1

Fundamentals of Commodity Spot and Futures Markets: Instruments, Exchanges and Strategies

1.1 THE IMPORTANCE OF COMMODITY SPOT TRADING

Commodity price risk is an important element of the world physionomy at this date, as it has an impact on the economy of both developed and developing countries: in a rough approximation, one can state that the latter include most commodity producing countries, the former being originators, marketers and manufacturers. All parties are still involved in activities of spot trading with physical delivery while the formidable development of liquid derivative markets – forward, Futures contracts and options – has paved the way for risk management and optimal design of supply and demand contracts.

Every commodity is traded on a spot market. In the old days, buyers and sellers used to meet on the marketplace where transactions led to immediate delivery. In the 18th and 19th centuries, potato growers in the state of Maine started selling their crops at the time of planting in order to finance the production process. In a parallel manner, numerous forward transactions were taking place in Chicago for cereals and agricultural products and in London for metals. A need for standardization in terms of quantity, quality, delivery date emerged and led to the establishment of the New York Cotton Exchange (NYCE) in 1842 and the Chicago Board Of Trade (CBOT) in 1848. The clearing house, unique counterparty for buyers and sellers of Futures contracts was the effective signal that the Exchange was operating. As of today, some of these clearing houses are owned by independent shareholders, others are primarily owned by market participants as in the case of the London Metal Exchange (LME) and the International Petroleum Exchange (IPE). Different qualities of the same commodity may be traded on different exchanges. The most famous examples include: coffee which in its ''arabica'' variety is traded on the New York Coffee, Sugar and Cocoa Exchange (CSCE), while the ''robusta'' type is traded on the London International Financial Futures Exchange (LIFFE); and oil which is traded on the New York Mercantile Exchange (NYMEX) as Western Texas Intermediate (WTI) and on the IPE in its Brent variety.

Let us observe that the fact that any transaction on commodities may be physical (delivery of the commodity) or financial (a cash flow from one party to the other at maturity and no exchange of the underlying good) is in sharp contrast to bonds and stock markets where all trades are financial. However, physical and financial commodity markets are, as expected, strongly related. Price and volatility observed in ''paper'' transactions are correlated to the analogous quantities in the physical market, both

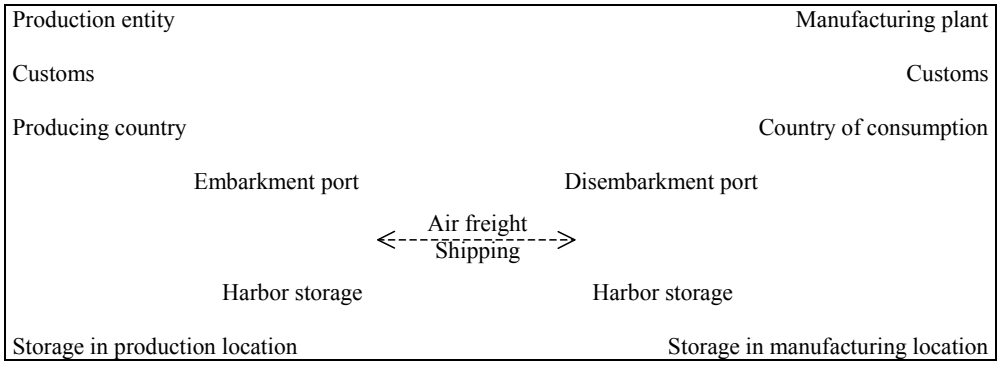
because of the physical delivery that may take place at maturity of a Futures contract and the existence of spot forward relationships that will be discussed throughout the book.

Lastly, let us note that the last two decades have experienced dramatic changes in world commodity markets. Political upheavals in some countries, economic mutation, new environmental regulation, a huge rise in the consumption of commodities in countries such as China and other structural changes have contributed to increase the volatility of supply and prices. This has made hedging activities (through forwards, Futures and options) indispensable for many sectors of the economy, the airline industry in particular being an important example.

As mantioned before, we call spot trading any transaction where delivery either takes place immediately (which is rarely the case in practice) or if there is a minimum lag, due to technical constraints, between the trade and delivery. Beyond that minimal lag, the trade becomes a forward agreement between the two parties and is properly documented by a written contract which specifies, among other things, who among the buyer and seller is responsible for shipping, unloading the goods and other transportation-related issues.

Consider a standard situation where the seller is a producer (e.g., of copper) and the buyer a manufacturer: in general, they never meet and, even if they did, would rarely agree on prices, timing and so forth. Hence the existence of intermediaries who play the role of go-between, are prepared to take delivery of goods that may not resell immediately and organize the storage and shipping.

We can represent the different phases of the physical execution of a trade as:



The document that represents the ownership of the good is called a *bill of lading*. It is issued either by the captain of the transportation ship or by the transporter in charge. That transportation contract may eventually be traded. It can bear the label "shipped" or "to be shipped"; the latter terminology indicates that the merchandise has been embarked, leading to the qualification *clean on board*.

Responsibility for commercial execution

It may lie in the hands of the seller, or the buyer, or the intermediary (since, in practice, many intermediaries will play a role, in particular because of the lags in the timing of different operations).

The responsibility will take different forms:

- For the exporter, sale Free On Board (FOB).
- For the commercial intermediary, purchase FOB out of the dock or in warehouse.
- For the importer, purchase on the dock or in warehouse.

Note that the commercial responsibility may be fragmented in the course of contract execution. For instance, a manufacturer who buys metals under a FOB specification is responsible for organizing the shipping but the armator is in charge of managing the shipping and holds the corresponding risk.

Major risks in commodity spot transaction

Four major types of risk may be identified in commodity spot markets:

- *Price risk*, which will be discussed throughout the book and for which the first examples of hedging strategies are presented in Section 1.2.
- *Transportation risk*, which is described below.
- *Delivery risk*, which concerns the quality of the commodity that is delivered and for which there is no financial hedge that may be put in place. The only coverage is provided by a very customized contract or by a solid long-term relationship with the originator.
- *Credit risk*, which is present all along until the final completion of the trade.

Risk attached to the transportation of commodities

1. The first category of risks concerns the deterioration, partial or total, of goods during transportation. Two types of risks are usually recognized in this category:
   - "ordinary" risks;
   - "extraordinary" risks such as wars, riots and strikes.

   The expeditor of the goods or the FOB buyer directly holds the transportation risk, unless they purchase an insurance contract to be covered. Different companies specialized in freight insurance (such as the famous Lloyds of London) propose various types of contracts. We need to keep in mind that transportation risk is an important one as it includes the entire community – the tanker that sank in Alaska being a sad example. If no specific insurance coverage has been purchased, the company that bears the liability must put in place some kind of *self-insurance* process as do some major oil companies today.
2. Cost of transportation risk: All Futures exchanges around the world quote FOB prices. Consequently, if a trade (e.g., on sugar) is settled for delivery 12 months later with the CIF price as a reference, the seller needs to hedge his position not only against a decline in sugar prices by, say, selling Futures on the New York Coffee, Cocoa and Sugar Exchange, but also against changes in the shipping cost. The latter risk will be hedged by entering into a Forward Freight Agreement (described in Section 1.5). Consequently, the two components of the CIF price will get hedged in totally different exchanges.

1.2 FORWARD AND FUTURES CONTRACTS

A forward contract may be generically described as an agreement struck at date 0 between two parties to exchange at some fixed future date a given quantity of a commodity for an amount of dollars defined at date 0. A Futures contract has the same general features as a forward contract but is transacted through a Futures exchange. The clearing house standing behind that exchange essentially takes away any credit risk from the positions of the two participants engaged in the transaction. This default risk is almost reduced to zero through margin deposits or initial margins that need to be made before entering into any contract, as well as the daily margin calls required to keep a contract alive if its market value has declined from the previous day.

Futures contracts serve many purposes. Their first role has been to facilitate the trading of various commodities as financial instruments. But they have from the start been providing a hedging vehicle against *price risk*: a farmer selling his crops in January through a Futures contract maturing at time T of the harvest (say, September) for a price $F^T(0)$ defined on 1 January has secured at the beginning of the year this amount of revenue. Hence, he may allocate the proceeds to be received to the acquisition of new machinery or storage facilities and, more generally, design his investment plans for the year independently of any news of corn oversupply possibly occurring over the 9-month period.

It is noticeable in many markets, ranging from agricultural commodities to electricity, that Futures contracts are used as a substitute for the spot market by hedge funds, Commodity Trading Advisors (CTAs) or any class of investors wishing to take a position in commodities, both because it takes away the physical constraints of spot trading and provides the flexibility of short and long positions, hence the choice of positive or negative exposure to a rise in prices. This will be discussed in detail in Chapter 14.

What follows describes in detail the mechanisms of forward and Futures contracts with their various characteristics as well as the way exchanges operate. The different classes of participants, the mechanism of *price discovery* and the crucial relationships, if they exist, between spot prices and Futures prices under some form of equilibrium assumptions are described in detail.

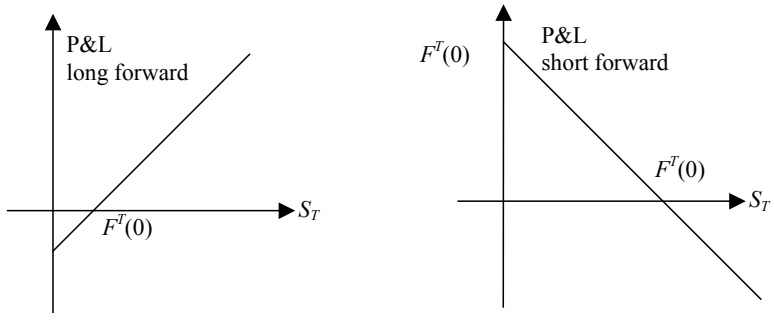
Forward contracts

A forward contract is an agreement signed between two parties A and B at time 0, according to which party A has the obligation of delivering at a fixed future date T an underlying asset and party B the obligation of paying at that date an amount fixed at date 0, denoted $F^T(0)$ and called the forward price for date T for the asset. Note that this price is not a price in the sense of the price of a stock, but rather a reference value in the contractual transaction. If the underlying asset is traded in a liquid market, the no-arbitrage condition between spot and forward markets at maturity implies that:

$$S(T) = F^T(T)$$

If the value at date T of the Futures contract maturing at that date was different from the spot price, an arbitrage opportunity would be realized by buying in one market and selling immediately in the other.

Keeping in mind that the buyer of the forward contract may immediately sell at maturity in the spot market at the price S_T the commodity which was delivered to him against the payment of $F^T(0)$ dollars, the respective Profit and Loss (P&L) of party A (called long forward) and party B (called short forward) are depicted by the following graphs:



Obviously, the contract is a zero-sum game between the buyer and the seller. Note also that, by definition, both P&Ls are expressed in dollars at date T.

For practical purposes, party A represents an economic agent who wants to hedge against a possible rise in the price of the underlying asset between dates 0 and T and locks in at date 0 a purchase price equal to $F^T(0)$. Party B, conversely, fears a collapse of this price or expects to profit from a rise. The price $F^T(0)$ represents their estimation at date 0 of how much the underlying asset S will be worth at date T together with the risk premium they are willing to pay (or receive). We will come back to this discussion in Chapter 2.

Should parties A and B enter into this T maturity contract at a future date t in the interval $(0, T)$, the price $F^T(t)$ on which they will agree is likely to be different from $F^T(0)$ and translates the changes between dates 0 and t in the expectations perceived by the market of the commodity future spot price $S(T)$.

Futures contracts

They are analogous to forward contracts in terms of their definition but present some key differences from them:

- They are "standardized" in terms of their characteristics (maturity, quantity of the underlying commodity, quality or variety).
- They are traded on an exchange, such as NYMEX or the IPE; hence, they carry no counterparty risk since both the buyer and the seller of the Futures deal with the clearing house of the exchange which is in principle fully trustworthy.
- They require the payment of margin deposits in order to be able to start placing orders on the exchange.
- They are marked-to-market daily and the participants have to adjust their positions: for instance, if a participant has a long position in a Futures contract acquired at the price $F^T(0)$ and if the price $F^T(\text{day } 1)$ is lower, then this participant has experienced a loss between days 0 and 1 equal to $F^T(\text{day } 1) - F^T(0)$. In order to keep his

position, he has to adjust it by adding at the end of day 1 a cash amount equal to his loss.

Forward and Futures prices on the same underlying asset with the same time to expiry are different because of taxes, transaction costs and other important elements, such as the impact of credit risk on the one hand and stochastic interest rates on the other hand. In practice, they remain very close to each other since the fluctuations of the underlying commodity represent the most important explanatory factor. Except when stated otherwise, we will view the two prices as the same in a first-order approximation.

We can recap the similarities and differences between the fundamental types of transactions prevailing in commodity markets as depicted in the following diagram:

Spot trading	**Forward contracts**	**Futures contracts**
◆ *commercial contract* ◆ flexible covenants	◆ *bilateral agreement* ◆ flexible covenants	◆ *standardized instrument* ◆ necessity of a physical delivery or termination of the position before maturity
◆ juridical commitments of the buyer and seller until execution of the contract	◆ replace spot transactions on many occasions (e.g., in the case of a non-storable commodity such as electricity)	◆ buyer and seller only refer to the clearing house
⇩	⇩	⇩
◆ long transaction ◆ illiquid and discontinuous market ◆ allows the transfer of goods in conditions suiting the demand	◆ form of contracting totally appropriate for commodities ◆ credit risk fully present ◆ flexibility regarding the optimal transfer of goods	◆ central clearing mechanism generating ''market prices'' ◆ price transparency ◆ liquidity ◆ low transaction costs

1.3 THE ACTORS IN FUTURES MARKETS

Hedgers

Futures markets were originally set up to meet the needs of hedgers, namely farmers who wanted to lock in advance a fixed price for their harvests. Commodity Futures are still widely used by producers and users of commodities for hedging purposes. Suppose that the date of analysis is January and company XYZ knows that it will have to buy on 25 September (date T) of the same year one million tons of fuel. In order to hedge against the possible increase in fuel price between January and the end of September, airline company XYZ will buy (equivalently, *enter a long position in*) Futures contracts written on fuel, maturity September and in an amount corresponding to the necessary quantity of fuel. By doing so, the airline company has locked in at the beginning of the

year the price $F^T(0)$ it will pay in September and has done so with no cash flow payment at the beginning of the year.

Another possible hedge (as we will see later) would be to buy options – again in the appropriate quantity – written on the fuel as the underlying, with maturity T and strike price $k = F^T(0)$ for example.[1] In this case, the resulting cost of fuel in September for company XYZ will be either $F^T(0)$ or, strictly, less if the market spot price is very low. This alternative is strictly superior for the hedger at maturity, but at inception of the option contract in January company XYZ will have to pay the premium of the options involved in the hedge.

Returning to Futures contracts, *basic risk* refers to the risk remaining after the hedge has been put in place and essentially represents the difference between the Futures price – should the Futures position be closed prematurely – and the spot price. It also includes other components such as:

- The price of cleaning the local grade of the commodity into a grade deliverable in a Futures contract (or the premium for a superior grade).
- The price of transportation to or from the delivery point in the Futures contract.
- The physical cost of storage, including insurance, between the time of the harvest and the delivery date of the Futures contract.

Speculators

While hedgers want to avoid exposure to adverse movements of the price of a commodity which is part of their manufacturing process in the economy, speculators wish to get exposure to commodity price moves (i.e., take risks in order to make profits). Using the same example as before, a bank ABC which has no "natural" exposure to the price of fuel may decide to take a position either in a Futures contract on fuel or in an option written on fuel and, by doing so, will create for itself exposure to the fuel price; obviously, the nature of the position – long or short in either instrument – will be determined by the "view" that bank ABC has on the subsequent moves of the fuel price. It is in fact "betting" that this price will go up or will go down and counting on the corresponding profits the bank will generate. Unsurprisingly, commodities are becoming increasingly attractive to investors and hedge fund managers who view them as an *alternative asset class* allowing one to reduce the overall risk of a financial portfolio and enhance the return as well. Futures are the obvious instrument – because of their liquidity, because of the low transaction costs on the exchange, because of the absence of credit risk – to take positions reflecting an anticipation of a price rise by purchasing Futures or a decline by selling Futures. Most of the liquidity is generated by the combined activity of speculators and hedgers.

Arbitragers

Arbitragers represent a third important – but smaller in size – group of participants in futures and options markets. An arbitrage is a *riskless* profit realized by simultaneously

[1] For practical purposes, this will be the strike most often chosen when hedging with an option since everyone has the forward position in mind as the alternative hedge.

entering into several transactions in two or more markets. Arbitrage opportunities are very desirable but not easy to uncover and they do not last for long. If a given instrument is underpriced, buying activity will cause the price to rise up to a value which is viewed by the market as the "fair" price and at which there will be no more excess demand.

In this book, as in the fundamental models of option pricing, the values of Futures and options contracts will be based on the assumption of no-arbitrage opportunities. Given the importance of this concept, we are going to propose several definitions of what is called in daily language "no free lunch".

Definition 1 A portfolio P is called an "arbitrage portfolio" if it satisfies simultaneously the following conditions:

$$\begin{cases} V_p(0) = 0 \\ V_p(H) \geq 0 \quad \text{in all states of the world at date } H \\ V_p(H) > 0 \quad \text{in some states of the world} \end{cases}$$

where H is a date later than date 0.

Definition 2 A market is said to be arbitrage-free if there exists no arbitrage opportunity; in other words, for any portfolio P:

$$\begin{cases} V_p(0) = 0 \\ \text{and} \qquad\qquad\qquad\qquad \Rightarrow V_p(H) = 0 \quad \text{in all states of the world} \\ V_p(H) \geq 0 \quad \text{in all states of the world} \\ \qquad\qquad \text{at date } H > 0 \end{cases}$$

In other words, if a portfolio *requires a null investment* and is *riskless* (there is no possible loss at the horizon H), then its terminal value at date H has to be zero. These are the various expressions of the no free lunch property: if you start with no money and *take no risk*, your final wealth will be zero. In the above statements, the assumption of "riskless" is crucial: if you have no money, you can always borrow from your banker and invest the proceeds in a hedge fund. Your final wealth may be quite large or very negative once you have repaid your loan, but rarely equal to zero.

Comments

For practical purposes, traders searching for arbitrage opportunities are realistically looking, in fact, for "quasi-riskless" strategies generating profits. Such a strategy should be as simple as possible and, hence, involve only spot and forward positions which have *linear payoffs and P&Ls* in the underlying price, making the nullification of risk possible by the resolution of a *single* equation in the price S of the underlying commodity. When we move to positions involving options, we will see that the convexity (or concavity) of the P&L (i.e., the gamma of the option), together with the sensitivity to volatility (i.e., the vega), make this "quasi-riskless" feature much more problematic. Hence, it is indeed in Futures markets that the fundamental concept of arbitrage finds its origin,

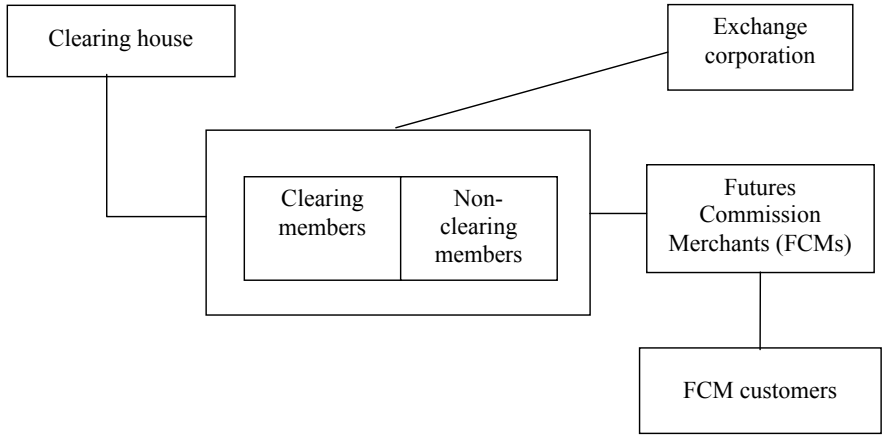
since *fungibility* between the underlying commodity and the derivative is highest. This property will be lost, however, in the case of electricity because of the specificities of this commodity (see Chapter 11) and this loss is certainly a significant part of the complexity of electricity markets. It allows us at the same time to measure the value of the spot–forward relationship when it exists, even if it holds in a temporal window because of some necessary assumptions on the convenience yield, as discussed in Chapter 2.

1.4 THE STRUCTURE OF FUTURES MARKETS

While some trading of Futures contracts may be traced back centuries ago in Europe and Japan, the modern form of Futures markets appeared in the 19th century in the American midwest. In fact, over the second half of the 19th century, more than 1,600 exchanges were established across the United States, often in the vicinity of harbors or railroad crossings. Most of them are gone today and there are only six exchanges in the United States where more that 600 million Futures contracts are traded every year (mostly softs in Chicago, energy in New York). The CBOT, established in 1848, was from the start an active exchange for agricultural commodities, especially corn and wheat. It set its General Rules in 1865. Shortly after, the New York Cotton Exchange organized cotton Futures trading. Futures trading in many other agricultural commodities followed.

The Grain Futures Act in 1922 defined the regulation of Futures exchanges; the Commodity Futures Trading Act of 1974 established the Commodity Futures Trading Commission (CFTC) as the new independent regulatory commission in charge of Futures markets. In the 1970s Futures contracts on stocks, equity indexes, bonds, foreign currencies as well as Futures on options were introduced. Active financial Futures markets have been introduced in different countries worldwide, such as Japan, the UK, France, Hong Kong and so on. Lower transaction costs, increased trading volume, expanded trading hours, electronic trading and international intermarket links contribute to make the Futures markets of today an efficient globalized trading network.

The classical structure of a Futures market is represented in the diagram below:



Most Futures exchanges are incorporated as membership associations and operated for the benefit of their members who are generally engaged in their own businesses related to Futures trading. The first purpose of an exchange is to provide an organized marketplace, with uniform rules and standardized contracts. Like any corporation, a Futures exchange has shareholders, a board of directors and executive officers. An exchange may operate markets for spot commodities, options and other financial securities in addition to Futures contracts and provide other services to the public (in particular, *price discovery* which will be discussed in Chapter 2). An exchange funds its activities by membership dues and by transaction fees paid on the contracts traded on the exchange.

EXCHANGE MEMBERS

Although membership is limited to individuals, these individual members often act on behalf of firms, such as brokerage houses, investment banks, or commodity dealers and producers. The total number of members of an exchange is limited; memberships are available for sale on the floor of an exchange. The value of membership lies mainly in the possibility it grants for trading contracts directly on the floor of the exchange. Those members, nominees of members and other individuals who actually use floor-trading privileges are traders. Although floor brokers sometimes trade on their own accounts, their basic role is to allow the public at large to buy or sell contracts. Collectively, they meet a critical need for *liquidity*, namely the ability of the market to act as a reliable and efficient mechanism for quickly taking or offsetting contract positions.

Major Futures exchanges

Chicago Board of Trade

CBOT used to be exclusively dedicated to agricultural commodities. Today, it trades Futures and options on corn, soybean, soy meal, wheat, rice as well as precious metals (gold and silver). Corn, soybean and wheat are, in this order, the most traded underlyings.

Chicago Mercantile Exchange

CME is the biggest Futures exchange in the US and the second in the world. It trades pork bellies, beef, dairy products and lumber. Founded in 1898 as a non-profit entity, it rapidly became a world platform for trading Futures.

New York Mercantile Exchange

NYMEX was founded in 1872 under the name ''Butter and Cheese Exchange of New York''. It merged in 1994 with the Commodity Exchange (COMEX), itself resulting from a merger in 1933 of four smaller commodity exchanges. Today, NYMEX is the biggest exchange for commodity Futures; in particular, crude oil (WTI), gas, copper, aluminum and precious metals.

Regarding energy commodities, NYMEX trades Futures and options on crude oil, natural gas, domestic fuel, unleaded gasoline and propane. Oil Futures contracts were introduced in 1983 and are the most active contracts in the world (see Tables 1.1 and 1.2).

Futures and options on gold, silver, copper and aluminium are traded on COMEX. The gold Futures contract, launched in 1974, is a world reference today.

New York Board of Trade

NYBOT regroups the two oldest commodity exchanges in New York: the Coffee, Sugar and Cocoa Exchange (CSCE) and the New York Cotton Exchange (NYCE). The first contracts on coffee, sugar and coca were respectively introduced in 1882, 1914 and 1925 on the CSCE; those on cotton and orange juice in 1870 and 1966 on the NYCE. NYBOT also controls the New York Futures Exchange (NYFE).

International Petroleum Exchange

IPE was founded in 1980 by a consortium of energy companies. The first contract, written on gas oil, was launched one year later. In June 1988, the successful Brent contract started trading and another on natural gas was quoted as of 1997.

London International Financial Futures Exchange

LIFFE was established in 1982 and started trading agricultural commodity Futures in 1996, after it merged with the London Commodity Exchange (LCE). Futures and options on cocoa, barley, robusta coffee, sugar and potatoes are traded on LIFFE.

London Metal Exchange

LME came to existence in 1877 to serve the needs created by the industrial revolution in the United Kingdom. It specializes in non-ferrous metals: aluminum (pure or alloy), copper, nickel, tin, lead and silver. LME is where metals are traded: producers trade with speculators and hedgers, e.g., a company producing copper wires and wishing to hedge its revenues against a rise in the price of copper.

Le Marché à Terme International de France

Created in 1986 and first dedicated to bond Futures, MATIF introduced commodity Futures two years later. Today Futures on corn and Futures and options on colza and wheat are traded.

It is interesting to observe that most US Futures exchanges still function today as *open outcry trading*. Many exchanges around the world now operate with an electronic platform, as do some divisions of the NYMEX and the whole EUREX system existing in Europe and recently established in Chicago.

More precisely, energy trading is conducted on NYMEX in open outcry from 10.05 a.m. until 2.30 p.m. After hours Futures trading is conducted via the NYMEX

Table 1.1 The currently most active commodity Futures exchanges in the US and worldwide

Traded commodities	Exchange	Abbreviation
Wheat, corn, soybeans, silver	Chicago Board of Trade (One Chicago) *www.cbt.com*	CBOT
Hogs, pork bellies, lumber, gold, weather	Chicago Mercantile Exchange (One Chicago) *www.cme.com*	CME
Cotton, rice	Chicago Rice and Cotton Exchange	CRCE
Cocoa, sugar, coffee	Coffee, Sugar and Cocoa Exchange	CSCE
Wheat, corn syrup, orange juice	Minneapolis Grain Exchange *www.mgex.com*	MGE
	New York Cotton Exchange	NYCE
	New York Mercantile Exchange *www.nymex.com*	NYMEX
Oil, crude oil, heating gasoline, propane gas	New York Mercantile Exchange	NYMEX
	Hong Kong Futures Exchange *www.hkfe.com*	HKEX
	Philadelphia Board of Trade	PBOT
	International Petrol Exchange *www.ipe.uk.com*	IPE
Metals	New York Mercantile Exchange	NYMEX
	London Metal Exchange *www.lme.co.uk*	LME
	Commodity Exchange *www.comex.com*	COMEX
Electricity	New York Mercantile Exchange (delisted in 2002)	NYMEX
	Minnesota Grain Exchange	MGEX
	Nordic Power Exchange	NORDPOOL
	European Energy Exchange	EEX
	Amsterdam Power Exchange	APX
	Paris Power Exchange	POWERNEXT

access Internet-based trading platform beginning at 3.15 p.m. on Mondays through Thursdays and concluding at 9.30 a.m. the following day. On Sundays, the session begins at 7 p.m.

On the metals front, CBOT unveiled in August 2004 details of a plan to challenge NYMEX's grip on trading of gold and silver Futures by offering them on an electronic basis on 6 October 2004. NYMEX announced in September that it would introduce on the same day a new system called "Neon" that will automatically send a customer's order to NYMEX gold and silver open outcry trading pits; currently, customers typically talk to floor clerks by phone. The Neon system should be extended to energy trading pits later. NYMEX – the largest energy futures and gold and silver Futures exchange – wants, however, to keep its practice of open outcry, which it views as a unique source of liquidity. It is interesting to observe how various exchanges are incorporating electronic trading while aiming at preserving their own specificity.

Returning to Futures contracts, trade can occur for delivery at different maturity dates in the future. The contract design also includes position limits, daily price limits

Table 1.2 Commodity Futures contracts

Commodity group	Commodity type
Grains	Corn Oats Rice Wheat
Oil and meal	Soybean
Livestock	Pork Beef
Foodstuffs	Cocoa Coffee Orange juice Potatoes Sugar
Textiles	Cotton
Forest products	Lumber Pulp
Metals	Gold Silver Platinum Palladium Copper Aluminum
Energy	Crude oil Heating oil Gasoline Natural gas Propane gas Electricity

and quotation conventions and attempts to reduce to the greatest extent any ambiguities as to the nature of a physically settled contract. Although an extremely small fraction of contracts purchased or sold are actually held until delivery, possible residual uncertainty as to the terms of the contract would reduce the quality of the hedge it provides and, in turn, its popularity. The details of delivery are fully specified by the exchange, namely: the quantity – number of bushels or tons per contract, number of cubic feet for natural gas; the type – robusta versus arabica for coffee; the location – which in general has nothing to do with the exchange (a NYMEX WTI contract is delivered at Cushing in Oklahoma). Sometimes, a choice is given to the seller with respect to one of these items, including the time window of delivery: this *option to deliver* (analogous to the one that exists for bond notional Futures regarding the specific bond that is delivered) has a positive value that can be computed in terms of the type of flexibility and this value is obviously negative for the buyer of the Futures contract.

Basis risk

1. Understanding basis risk is fundamental to hedging. *Basis* is defined as:

$$\text{Basis}_{t,T} = \text{Spot price}_t - F^T(t)$$

is usually quoted as a premium or discount: the cash price as a premium or discount to the Future price.

The basis is said to be one dollar "over" Futures if the spot price is one dollar higher than the Futures price.

2. There are several types of basis risk:
   (a) In the case of a trading desk which needs to cut at date t (e.g., to avoid negative margin calls[2]) – a position in Futures which was meant to hedge a position in the spot commodity – the basis risk is represented by the quantity defined above.
   (b) More generally, basis risk exists when Futures and spot prices do not change by the same amount over time and, possibly, will not converge at maturity T:
   – because the Futures contracts were written on an underlying similar but not identical to the source of risk, such as an airline company hedging exposure to a rise in jet fuel prices with NYMEX heating oil Futures contracts;
   – because of the optionalities left to the seller at maturity in the physical settlement of the Futures contract: grade of the commodity, location, chemical attributes.

Today, market participants analyze their risk in a mark-to-market perspective at date t (and not only at date T). Consequently, basis risk is often defined as the *variance of the basis*:

$$\sigma^2(S_t - F^T(t)) = \sigma^2(S_t) + \sigma^2(F^T(t)) - 2\rho\sigma(S_t)\sigma(F^T(t))$$

where ρ is the correlation coefficient between the Futures and spot price series.

This equation shows that basis risk is zero when variances between the Futures and spot prices are identical *and* the correlation coefficient ρ between spot and Futures prices is equal to one. In practice, the second condition is the most stringent one and the magnitude of basis risk depends mainly on the degree of correlation between cash and Futures prices.

Since hedgers are trying to eliminate price risk, the classical measure of the effectiveness of hedging a spot position with Futures contracts is defined by:

$$h = 1 - \frac{\sigma^2(\text{basis})}{\sigma^2(S_t)}$$

The closer h is to one, the more effective the hedge. To return to the airline example, if crude oil contracts and heating oil contracts are available to hedge its exposure to jet fuel price risk, it will choose the solution leading to the higher number h. Remembering

[2] One needs to keep in mind that the major bankruptcies of hedge funds occurred because of funds' inabilities to face the margin calls related to existing positions.

that the position in the hedging of Futures may need to be cut at any time, one wants to be left with as small a basis as possible.

Returning to the different optionalities attached to delivery of the physical commodity, they have been the subject of a vast body of literature since both the seller and buyer of the Futures contract are quite aware of their financial value (see, e.g., Gay and Manaster, 1986).

Some commodity contracts, like most financial Futures, are based on cash delivery rather than physical delivery. In this case, the holder of a long contract receives at maturity the last marginal call, positive or negative, corresponding to the change of the Future price over the last trading day, since his gain or loss over the period has been incorporated daily in his account at the exchange.

In summary, a Future position may be terminated essentially in three ways:

1. By taking prior to maturity a symmetric position in an equal number of contracts in order to nullify the position and avoid the cumbersome and expensive procedure of physical delivery.
2. Roughly 1% of the Futures contracts go into physical delivery at maturity. The benefit of the existence of physical delivery is that it implies the convergence of spot and Futures prices at maturity of the contract; hence, the consistency in the moves of these two quantities over time. The constraining part, however, is that the clearing house needs to fully specify the delivery location, the delivery period – which usually covers the delivery month for monthly Futures contracts on commodities, in contrast to financial Futures on bonds, for instance, which result in a unique delivery of the bond – as well as the delivery rate. Lastly, the grade of the commodity needs to be made clear as well as the optionalities left to the seller (respectively, buyer) in the delivery procedure. When the grade specification is left open, the seller will choose *the cheapest to deliver*; a vast literature exists on this issue in the case of bond Futures contracts.
3. By entering into an Exchange For Physical (EFP) agreement.

Exchange For Physical

An EFP is an agreement between a party holding a long Futures position and a party with an equal size short position to enter a bilateral contract specifying the terms of physical delivery (location and price). The two parties notify the clearing house of the quantity and price negotiated between them and both futures positions are then terminated under the terms of the EFP. In grain markets, this type of transaction is called "ex pit".

Alternative Delivery Procedure

An ADP is available to buyers and sellers who have been matched by the exchange subsequent to the termination of trading in the spot month contract. If buyer and seller agree to achieve delivery under terms different from those prescribed in the contract specifications, they may proceed on that basis after submitting a notice of their intention to the exchange.

1.5 SHIPPING AND FREIGHT: SPOT AND FORWARD MARKETS

The current issues in the booming freight market

A recent jump in ocean-shipping rates to their highest levels in decades is adding upward pressure on already rising commodity prices that could increase further the cost of imported goods in the US, in China, in Europe and worldwide. The demand for sea-faring vessels is far outstripping supply and the cost of shipping iron ore, soybeans and other commodities used in the manufacture of a wide range of goods nearly tripled in 2003. The Baltic Dry Index (BDI), the key industry indicator published in London and representative of loose goods transportation (cereals, minerals, coal) kept rising sharply, showing no signs of relief on the horizon in terms of lower prices or additional supply of vessels. The Baltic Panama Index (BPI), essentially dedicated to cereals, follows the same pattern. A similar trend, at an even larger scale, is observed in the cost of oil tankers where the price of insurance for tankers coming from the Middle East adds to the other rising components.

China's surging economy is creating a huge demand for ships to import the basic raw materials the country needs to build infrastructure, supply its massive manufacturing sector and satisfy a growing consumer market. As more ships go to China, fewer are available to ferry goods between other parts of the world, causing a supply shortage and price rises. Compounding the problem, shrinking mining industries in the Americas and Europe have increased these regions' imports of coal. Besides these structural elements, events like the summer 2003 drought in Europe that boosted grain shipments from the US contribute to the price pressure.

Clarksons, a large London-based ship broker which has kept records on shipping rates for about 30 years, observed that the end of 2003 was the highest rate market of all times. Obviously, the impact on the world economy comes with some lag in the form of higher prices on goods made of steel, aluminum and other metals. For countries like China, the US and the European Community, which import more that they export, this may translate into inflationary pressure. The increase in the shipping cost is particularly clear for products like textiles and metals since they are heavier and bulkier (the situation being quite different for electronic equipment, for instance). In September 2003, copper was trading on the LME at $2.083 per ton, a 6-year high point. The cost for alumina, the basic ingredient to produce aluminum, nearly doubled in 2003 and cotton prices were trading at 5-year highs of about 84 cents a pound, in part because of increased demand from China and India.

The growing use of world freight is greatly explained by the rising demand in China which, for instance, in 2003 increased its imports of iron ore (the basic material to make steel) by nearly 40 million tons, or 33%. Meanwhile, imports by Europe of coal from China, Indonesia and Australia rose by 35%. On another register, Brazil – a major producer of soybeans (as we will see in Chapter 7) – shipped greater quantities of them to China where they are used for animal feed and human food products, such as soybean oil.

Higher freight rates are mainly hitting bulk-shipping vessels, specialized carriers that transport commodities in their raw form and that account for about one-third of all commercial ocean-going trade. More that 30% of all bulk ships carry iron ore and coal.

The other classes of freight ships are: container vessels that carry semifinished and finished goods, such as electronic devices and appliances; and tankers that are used for oil and, more recently, natural gas. Although ships come in different sizes and shapes, the spot cost to rent a typical bulk to ferry coal or iron ore was about $75,000 a day at the end of 2003, according to traders and ship brokers – quite different from the $20,000 to $28,000 a day prevailing in January 2003. About 40% of goods are transported in ships hired on the spot market. As a comparison, companies that had bought forward contracts on freight back in 2001 or 2002 for "delivery" of freight in 2003 had locked in a forward price which was only around $30,000 a day.

At the same time, the shipbuilding business, centered in South Korea, Japan and China, is backed up with orders and the lead times for taking new deliveries are almost twice as long as normal. One of the reasons for the delays is the fact that the world's shipbuilders are busy building new oil tankers to satisfy the more stringent safety requirements called for by European regulators. Hence, previous orders for new container ships have pushed any new orders for bulk ships to the back of the line; a new ship that used to take 18 months to 2 years for completion now requires as much as 3 years for delivery.

Spot and Forward Freight Markets

Freight contracts can be transacted either in the spot market or in the Forward Freight Agreement (FFA) market, since Futures exchanges no longer trade them today. The Baltic International Freight Future Exchange (BIFFEX) offered Futures contracts between May 1985 and April 2002; the underlying asset was a basket index comprising the seven routes of the BPI. This index, as it stands today, is presented in Table 1.3.

Table 1.3 Baltic Panama Index (BPI) weighting

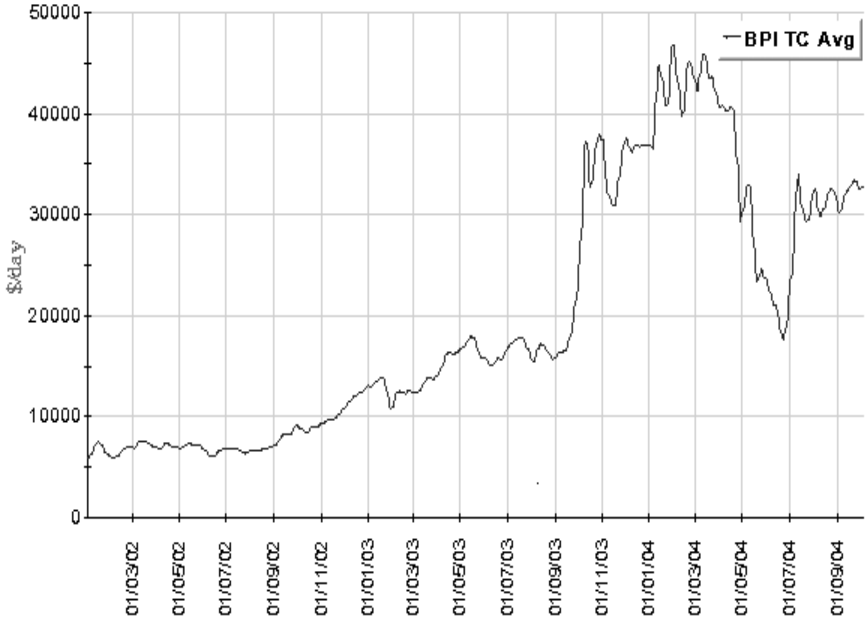
Routes	Route description	Cargo	Weight in the BPI (%)
1	US Gulf of Mexico to ARA (Antwerp–Rotterdam–Amsterdam)	Light grain	10
2	Transatlantic round of 45–60 days	Time charter contracts	20
3	US Gulf to South Japan	Heavy grain, soybean, sorghum	12.5
4	Gibraltar to the Far East via Gulf of Mexico (duration 50–60 days)	Time charter contracts	12.5
5	US North Pacific port to South Japan	HSS	10
6	Transpacific round of 35–50 days	TCC	20
7	US West Coast or British Columbia to Japan/South Korea	TCC	15

Since April 2002, only FFAs have been traded. They mostly trade on specific routes rather than on the entire index.

The aim of the introduction in 1992 of forward contracts, besides the BIFFEX Futures contracts, was to provide another way of hedging freight rate risk in the dry-bulk and wet-bulk sectors of the shipping industry. FFA contracts are principal-to-principal contracts to settle a freight or hire rate for a specified quantity of cargo or type of vessel for usually one (or a combination) of the major trade routes. The reason for the success of FFA contracts over BIFFEX ones is primarily related to the high basis risk remaining after hedging with a contract written on an index. Most market agents in the shipping industry operate in some defined regions of the world and, therefore, demand route-specific derivatives contracts.

Typically, a shipowner or a charterer feeling that the freight market in a given route and a specific vessel/cargo size might move against him would approach an approved broker to buy or sell FFA contracts. This broker would find another charterer or another broker with a client with opposite expectations in order to fix the FFA contract. The major FFA brokers are those on the panel of shipbrokers of the Forward Freight Agreement Brokers Association (FFABA) created in 1997. They include Clarksons Securities Ltd, Lynch Flynn & Associates, Yamamizu Shipping. The city of London has established itself as the major FFA market.

Each member shipbroker of the FFABA submits to the Baltic Exchange its daily review of the rate on each constituent route of the Baltic indices. The Baltic Exchange excludes the highest and lowest assessments of the day and takes an arithmetic average of the remainder. The average rate of each route is then multiplied by the weighting factor to return the contribution of each route to the index; finally, by adding all the route contributions together, an overall average index is created (i.e., the daily BPI):



Source: Clarksons

Currently, FFA contracts have the BHMI, BCI and BITR as underlying asset spot freight rates in routes of the BPI. As an example, consider a charterer who, on 10 June 2004, is interested in transporting Heavy grain, Soya and Sorghum (HSS) from the US Gulf to Japan under a voyage charter party two months later (31 August). In order to avoid adverse freight-rate movements between 10 June and 30 August (day of the spot fixture), the charterer will approach a broker and define the following contract specifications: route US Gulf–Japan; cargo size 80,000 tons HSS, contract date 31 August 2004. The broker will search for another broker with a client, typically a shipowner, having the same contract characteristics in mind, but with opposite expectations on evolution of the freight rate.

The FFA market is a private market; hence, transactions and their nature are not made public. According to reliable sources, the total FFA volume went from 2,000 contracts in 2000 to 2,500 contracts in 2001 and more than 3,000 contracts in 2002. In practice, most of the trading concentrates in the nearby (1-month) and 2-month contracts, with much lower volumes in 3-month contracts. According to Kavussanos and Nomikos (2001), new information disseminates faster in the FFA market than in the spot market. Hence, it seems that FFA prices in all routes contain useful information about subsequent spot prices and can be used as price discovery vehicles for decision-making. Kavussanos and Nomikos (2001) investigate the relationship in daily returns and volatilities between spot and FFA price series on the major transatlantic and transpacific freight routes. Not only do they show that prices and volatilities in the spot and forward freight markets are "co-integrated" in the sense that they move together over long time periods,[3] but, by going through a lead–lag analysis, they also exhibit that it is the *forward market that leads the spot market*, as is the case in all commodity markets. They conclude that FFA prices in all routes contain information about future freight spot prices and, therefore, can be used as price discovery vehicles.

1.6 VOLUME, LIQUIDITY AND OPEN INTEREST IN FUTURES MARKETS

Table 1.4 displays the average daily volumes of Futures contracts traded on major exchanges in January 2004. Underlyings are divided into broad categories and ranked according to decreasing volumes. Unsurprisingly, oil products are by far the most traded: more than 200,000 transactions on crude oil take place every day on NYMEX and 100,000 on the IPE Brent. Gas immediately follows oil, showing the growing importance of this commodity. Agricultural products come after the energy group, starting with cereals. Among all commodities, corn has the second largest volume of trades after crude oil. Corn volume is higher than that for soybean, but not that of soybean and soybean complex. Outside cereals, it is coffee which has the highest volume. Aluminum and copper are the most traded among the industrial metals, while gold and silver are the most traded among the precious metals.

[3] Two processes (X_t) and (Y_t) are said to be co-integrated if there exists a linear combination $(aX_t + bY_t)_{t\geq 0}$ of the two processes that is a stationary process.

Table 1.4 Average daily volumes on various commodity Futures during January 2004

Exchange	CBOT	CME	NYMEX	COMEX	NYBOT	IPE	LME	MATIF
Energy								
Crude oil WTI			216,728					
Brent						97,801		
Natural gas			61,165			2,377		
Heating fuel			60,728					
Unleaded gasoline			50,320					
Gasoil						44,177		
PJM electricity index			322					
Propane			149					
Agriculturals								
Corn	101,286							161
Soybean	75,485							
Soymeal	32,435							
Wheat	32,844							373
Sugar					27,030			
Coffee					20,519			
Cotton					14,366			
Cocoa					9,194			
Oatmeals	1,687							
Rice	891							
Colza								647
Metals								
Aluminum				496			106,830	
Copper				11,239			85,235	
Zinc							44,211	
Lead							18,369	
Nickel							14,751	
Tin							5,061	
Gold				83,227				
Silver				20,266				
Platinum				860				
Palladium				806				
Agriculturals								
Beef		18,115						
Pork bellies		10,621						
Milk		893						
Lumber		896						

An important feature shared by all commodity Futures is that the highest liquidity is observed for short maturities, of the order of a few months. As an example, Figure 1.1 depicts the average daily volume observed in January 2004 on a Brent Future contract as a function of its maturity; volume gets divided by 10 when the time to maturity is 4 months instead of 1 month. This makes the establishment of reliable statistics difficult for the prices of Futures with medium- to long-term maturities.

Even though liquidity modeling is one of the topics on which financial theory needs more findings even in the context of classical instruments such as bonds and stocks, some qualitative concepts have emerged that can be extended to commodity markets:

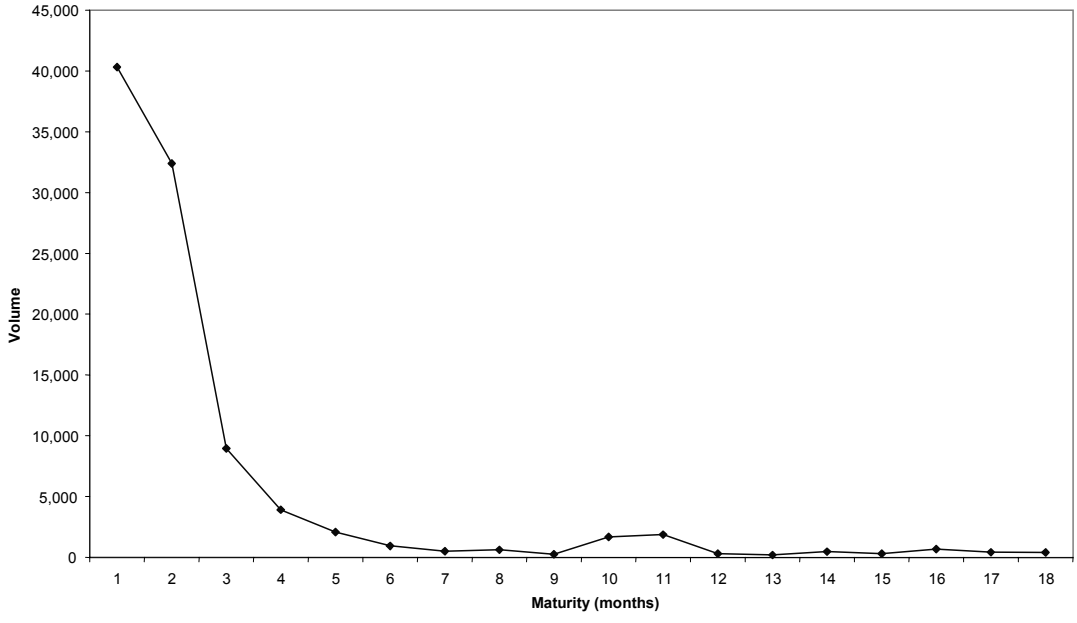


Figure 1.1 January 2004 average daily volume on the IPE Brent Future contract as a function of its maturity.

- Liquidity may be measured by the size of the trade it takes to move the market.
- *Market depth* may be measured by the time it takes for an order of a standard size to be executed.

Open interest in Futures market

Open interest refers to the number of futures contracts outstanding at a particular moment, i.e., the number of contracts that have not been canceled by an offsetting trade. Official figures on open interest are released by the exchange in a daily manner for the day before. One needs to keep in mind that it represents the total number of contracts held by buyers *or* sold short by sellers since these two numbers are always equal. The size of the open interest reflects the determination of the two groups, longs and shorts, to hold to their positions. It is a major indicator for technical analysts who derive buy-and-sell rules from the combined effect of an upward or downward trend with a rising or falling open interest.

Conclusion

Commodities and commodity markets have undergone dramatic changes over the last few years, with the deregulation of gas and electricity markets, the boom in South American production of soybean and the arrival of new actors in the coffee market. Countries like China are absorbing an increasing percentage of world commodity production and shifting up demand figures. Liquidity has increased in all Futures

contracts, in particular for energy commodities which represent today the highest volume of traded Futures. This translates into higher volatility and price risk in all markets; hence, more hedging activities become necessary in all sectors of the economy, from the agrifood business to airline companies.