	-	-	-	-	515.00	0
Sep 23	-	500.00	-	-	0.00	-	-	-	-	515.00	0
Dec 23	-	-	-	-	0.00	-	-	-	-	515.00	0
Mar 24	-	500.00	-	-	0.00	-	-	-	-	515.00	0
May 24	-	-	-	-	0.00	-	-	-	-	515.00	0

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Figure 2.4 - Prices of various futures contracts for European Durum Wheat.

This theory is based on the pattern of longs when they decide to take delivery of future contracts and accept the commodity as a settlement, which is profitable only when the spot price for a contract grade is lower than the futures price. This arbitrage will prevent futures prices from falling below the spot price at maturity. If this is not the case, it is more profitable to purchase the commodity at the spot price and deliver it later through a future contract. This behavior implies that the spot price will be equal to the futures price at maturity, adding the carrying charge (storage costs). Futures prices were therefore believed to forecast prices at maturity, often in a downward bias over time due to the arbitrage opportunities for

longs of taking delivery. In contrast to the latter, Hicks developed his “contango” theory (Hicks, 1939). According to the author, there may be times when speculators are short, which means that they expect prices to fall. This results in futures prices for delivery in the months ahead being higher than the spot price (Houthakker, 1957). This is in sharp contrast to Keynes' view that futures prices are normally lower than spot prices because risk-averse producers are willing to accept a discount relative to the price of goods traded in the months ahead (Rau-Bredow, 2022). The storage theory incorporates the Keynes-Hicks theory but focuses on the value provided by storage, a "convenience yield" that allows traders to exploit the buffer capacity of meeting demand and determining commodity prices. Working's later attempts to explain this phenomenon were inspired by his research into the US grain markets. A competitive market in which professional traders provided storage facilities while maintaining equal price expectations (Working, The theory of price of storage, 1949). According to the author, "hedging [...] is a sort of arbitrage, [...] is not necessarily done for the sake of reducing risks, [...] does not eliminate risks arising from price variability" (Working, 1953). He noticed that futures prices, specifically the difference between consecutive month contracts, reflects the market's expectation of the marginal cost of carrying the commodity from one month to the next. Because of the storage costs, it was common for spot prices to fall below futures prices and in some cases, when stocks are low and the convenience yield is positive, the net carrying costs (the difference between storage costs minus convenience yield) will be negative (Cristiano, 2012).

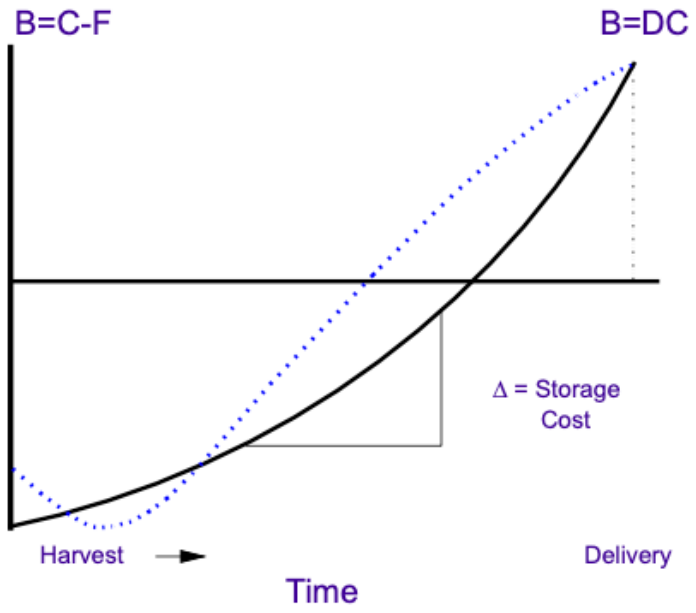

Figure 2.5 - Expected behaviour of basis with respect to time.

2.4. Issue of Non-Convergence

Because futures contracts are considered to be essentially equivalent to buying grain in cash at expiration, it is expected that their convergence will occur at maturity. This assumption is not always correct, as non-convergence can appear in certain markets, such as the wheat, soybean, and corn markets in the United States from 2005 to 2010. Non-convergence can endanger market functioning by making hedging less effective and signaling to market participants that the price discovery mechanism is not working as intended and is no longer an efficient mechanism of agricultural resource allocation. According to a study conducted by United States Department of Agriculture (USDA), inconsistency in storage rates is a major cause of non-convergence. More specifically, the exchange-set storage

rate was lower in comparison to the real cost of storage and this cost differential has resulted in a wider spread in the delivery month basis, preventing convergence. The study also refuted the theory that this effect was caused solely by market participants' trading activities (Adjemian, 2013). The introduction of a Variable Storage Rate (VSR) for certain contracts was one of the solutions proposed to solve this problem. The VSR will increase when the market is at full carry (wider spread) and decreases when the spread is narrower. According to some studies, this helped reduce non-convergence issues and prevent cornering and market manipulation (Pirrong, 2001). One disadvantage of this instrument is that it complicates the calculation method for storage costs and makes the delivery mechanism overly complex, to the point of avoiding delivery as part of contract settlements.

3. Trading And Risk Analysis With Regards To Recent Global Developments

3.1. Introduction

Agricultural commodity price volatility exposes farmers to risks on a regular basis, and hedging can be a good way to mitigate this risk. The effectiveness of hedging was evaluated in this chapter using the Value at Risk (VaR) method on historical price data extracted from the EURONEXT database, Europe's main financial

commodity market, with the goal of demonstrating the risks posed and ways to avoid them, with a particular focus on cases applied to the Italian market.

3.2. Background

The VaR method can help a company understand the market risk it is taking, by calculating a statistical measure of a portfolio loss, which in our case is carried for the aim of hedging the market with a diverse portfolio of agricultural commodities. In the late 1980s, major financial firms used VaR to measure the risk of their portfolios during market movements and over the years this methodology has become more and more spread (Holton, 2002). The primary application of VaR in agribusiness is to reduce a company's market exposure to risks. This is accomplished by establishing a maximum tolerable loss, or a level of confidence that can be tolerated, and by creating processes to enact in cases where the threshold is exceeded. The "at-risk" model should not be viewed as a crystal ball capable of predicting the future, but rather as one of many tools to interrogate to answer risk management decisions. Many tools that do not rely on historical data, such as forward curves (extracted from a contract intermonth spreads) and options implied volatilities (derived from the Black-Scholes formula), can also be used. In statistics, VaR is a probability of x percent over t days that a loss will be exceeded according to a certain confidence interval. The typical values for this probability x are 0.1, 1 and 5%, these were used to construct a 95%, 99%, and 99.9% confidence interval using the available data. There are three methods for

computing VaR. The simplest theoretical approach to VaR is historical simulations from which Historical Value at Risk (HVAR) is derived for each of the four commodities contracts. It requires few assumptions about the statistical distribution of market factors, one of the most important being that historical performance does not reflect future returns. We first compute the daily historical returns of the four commodities separately, then combine them using an equal percentage of distribution across the four contracts (25% each). This results in the average portfolio return for the day. The following formula was used to calculate the daily return Where P_1 corresponds to the closing price of the previous day and P_0 to the closing stock price of the current day:

$$Total\ Return = \frac{P_1 - P_0}{P_0} * 100$$

The Confidence Interval (CI) was calculated using the following formula, where $\bar{x}$ is the sample mean, z is the confidence level value, s is the sample standard deviation, and n is the sample size:

$$Confidence\ Interval = \bar{x} \pm z\frac{s}{\sqrt{n}}$$

3.3. Data Utilized

The Reuters-Eikon platform was used to extract an average of 500 daily and weekly closing prices over the last two years. The following contracts were examined:

- Euronext Milling Wheat Commodity Future Dec 2022
- Euronext Maize (Corn) Commodity Future Mar 2023
- CBoT Soybeans Composite Commodity Future Jan 2023
- Euronext Durum Wheat Commodity Future Dec 2022

The data's accuracy was verified both manually and by the Euronext official website as comparison. The analysis period ran from November 2022 up to five years ago when enough data was present to carry the analysis. General statistics of the dataset is summarized in the figure below (Figure 3.2, Figure 3.3, Figure 3.4, Figure 3.5). The decision to use for the majority part EURONEXT futures data rather than overseas market stem from the geographical location vicinity which makes it more relevant and closely correlated to the Italian market situation which we are looking to analyze. The vicinity means that price variations are more accurate with the local spot price changes and reduce potential disturbances due to the possibility of spatial arbitrage because agricultural commodities are expensive to transport, and this creates variation in the basis values on different

locations. The following commodities' weekly cash prices were obtained and extracted from AGER Borsa Merci Bologna:

- Milling Wheat: Frumento Tenero (n° 3 – “Fino” - Proteins 11%)
- Durum Wheat: Frumento Duro (“Fino” – Proteins 3%)
- Corn: Granoturco Secco (Humidity 14%)
- Soybean: Seme di Soia Nazionale

Borsa Merci Bologna is one of the main commodities markets in Italy, where buyers and producers negotiate prices every week. Different sub-categories, divided by physiological characteristics are quoted, only the ones more closely presenting similar characteristics to the delivery specification of their futures contracts counterpart were considered.

3.4. Results

On a graph, previously obtained cash prices were plotted. From their historical trend we can observe that prices were relatively stable from 2017 to the end of 2020 and gradually declining. By the beginning of the year 2020, all four commodity prices began to rise, but the first noticeable spike is seen with soybean, followed by a significant increase in durum wheat prices, with milling wheat and corn prices lagging behind (Figure 3.1). When we compare cash prices to futures prices, we find that Italian cash prices are almost always higher than futures

contracts. This is an important phenomenon that may indicate that the market is in backwardation and futures prices are perceived to be higher than expected. This means that investors anticipate a drop in cash prices. The intermonth spread appears to confirm this view by plotting a downward sloping forward curve. This means that it is better to sell cash prices and buy futures contracts at this time. The distribution of logarithmic returns of futures contract was analyzed an plotted in various histogram graphs. (Figure 3.10).

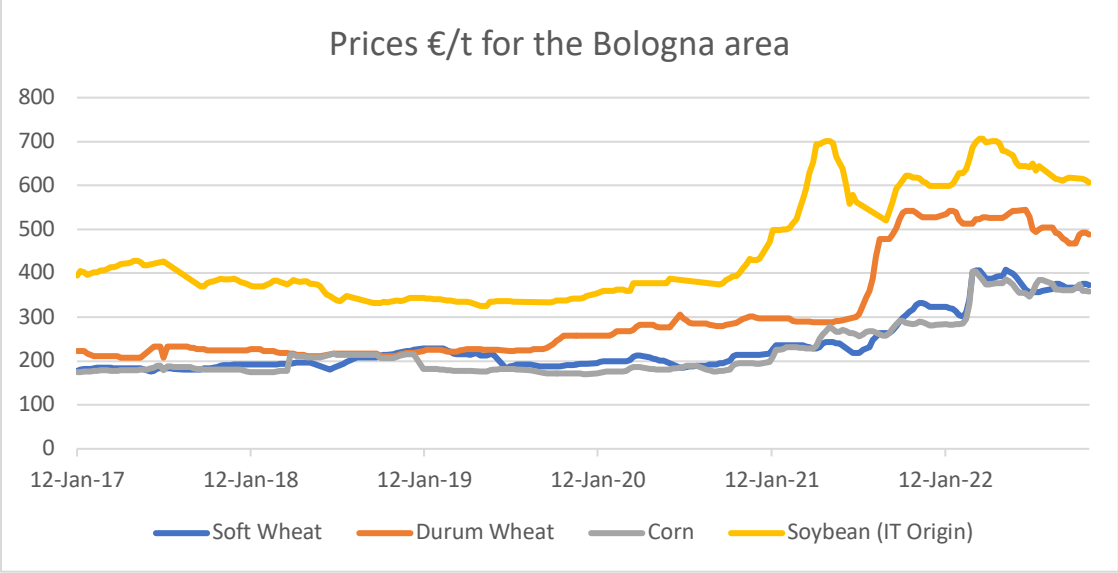

Figure 3.1 - Prices for various commodities based on AGER Borsa Merci bulletins.

Usually stocks returns are believed to be normally distributed and it is safe to assume that in a longer timeframe this would be the case as well. The pattern of distribution of returns varies by type of commodity. Durum Wheat and Milling Wheat returns appear to be normally distributed and centered around a mean of

zero, resembling a bell-shaped normal distribution pattern (Figure 3.13) whereas Soybean and Corn do not (Figure 3.14).

Price			Volume					Up/Down		Price Change (Close-Close)		
High	437.50	20-May-2022	Max	205,904	23-Sep-2022	Advancing	2,944,716	Up	77	Up	+14.88%	04-Mar-2022
Low	182.00	08-May-2020	Min	1	25-Sep-2020	Declining	2,506,888	Down	71	Down	-8.97%	24-Jun-2022
Avg	239.48		Avg	35,402		Total	5,451,917	Unch	5	Period	+71.45%	10 Years

Figure 3.2 – Summary data for Euronext Paris Milling Wheat Commodity Future Dec 2022 contract.

Price			Up/Down		Price Change (Close-Close)		
High	565.25	24-Jun-2022	Up	17	Up	+25.71%	21-Jan-2022
Low	350.00	14-Jan-2022	Down	16	Down	-8.48%	09-Sep-2022
Avg	483.77		Unch	11	Period	+28.08%	10 Years

Figure 3.3 - Summary data for Euronext Paris Durum Wheat Commodity Future Dec 2022 contract.

Price			Volume					Up/Down		Price Change (Close-Close)		
High	379.75	20-May-2022	Max	10,583	18-Nov-2022	Advancing	53,799	Up	48	Up	+14.06%	30-Jul-2021
Low	173.50	09-Jul-2021	Min	2	24-Dec-2021	Declining	55,588	Down	40	Down	-9.55%	03-Jun-2022
Avg	256.12		Avg	1,229		Total	109,387	Unch	0	Period	+55.71%	10 Years

Figure 3.4 - Summary data for the Euronext Paris Maize (Corn) Commodity Future Mar 2023 contract.

Price			Volume					Up/Down		Price Change (Close-Close)		
High	15 13/32	23-Sep-2022	Max	580,314	28-Oct-2022	Advancing	2,302,765	Up	61	Up	+11.3815%	29-Jul-2022
Low	8 1/32	04-Dec-2020	Min	0	15-Jan-2021	Declining	2,881,992	Down	44	Down	-7.8230%	24-Jun-2022
Avg	11 18/32		Avg	48,913		Total	5,184,757	Unch	0	Period	+67.7119%	5 Years

Figure 3.5 - Summary Data for the CBoT Soybeans Composite Commodity Future Jan 2023 contract.

The daily returns were also calculated by simulating an equally divided portfolio (Figure 3.10). The Historical VaR was then calculated using the percentile function (Figure 3.11). Soybean is the most risky commodity with the highest loss, which makes sense given that it is the most volatile commodity of all. Wheat futures contracts are the least risky because they have smaller variations. A portfolio

strategy is the safest, and with a 99% confidence level, we calculate that our worst loss in one day will be equal to – 5.62%.

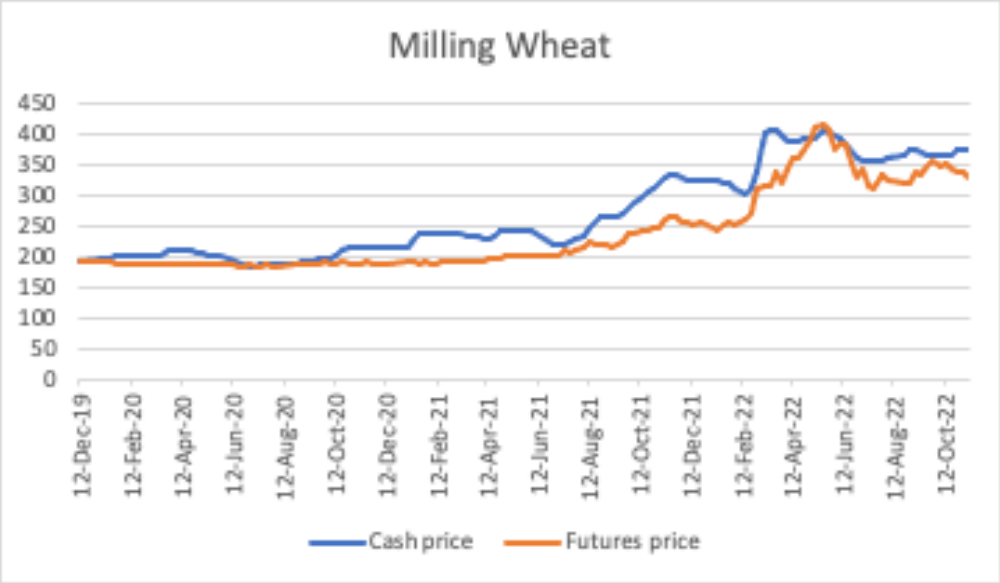

Figure 3.6 - Price comparison of milling wheat prices.

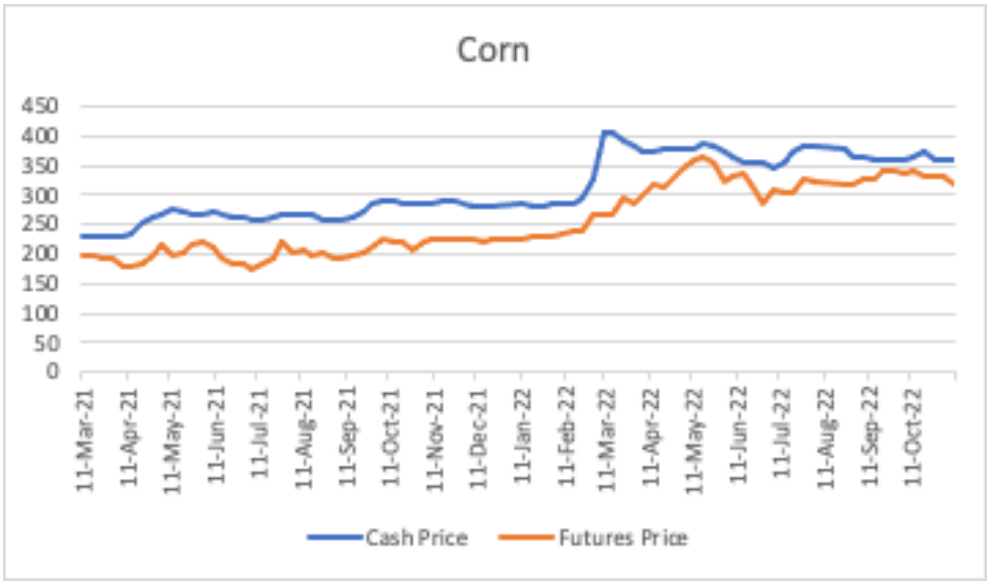

Figure 3.7 - Price comparison of corn prices.

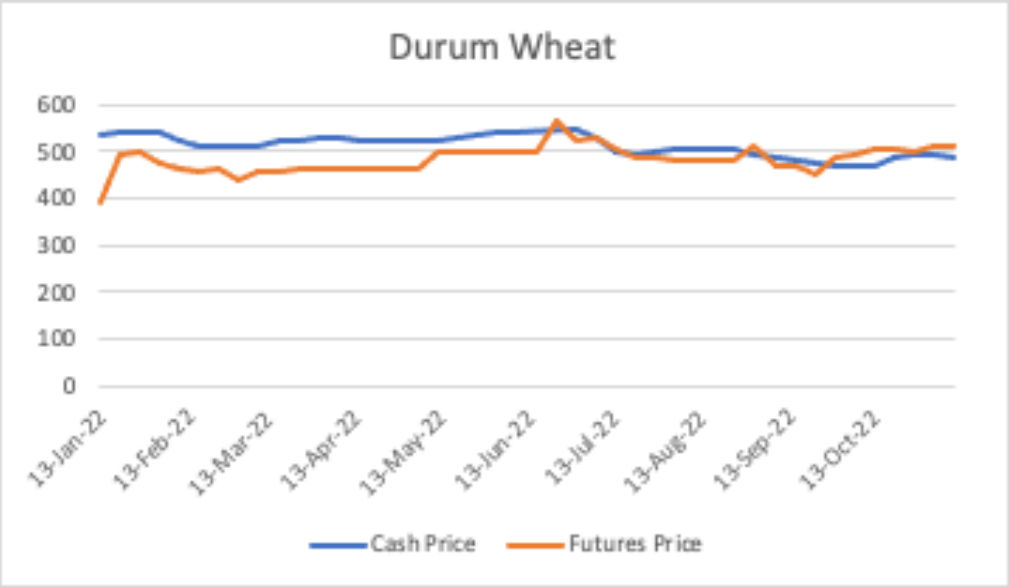

Figure 3.8 - Price comparison of durum wheat prices.

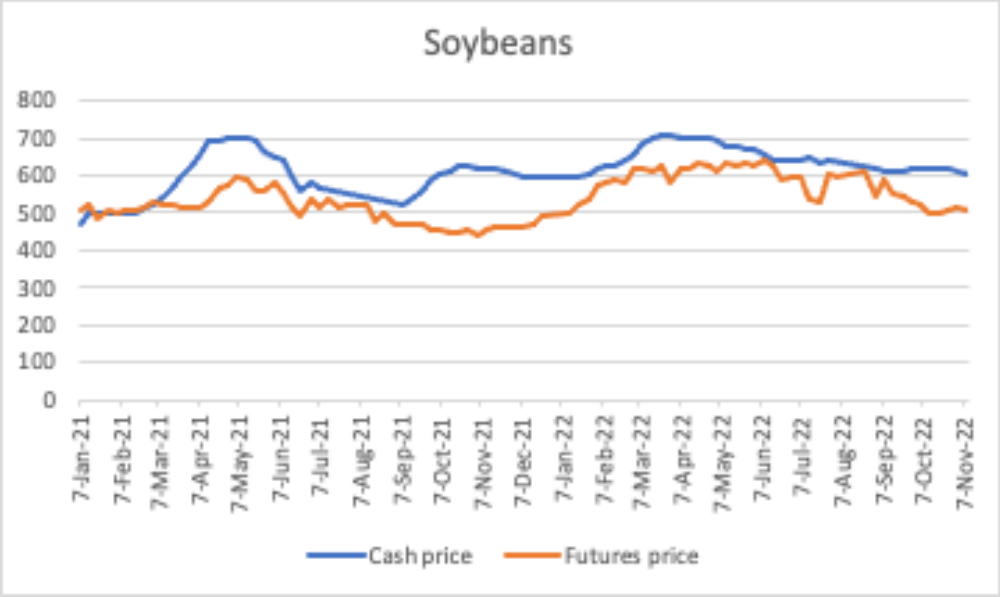

Figure 3.9 - Price comparison of soybeans prices.

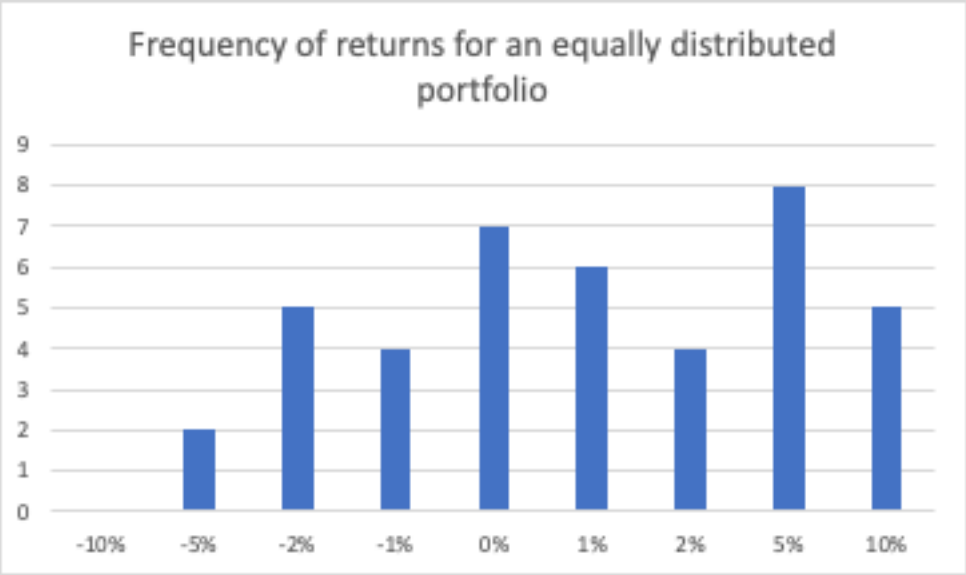

Figure 3.10 – Distribution of returns of the equally distributed portfolio.

Confidence Level	95%	99%	99.9%
Milling Wheat	-3.11%	-8.35%	-8.90%
Corn	-8.43%	-9.10%	-9.51%
Soybean	-7.43%	-10.14%	-10.75%
Durum Wheat	-5.14%	-8.01%	-8.43%
Portfolio	-4.27%	-5.62%	-5.75%

Figure 3.11 - 1 day value-at-risk by commodity type and confidence intervals.

3.5. Variance Covariance Method

The parametric method, also known as the variance-covariance method, is a risk management technique used to calculate the VaR of an asset portfolio by first determining the mean, or expected value, and standard deviation of an investment portfolio. This method assumes that the underlying market factors have a multivariate normal distribution with means of zero and that the covariance matrix on the distribution of these changes can be represented as a matrix distribution. Once we've determined the profit and loss distribution, we can use mathematical

properties from the normal distribution to calculate the value-at-risk. We used the formula below to estimate our portfolio's variance σ_P^2 while accounting for excess returns (Figure 3.12).

$$\sigma_P^2 = X_1^2\sigma_1^2 + X_2^2\sigma_2^2 + X_3^2\sigma_3^2 + X_4^2\sigma_4^2 + 2(X_1\sigma_1 X_2\sigma_2 X_3\sigma_3 X_4\sigma_4)\rho_{1,2,3,4}$$

$$\sigma_P^2 = w^T \sum w$$

To obtain the variance-covariance matrix the excess returns matrix is transposed and multiplied by the given excess returns before being divided by the number of observations. The 1 day VaR is then calculated by assuming an equal proportion of all of our assets, 25% in our case. The portofolio returns are calculated as the transposed matrix product of the returns and the portolio proportions. The portfolio standard deviation (portfolio sigma) is the square root of the matrix product obtained by transposing the portoflio proportions by the variance-covariance matrix and then transposing the portfolio proportions again. We are then able to extrapolate the 1 day VaR at the 1% confidence level from our initial investment, which is equal to 7.27%.

	Milling Wheat	Corn	Soybeans	Durum Wheat
Milling Wheat	0.002139	0.001850	0.001137	0.000027
Corn	0.001850	0.001923	0.000854	-0.000203
Soybeans	0.001137	0.000854	0.002125	-0.000274
Durum Wheat	0.000027	-0.000203	-0.000274	0.002664

Figure 3.12 - Variance Covariance Matrix

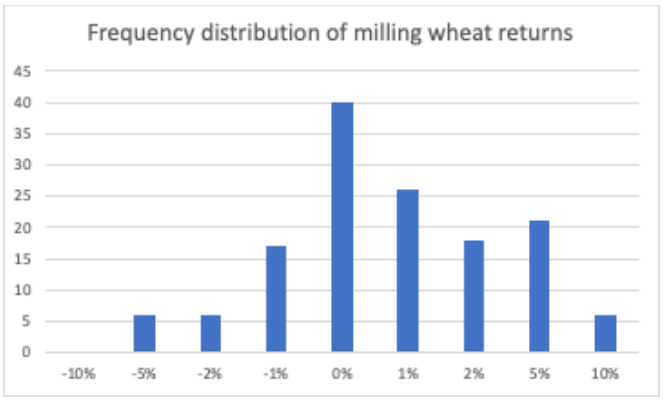

Figure 3.13 - Distribution of returns of milling wheat contract.

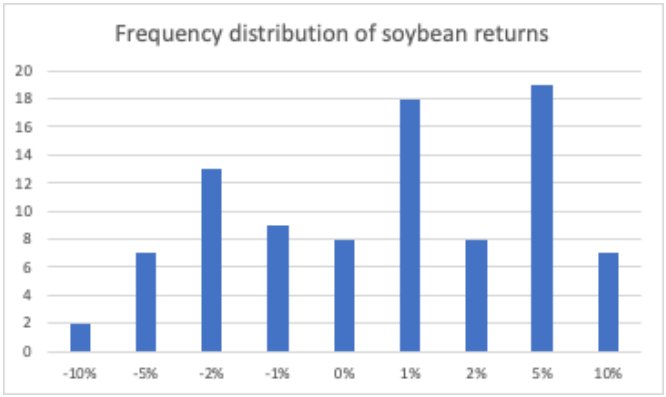

Figure 3.14 - Distribution of returns of the soybean contract.

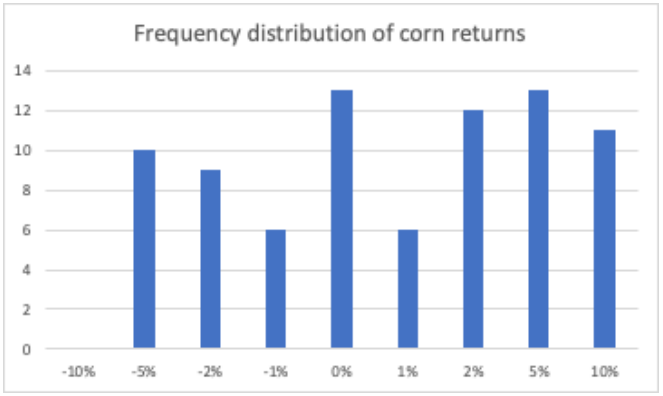

Figure 3.15 - Distribution of returns of the corn contract.

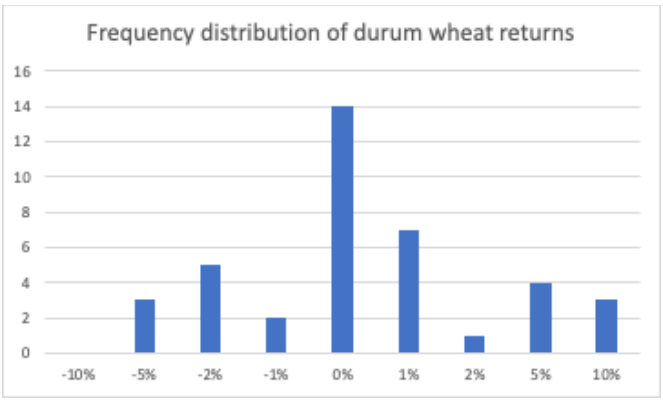

Figure 3.16 - Distribution of returns of durum wheat contract.

3.6. Hedging simulation in the Italian Market

We will impersonate the role of a durum wheat farmer that produces a certain amount of crops each year that he would like to store in order to increase our financial gain in order to simulate a short hedge. Let's run a simulation to see what would have happened if we had hedged our crops with and without futures contracts.

Durum Wheat (€/tons)			
Date	Cash position	Futures Positions	Basis (C-F)
15-Jun	542.5	500.25	42.25
10-Nov	485	513	-28
Results	-57.5	12.75	-44.75

Figure 3.17 - Example of an Italian farmer short-hedging the market.

Because the market is in a recession, the final selling price will be higher in this case, and we have profited more by shorting the future contract. Although this example does not take into account any storage costs, we have achieved our profit maximization objective as we were able to sell at a higher price than without using any hedging technique (Figure 3.17).

$$P_{selling}(€\ per\ ton) = 485 + 12.75 = 497.75$$

Let us now consider a long hedge. We are a soybean-based feed manufacturer. We process the seeds in our factory, so we only buy raw materials and not byproducts. Our goal is to pay as little as possible for the goods we intend to purchase in December 2022.

Soybeans (€/tons)			
Date	Cash position	Futures Positions	Basis (C-F)
16-Sep	592.5	458	134.5
1-Mar	706	582	124
Results	113.5	124	237.5

Figure 3.18 - Example of a soybean-based plant protein manufacturer hedging a delayed purchase.

$$P_{buying}(€\ per\ ton) = 706 - 124 = 582$$

The soybean example must be taken with caution because feed producing companies tend to buy GMO Soybean from abroad rather than the national one, which is more used for human consumption, but we can still see that the price of national soybean has increased by 113.5 euros per ton and the futures price has increased as well, allowing us to rebalance our buying price, and hedging has proven useful in this case (Figure 3.18).

4. Conclusion

The goal of the thesis was to provide an understanding of commodity trading markets and how futures contracts can be used to hedge the market. The structure of commodity trading markets was then explained, as well as the most important mechanism that regulates futures contract terms, their function, and how they can be bought or sold. Finally, we dug deeper into analyzing cash and futures data to determine whether hedging techniques could be used in Italy as well. The commodity trading market has recently been dominated by a high level of volatility, and the use of hedging techniques has proven beneficial to both buyers and sellers. The analysis found a strong correlation between Italian market cash prices and futures contracts. Even if cash price data are not currently available to the public because they vary with premiums and discounts and are frequently kept secret from the public, more can be done by using precise data from actual grain buyers. More activities should also be conducted to promote hedging as a risk management technique, as most farmers and producers are unaware of it and take

significant risks by storing their grains for an extended period of time in silos in the hopes that prices will increase. In a market dominated by multinational corporations, it is important to remember that these techniques can be used by anyone, and futures contracts are one of these tools. The VaR technique is simple to understand and applicable to many situations, but it is simplistic in its assumptions that a portfolio returns a normal distribution and can provide a false sense of security. More sophisticated techniques, such as Monte Carlo simulations, can be utilized

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