

Part
One

**Commodity Markets
and Products**

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CHAPTER 1**Oil Markets and Products****Cristiano Campi and Francesco Galdenzi****1.1 INTRODUCTION**

The price of crude oil and oil products, once discussed solely in industry and government circles, has taken centre stage in the past 15 years among the lead indicators of the state of the economy and is now always quoted when forecasting economic trends. This phenomenon has occurred in conjunction with the growing acceptance of commodities as a mainstream financial and investment asset class, with the resulting growth in the volume and variety of financial instruments linked to them and the widespread use of these financial instruments in hedging, risk management and investments products.

This chapter focuses on two important offshoots of this ‘coming of age’ of the energy markets: the implementation of financially settled risk management policies by corporations exposed to fluctuating oil and oil product prices and the growth of hedging activities for companies active in physical oil trading. Before going further, it is worth looking at some key elements that determine the economics in the oil and oil products value chain. The oil industry is based on two main types of processes:

1. *Upstream*. This part of the oil cycle is associated with the exploration and production of crude oil.
2. *Downstream*. This part encompasses the transportation, refining and marketing of refined oil products (gasoline, diesel, jet fuel, naphtha, etc.).

The production of crude represents the starting point of the oil cycle. A producer is a company dedicated to extracting crude oil, which is supplied to the refinery system for the production of products needed to satisfy the demand of its energy consumers. The oil cycle is composed of the following elements.

1. The production of crude oil by several kinds of players, including:
 - (a) Integrated oil companies, such as Royal Dutch Shell in the UK, Eni in Italy, China National Petroleum Corporation in China and Exxon in the United States.

- (b) Independent oil companies, such as Cairn Energy in the UK and Perenco in France.
 - (c) National oil companies (NOCs), such as Petrobras in Brazil, Saudi Aramco in Saudi Arabia or Petronas in Malaysia.
2. The demand for crude oil by the refinery system to produce oil products from:
 - (a) Refineries owned and managed by integrated oil companies or NOCs sourcing crude oil from their own production as well as buying it from international oil markets.
 - (b) Independent refineries, such as Saras in Italy and Valero in the United States, sourcing crude oil from the international oil markets.
 3. The demand for oil products by final consumers, such as utilities, airlines, shipping companies, energy-intensive manufacturers, petrochemical companies, gasoline and diesel retailers.

The cycle described above is complemented by the transportation system, a vast and complex network of pipelines, crude oil and product carriers (by sea, rail and road) and storage facilities dedicated to the logistics behind the delivery of crude oil to refineries and of products to the final consumers.

The price of crude oil and oil products is driven by many factors, from macroeconomics to environmental legislation, from geopolitics to the weather and from production levels to taxation. The list in Table 1.1 proposes a scheme of the key factors observed by market operators when trying to assess price trends for oil and oil products.

1.2 RISK MANAGEMENT FOR CORPORATIONS: HEDGING USING DERIVATIVE INSTRUMENTS

1.2.1 Crude Oil and Oil Products Risk Management for Corporations

1.2.1.1 Corporate Risk Management Overview Companies with exposure to the price volatility of oil and oil products are taking an active role in managing this risk. They do so by entering into financially settled derivatives transactions, with the goal of achieving one of the following objectives:

1. Budget and/or profit margin protection.
2. Stabilization of cash flow and control of supply chain prices.
3. Gaining competitive advantage through swift reactions to changes in market prices.

Effective energy price risk management requires expertise in both financial instruments and oil markets: one must find financial instruments that mimic the prices from the suppliers (or to the customers) and constantly analyse oil price movements in the commodity markets. Because so few organizations have the in-house resources to support such specialization, energy price risk management expertise is often externally sourced from consultants or performed with the support of the sales and trading desks of investment banks, brokers and trading companies.

TABLE 1.1 Key factors impacting price trends of oil and oil products

Macroeconomics	Gross domestic product (GDP) growth is generally linked to the increased consumption of energy and is positively correlated with spot and forward prices for crude and refined products.
Technology developments	Technological breakthroughs in the exploration sector (such as horizontal drilling, hydraulic fracturing or 'fracking', oil sand extraction, deep sea drilling) often force a re-evaluation of available oil reserves and can impact spot and forward prices.
Level of proven reserves	Technological developments such as those listed above plus improved seismic surveys often lead to new discoveries or to upgrading the amount of recoverable oil in existing oil reservoirs, with a potential impact on the level of forward prices.
Commercial and strategic storage	Additions to the worldwide network of commercially operated storage facilities or to state-controlled strategic storage can impact the behaviour of spot versus forward prices.
Weather	Hurricanes and typhoons can severely disrupt the logistics around oil and oil product markets, often impacting spot prices. Unusually cold or hot weather patterns can affect the consumption of gas and electricity, with an indirect impact on the spot and forward prices of oil products.
Arbitrage among energy commodities	The relative value of oil products versus that of other energy commodities can push prices up or down. For example, if the price of natural gas goes up, some industrial consumers using natural gas for heat and steam production may decide to switch to fuel oil if this proves to be cheaper on a per unit of heat basis. This would increase the demand for fuel oil and up its price, reducing the demand and price for natural gas.
Geopolitics	Trouble in important oil-producing countries (wars, terrorism, resource nationalism, etc.) will most likely lead to spikes in spot and forward prices, especially when spare production capacity is limited.
Financial markets	Crude oil is now an established asset class for financial investors (via index products or exchange-traded funds or directly on the futures markets). Changes in investment allocations by large players such as pension funds and asset managers can lead to material changes in oil future prices.
Exchange rates	Oil markets are denominated in US dollars, so US currency movements have a direct impact on the cost of consuming oil and oil products when expressed in the local currency, thus causing increases or reductions in demand.
Refining capacity	The construction of an oil refinery is a long and capital-intensive process; thus, when a global refinery system's spare capacity is limited, sudden increases in demand for oil products will likely lead to increases in oil product prices.
Shipping	Shipping rates for the transportation of crude and oil products, among the various production and consumption points, are a traded commodity per se. Changes in shipping rate levels have a direct impact on oil and oil product prices.
Taxation policy	Taxation policy can affect oil price economics at the upstream level (royalties policy, petroleum revenue taxes, etc.) by impacting the profitability of the extraction of crude oil and at the downstream level by taxing certain kinds of oil products differently (e.g., diesel cars receive more favourable tax treatment than gasoline cars in certain countries).
Environmental policy	Environmental policies generally lead to an improvement in efficiency of the consumption of oil products (e.g., mandatory minimum fuel efficiency ratings for cars), resulting in a reduction in the demand for oil products and a progressive elimination of pollutants (e.g., reduction in the sulphur content of diesel and fuel oil), resulting in an increased demand for higher-quality crude oil (e.g., with a lower sulphur content).

Many factors affect the decision as to what is the appropriate risk management instrument, including the following:

1. *Payoff structure.* The hedging tools used need to create a cash flow consistent with the stated requirements of the hedging policy.
2. *Credit exposure.* The choice of hedging strategy can be influenced by its impact on the credit exposure versus the hedging counterpart. For example:
 - (a) Swaps are generally more credit intensive (i.e., they generate a higher credit exposure) than options structures.
 - (b) A strategy based on a combination of options and/or swaps plus options can help reduce the consumption of credit lines.
 - (c) Long-term maturities are more credit intensive than short-term ones.
3. *Documentation.* Hedging counterparts with master agreements – such as with the International Swap Dealers Association (ISDA) – in place with a credit support annex (CSA) generally generate less credit exposure compared with their hedging counterparts without such documentation.
4. *Accounting rules.* Hedging instruments compliant with accounting rules (such as International Accounting Standards (IAS) 39, *Financial Instruments: Recognition and Measurement*) tend to be preferred to limit their impact on financial reporting activity. Regulation IAS 39 requires that all derivatives are marked to market, with changes in the mark to market being taken to the profit and loss account. For many entities this would result in a significant amount of profit and loss volatility arising from the use of derivatives spilling over into the financial reports. Customers can mitigate the profit and loss effect arising from derivatives used for hedging by using hedging instruments that comply with certain tests of hedging effectiveness defined in the IAS regulations.
5. *Financial legislation.* New legislation on financial markets introduced after the financial crisis of 2008 (e.g., Dodd–Frank in the UNITED STATES or MIFID and EMIR in the EU) is having a deep impact on the hedging strategies and behaviour of the market participants.
6. *Suitability.* Not all hedging instruments and strategies are suitable for all customers. Local and international financial regulations require banks, trading companies and other providers of risk management services to assess the suitability of the product or strategy offered against several factors, such as the customer's actual risk management needs and ability to understand the implications of the products offered and whether the customer is authorized to enter into such a transaction.
7. *Basis risk.* Most hedging strategies will not match the exact price behaviour of the underlying physical commodity price exposure, since physical contracts can be pricing off indexes that are similar but not equal to the indexes traded on the financial markets. An important part of the risk manager's job is to find the most effective instrument (or the right combination of instruments) to minimize this residual risk.
8. *Liquidity of the instruments.* The choice of the most effective risk management strategy is also driven by market liquidity factors. Hedging large volumes and long tenors generally restricts the strategy to the most liquid indexes and instruments available.
9. *Internal hedging policy.* Most corporations active in the energy risk management space have risk management policies – approved at board level or issued by the chief financial officer (CFO) – defining the hedging volume profile, maximum tenors and derivatives strategies that can be used.

10. *Market risk measurability.* The correct evaluation (fair value) of the risk of the hedging structure at any time during the life of the transaction depends on the availability of reliable market data points across the maturities and volatility of the traded commodities. The availability of these data varies greatly across commodities. Many companies are barred from entering into transactions where the fair value cannot be properly calculated.
11. *'Bookability' and the back office.* A hedging strategy is often defined by the limits of the counterparts booking and documenting the trade, with only transactions that are bookable eventually being executed.

1.2.1.2 Oil and Oil Products Overview The oil we find underground is called crude oil, and it is a mixture of hydrocarbons – from almost solid to gaseous – produced when plants and animals decayed under layers of sand and mud millions of years ago. Many grades of crude oil are produced today, each grade identified by many characteristics (listed in a document called an 'assay'), such as viscosity, flash point and aniline point. For the purposes of this chapter, only two of the main characteristics are considered: the American Petroleum Institute (API) gravity and the sulphur content.

1. *API gravity.* This is a measure of the crude oil density relative to the density of water, an index developed by the API and expressed in the range from 0° to 100°, with 0° being the heaviest and 100° the lightest. Water has an API gravity of 10° and the majority of crude oils have an API gravity in the range of 30° to 40° (also called intermediate or medium crude oils) – most refineries are configured to process crude oil within this range. Crude oils with an API gravity above 40° are called light and those with an API gravity below 30° are called heavy. The higher the API gravity, the higher the proportion of high-added-value products (such as gasoline, kerosene and naphtha) that can be obtained from a specific crude oil during the refining process. Light crude oil trades at a premium compared with intermediate crude oils, and intermediate crude oils trade at a premium to heavy crude oils.
2. *Sulphur content.* The higher a crude oil's sulphur content, the lower its value, since a higher number of sulphur molecules displace hydrocarbon molecules. High sulphur content also has other negative side effects, such as increasing the speed of corrosion in pipelines and refinery equipment, and is an atmospheric pollutant when the oil or oil product is burned. Sulphur content is expressed as a percentage of weight, with three main categories: sour (>1.5%), medium sour (0.5–1.5%) and sweet (<0.5%). Sweet crude oil trades at a premium to medium sour and sour crudes.

The API grade and sulphur content are the main elements defining the value of crude oil. Figure 1.1 presents the main crude oil benchmarks traded in the international markets.

Before crude oil can be used for anything it must be processed in an oil refinery. Crude oil is a mix of different chemical compounds, a combination of hydrogen and carbon atoms called hydrocarbons. Each of these chemical compounds has its own boiling temperature. Hence if one progressively raises the temperature of crude oil in a container, one obtains progressive separation by evaporating the various chemical compounds; once separated, the compounds are cooled and turned back into liquid. The temperatures at which the different chemical compounds reach their boiling points define what is called a distillation curve, and different types of crudes have different distillation curves. The main refinery techniques are discussed later, when we examine the refinery sector's hedging strategies.

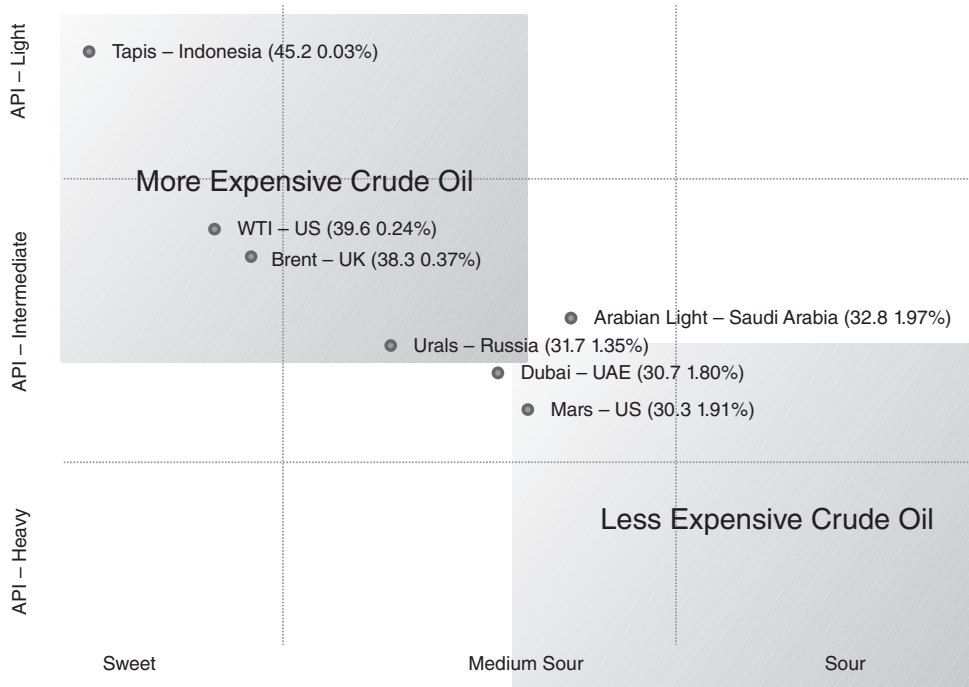


FIGURE 1.1 Main crude oil benchmarks (API and sulphur content)

A single crude oil or mix of crude oils (called a ‘crude slate’) can be used as feedstock and processed in a refinery, with the resulting mix of oil products called a ‘product slate’ (see Figure 1.2). Refinery operators always try to optimize production by purchasing a crude slate that maximizes the desired product slate. The percentage of each oil product produced per unit of feedstock is called the ‘yield’ (see Table 1.2). Local market requirements, product demand seasonality and the complexity of the refinery all affect the yield values for refineries around the world.

1.2.1.3 Oil Price Risk Management Overview The implementation of hedging strategies to protect against the movement of oil and oil product prices affects many different industrial sectors, from those (such as crude oil exploration and production and oil refinery) where the value of oil or oil products is the main driver of business strategy and business economics to those (such as transportation and power generation) where the value of oil and oil products is a key component of the cost line, although not necessarily the main one (but it is often the most volatile).

Corporate hedging strategies are not homogeneous across different industrial sectors and, even within the same industry sector, substantially different hedging strategies are used by the various market participants. The general principle is that smaller/newer corporations tend to have no hedging policy in place or will be active in the hedging market on a ‘one-off’ basis; the more such companies increase in size and knowledge and/or confidence (in terms of the hedging process, oil markets and tools), the more likely they will be to develop a proper risk management policy. A larger company will also have a better credit risk profile, and will

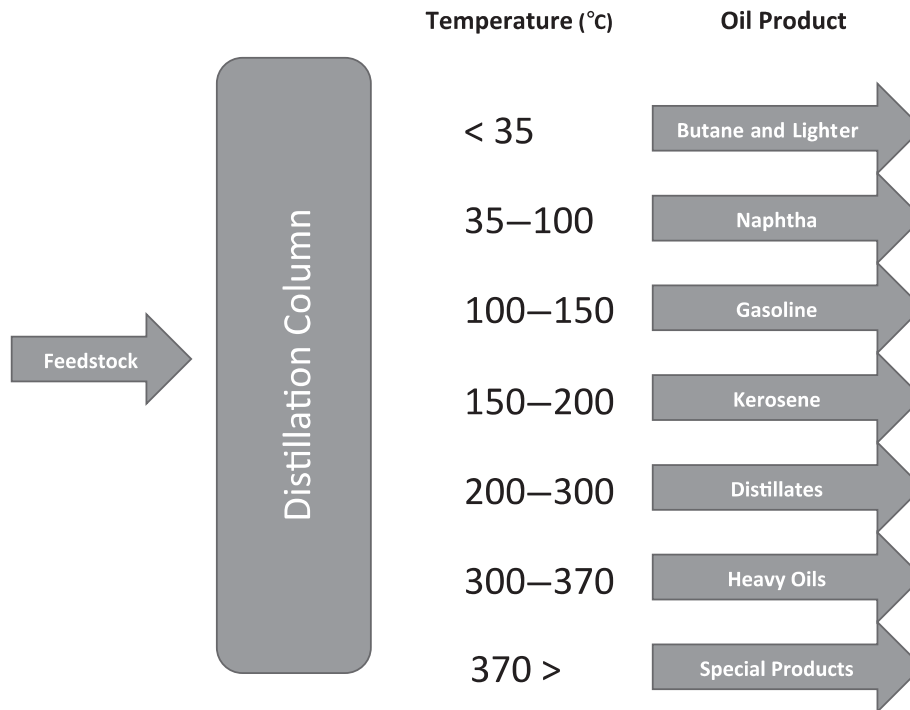


FIGURE 1.2 Distillation column

therefore have access to a wider group of risk management service providers (e.g., futures and over-the-counter (OTC) clearing platforms), thus improving the quality and price of the hedging structures they can transact. Medium to large companies often have a dedicated risk management team that manages oil price exposure and is involved with the preparation and execution of risk management strategy.

A company's risk management strategy is often approved at the board level (or at least at the CFO level) and defines the size and scope of the risk management activity. The following elements are generally included:

1. Derivative instruments that can be used, such as swaps, options and exotics.
2. Underlyings that can be used for risk management purposes, such as ICE Brent, fuel oil and gasoil cracks.
3. The volumes of the product that need to be hedged.
4. Maximum maturities for the above-mentioned instruments, such as ICE Brent up to five years but fuel oil up to two years only.
5. A hedging matrix (or hedging envelope), which defines the combination of instruments, underlyings and maturities that can be used when implementing a hedging strategy.
6. A credit envelope, which defines the criteria the hedging counterparts of a corporation need to meet to qualify as a counterpart (e.g., credit ratings, legal documentation).
7. A list of the people authorized to trade on behalf of the company.
8. Set-up and credit limits with futures exchanges and OTC clearing houses.

TABLE 1.2 Average yield structure

Product category	Subproducts	Typical use	Average yield (EIA data: Global Refineries)
Butane and lighter	Methane	Home heating, fertilizers,	9%
	Ethane	petrochemicals	
	Propane	Petrochemicals	
	Butanes	Petrochemicals	
Naphtha	Light naphtha	Blended with gasoline	6%
	Heavy naphtha	Petrochemicals	
Gasoline	Motor gasoline	Blended with gasoline, fertilizers	26%
	Kerosene	Automotive petrol engines	
Distillate	Jet fuel	Jet propulsion aircraft fuel	8%
	Gas turbine fuel	Power generation turbine	
	Kerosene	Heating and lighting	
Distillate	Diesel (auto and marine)	Auto and marine diesel engines	27%
	Heating oil	Heating and power generation	
Heavy oil	Marine fuel oil (bunker)	Marine engines	14%
	Heavy industrial fuel oil	Power generation	
Speciality products	Base oil	Lubricants	10%
	Waxes	Candles, packaging, food industry	
	Bitumen	Asphalt and construction	
	Petroleum coke	Fuel used in steel and cement industries	
	Carbon black	Rubber tyres	

A typical risk management strategy comprises two components:

1. A non-discretionary component defining transactions that the risk management team executes automatically, either at specific dates during the hedging year or whenever the market reaches certain levels.
2. A discretionary component where the risk management team is authorized to have a more opportunistic approach and transact whenever they see fit.

Before analysing in depth the risk management strategies of different energy-intensive customers, it is worth examining the way oil and oil product prices are created and reported. Some of the most traded oil products – such as Brent and West Texas intermediate (WTI) crude oil, European gasoil and heating oil in the United States – have their prices reported on the major oil futures exchanges (such as the Intercontinental Exchange (ICE) for Brent and European gasoil and the New York Mercantile Exchange (NYMEX) for WTI and heating oil).

Together with the energy futures exchanges, the major providers of energy price assessments are Platts and Argus. These companies publish news, research, commentary, market data and analysis and several hundred price assessments daily that are widely used as benchmarks in the physical futures markets and for OTC financial hedging. Their products

and services include real-time news and price information, end-of-day market data, newsletters and reports.

A market-appropriate methodology is used to assess prices in the various markets covered. This methodology is generally produced in consultation with a range of market participants. To assess the price of a certain oil product, it first needs to be properly identified. Without going too much into the specifics of the methodologies used by the price providers, three elements are generally used in oil product classification:

1. *Product type.* For example, fuel oil, diesel, gasoil and jet fuel.
2. *Sulphur content.* For example, fuel oil 3.5%, diesel 10 parts per million (ppm), gasoil 0.1%.
3. *Delivery information.* That is, the geographic point at which the title to goods transfers from the seller to the buyer. This is generally either free on board (FOB), where the buyer assumes the risk of loss and any further freight and handling charges at the crude oil loading facility or refinery terminal or cost insurance and freight (CIF), where the quoted price includes the cost of the goods, insurance and freight charges for a crude or oil product terminal in a specific region. For example, Fuel Oil 3.5% FOB Mediterranean (MED), Diesel 10 ppm CIF North West Europe (NWE) and Jet Fuel Singapore (Sing).

As a final note, while at the time of printing the product references are deemed to be correct and a good reflection of the various products used in risk management in the various trading regions, it is important to remember that this is a slow but constantly changing market. Occasionally regulations on chemical additives for some of the oil products may change, thus forcing the creation of a new specification. In addition, there is constant pressure to phase out polluting products (like sulphur) in favour of products with a lower impact on the environment.

Please also note that the swap, forward and option premium levels in the hedging strategy examples presented in the next paragraphs are for illustration purpose only and do not reflect actual market trading levels.

1.2.2 Aviation: Risk Profile and Hedging Strategies

1.2.2.1 Introduction: The Aviation Industry The term *aviation industry* encompasses both civil and military aviation. Civil aviation is further divided into general aviation (i.e., everything that is not a military flight, such as scheduled civil and cargo flights) and scheduled air transport. To analyse risk management activity, we focus on scheduled air transport companies, namely:

1. Large regional airlines.
2. Medium and large international airlines.

It is worth noting that one occasionally encounters hedging activity from cargo airlines and national military air forces.

The aviation industry is a major consumer of oil products in the form of jet fuel (or aviation fuel), a product of the family of middle distillates. According to the International Air Transport Association (IATA, *Economic Briefing*, December 2012), following the increase in energy prices of 2007, jet fuel is now the largest expense for airlines, accounting for roughly

a third of the industry's total variable cost base (up from 28% in 2007 and 14% in 2003), followed by labour costs (including pensions).

While fuel makes up a significant portion of an airline's total costs, efficiency among different carriers can vary widely:

1. Short-haul airlines typically get lower fuel efficiency because takeoffs and landings consume high amounts of jet fuel.
2. Low-cost airlines generally have more modern and hence more fuel-efficient fleets.
3. Low-cost airlines tend to have a lower cost base compared with national carriers; hence, fuel costs often represent a higher percentage of the overall cost.

Large airlines are among the most sophisticated players in corporate oil risk management, with dedicated teams actively trading the swap and option markets for crude oil, gasoil and jet fuel for maturities from six months to five years forward.

1.2.2.2 Jet Fuel and the Jet Engine Aviation fuel is a specialized type of petroleum-based fuel used to power aircraft. It is generally of higher quality than fuels used in less critical applications, such as heating and road transport, and often contains additives to reduce the risk of icing and explosion due to high temperatures, among other properties. The most commonly used jet fuel types are Jet A and Jet A-1, but other kinds of jet fuels are available (JP-8, JP-5, etc.) for military use, with higher specifications (such as a lower freezing point or higher flash point).

Another type of fuel, aviation gasoline (avgas), is generally used in the high-compression sparkplug ignition piston engines of small private propeller airplanes and helicopters. It is sold in much lower volumes but to many more individual aircraft, whereas jet fuel is sold in high volumes to large aircraft operated typically by airlines, the military and large corporations. For the purposes of this chapter, the focus of the analysis is on references that are useful for scheduled air transport only: jet fuel, gasoil and crude oil.

Although modern aircraft engines contain some of the most sophisticated engineering technology in everyday use, their basic principles are quite simple and have changed little since jet engines came into use at the end of World War II. In its simplest form, the jet engine is a tube into which air is sucked before being compressed, mixed with fuel and burnt. Combustion causes the fuel-air mixture to expand and accelerate towards the rear of the engine. This high-speed exhaust generates the thrust to push the engine forward.

1.2.2.3 Product Specifications

Europe, Middle East and Africa Regions The jet fuel references generally used by European-based airlines for risk management purposes are published by Platts, as follows:

1. Jet Kero CIF NWE Cargoes (in US\$ per metric tonne (USD/MT)). Platts considers the prices of cargoes delivered into Amsterdam, Rotterdam and Antwerp (ARA), the UK and northern France for the assessment.
2. Jet Cargoes FOB NWE (USD/MT). Platts considers transactions from ARA, Ghent and Flushing. Any transactions at other loading ports in NWE are typically normalized on a freight differential basis back to Rotterdam.

3. Jet Barges FOB ARA (USD/MT). Platts considers as transactions basis FOB Rotterdam. Any transactions occurring at other loading ports in NWE are typically normalized on a freight differential basis back to Rotterdam. Platts considers bids and offers from Rotterdam, Antwerp, Amsterdam, Ghent and Flushing.
4. Jet Fuel FOB MED (USD/MT). Platts derives this quote from the Jet Kero CIF NWE Cargoes quote adjusted for the cost of transportation from NWE into the Mediterranean region (Augusta, Italy).

Jet fuel is not the only price reference used by European airlines when hedging price risk. The market for financial OTC products for jet fuel has limited liquidity in terms of maximum volume and maximum tenor executable. Hence, airlines often use crude oil and oil product references whenever the volume to be hedged is too large or the tenor is too long to be accommodated within the liquidity of jet fuel references. The main alternative references used by European airlines are as follows:

1. ICE Brent (in US\$ per barrel (USD/bbl)), based on the daily settlement price of the ICE Brent futures contract.
2. ICE gasoil (USD/MT), based on the daily settlement price of the ICE gasoil futures contract.
3. NYMEX WTI (USD/bbl), based on the daily settlement price of the NYMEX WTI futures contract.
4. Jet differential (USD/MT) = jet fuel – ICE gasoil.
5. Jet crack (USD/bbl) = jet fuel/7.45 (conversion factor MT to bbl) – ICE Brent.
6. ICE gasoil crack (USD/bbl) = ICE gasoil/7.45 (conversion factor MT to bbl) – ICE Brent.

Asian Region The references generally used by Asian airlines for risk management purposes are published by Platts:

Jet Kerosene FOB Cargoes Singapore (\$/bbl). The Singapore physical assessment reflects transactions, bids and offers of a minimum of 100,000 bbl and a maximum of 250,000 bbl, and loading within 15–30 days from the date of publication.

Asian airlines also use other crude oil and oil product references whenever the volume is too large or the tenor is too long to be accommodated within the liquidity of jet fuel references. The main alternative references used by Asian-based airlines are as follows:

1. NYMEX WTI (USD/bbl), based on the daily settlement price of the NYMEX WTI futures contract.
2. ICE Brent (USD/bbl), based on the daily settlement price of the ICE Brent futures contract.
3. Singapore Gasoil Reg 0.5% Sulphur (USD/bbl).

Americas Region The references generally used by airlines in the Americas region for risk management purposes are published by Platts and include:

US Gulf Coast Jet Kerosene 54 Waterborne (in USD cents per gallon (USDc/gal)).

Airlines also use other crude oil and oil product references whenever the volume is too large or the tenor is too long to be accommodated within the liquidity of jet fuel references. The main alternative references used by Americas-based airlines are as follows:

1. NYMEX Heating Oil (HO) (USD/bbl), also known as #2 contract, based on the daily settlement price of the NYMEX heating oil futures contract.
2. NYMEX WTI (USD/bbl), based on the daily settlement price of the NYMEX WTI futures contract.

1.2.2.4 Risk Management Strategies for the Aviation Industry The airlines sector has no such thing as a generic hedging strategy: the approach to what and when to cover exposure to jet fuel prices varies widely across the various players and is based on many factors, including local accounting regulations, the size of the airline, the presence of an approved hedging programme, tolerance and understanding of basis risk at the CFO and board levels, oil market dynamics, what the competition is doing and fuel surcharge policies.

Important elements affecting an airline's risk management behaviour are its credit standing and the contractual arrangements put in place with hedging counterparts:

1. *Credit considerations.* Large international airlines generally obtain larger and longer credit lines from banking counterparts. Hence, they are able to execute more refined hedging strategies compared with those that can be executed by smaller airlines with access to smaller and shorter credit lines. Some large airlines are also actively using futures and OTC cleared platforms.
2. *Contractual considerations.* Large international airlines have the resources to negotiate master ISDA agreements (and an occasional CSA, although this is not very common in the airline industry). Smaller airlines do not have the internal legal resources and are, in general, more resistant to enter into ISDAs and tend to rely on single trade (long-form) confirmations. The presence of an ISDA master agreement generally leads to obtaining better credit terms with trading counterparts.

Based on observations of the behaviour of market participants, some generic conclusions on risk management behaviour can be drawn.

1. Small to medium airlines (e.g., with a total consumption of less than 500,000 MT of jet fuel per year) tend to implement and execute risk management strategies with the following characteristics:
 - (a) Involving short to medium maturities (e.g., less than three years), generally covering no more than three seasons ahead (winter season is from October to March and summer season is from April to September).
 - (b) Mainly using swaps or plain vanilla options.
 - (c) Limited exposure to basis risk between jet fuel and gasoil or jet fuel and crude oil.
2. Medium to large airlines (with jet fuel consumption of 500,000 MT per year and above) generally have a dedicated team for the structuring, implementation and execution of hedging programmes and their strategies have the following characteristics:
 - (a) Involving short to long maturities (up to seven years), depending on what product is used (e.g., short maturities for jet fuel quotes, long maturities for crude oil quotes).

- (b) A hedging schedule, approved at the board level and an integral part of the financial strategy communicated to shareholders, with typical hedging ratios of
 - (i) up to 75% of forecasted consumed volumes one year ahead
 - (ii) up to 50% of forecasted consumed volumes two years ahead
 - (iii) up to 35% of forecasted consumed volumes three years ahead
 - (iv) up to 25% of forecasted consumed volumes four years ahead and beyond.
 - (c) Using a combination of swaps, plain vanilla options and exotic structures.
 - (d) Exposure and active management of basis risk.
3. On a regional basis, European and American airlines tend to use exotic structures less than Asian airlines.

Common risk management structures used by airlines are discussed next.

Jet Fuel Swaps: Simple and Straightforward *Situation.* An airline, let it be called DreamAir, has a strategic hedging programme in place with a provision that at any time at least 55% of the forecasted jet fuel consumption over the next 12 months needs to be at a fixed price. DreamAir's forecasted consumption over the next 12 months is 350,000 MT.

Strategy. DreamAir will enter over time into several swap transactions, for a total volume of $350,000 \times 55\% = 192,500$ MT for a tenor of 12 months. Every month (or as often as stated by the hedging policy), DreamAir will adjust the hedged volumes to take into consideration expired periods and changes in fuel consumption forecasts.

Pros. Swap transactions are the basic building block of any risk management structure. They are generally the simplest and most liquid tools available for hedging purposes. Hence, they are well understood and accepted by customer boards and auditors. Pricing is easy and relatively transparent (depending on the location of the Platts quote).

Cons. The beauty of the swap is also its main limitation. The customer is locked into a fixed price level. Hence, if the jet fuel price moves in favour of the customer (e.g., the jet fuel price goes down in the future for an airline), DreamAir will eventually be paying for jet fuel at a fixed level higher than the price paid by its competitors that did not hedge (or hedged less) with swaps. Volumes are also fixed and so if the forecasted consumption changes (e.g., as a result of expected reduced demand for air travel due to economic recession), then DreamAir can find itself with a hedging ratio higher than that which would have been desired.

Example. Figure 1.3 represents a situation where DreamAir has entered into a swap on jet fuel for 12 months forward at 525\$/MT (straight line). If we assume that no other hedges are put in place until the expiry of this hedge, the net result of this hedging strategy is as follows.

1. DreamAir is effectively paying its jet fuel consumption at 525\$/MT during the 12-month period, since (assuming the price of jet fuel moves as described by the dashed line):
 - (a) In months 1 to 3 and 10 to 12 DreamAir pays its physical supplier of jet fuel a price below 525\$/MT but also pays to the hedging bank the difference between 525\$/MT and the market price.
 - (b) In months 4 to 9 DreamAir pays its physical supplier of jet fuel a price above 525\$/MT but also receives from the hedging bank the difference between the market price and 525\$/MT.

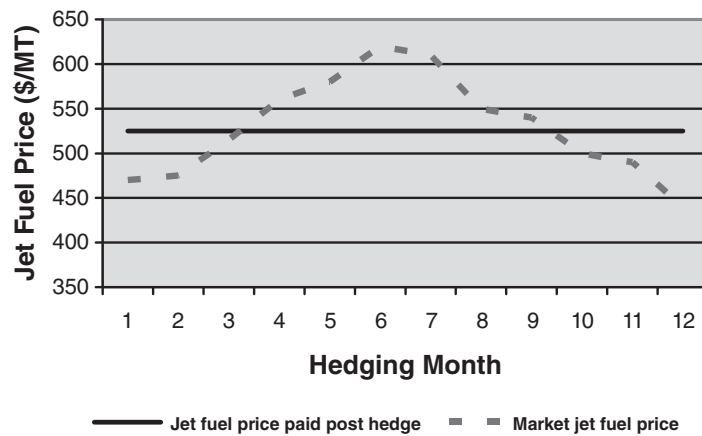


FIGURE 1.3 Jet fuel swap

Gasoil and Jet Fuel Differential: Optimizing Relative Value *Situation.* DreamAir now wants to protect additional volumes of jet fuel but, while the CFO is concerned about the price trend for oil products, there are worries about changes in the relative value of jet fuel against that of other oil products due to the increased refinery capacity from the opening of new refineries in India and China. The CFO wants to protect DreamAir against a general increase in the oil complex but also has a view that jet fuel may be weaker in the future compared with other oil products.

Strategy. DreamAir initially enters into a swap transaction on ICE gasoil for a tenor of 12 months. After this initial transaction (which leaves DreamAir exposed to the ICE gasoil differential with Jet), DreamAir continues to monitor the differential between jet fuel and gasoil for that hedged period. If the CFO is correct and this forward differential is reducing over time (as a result of the increased volumes of jet fuel coming onto the physical markets from the new refineries in India and China), DreamAir will enter, at a later stage, into a second transaction buying the swap differential (jet swap differential = jet fuel swap – ICE gasoil swap) between jet fuel and ICE gasoil, effectively transforming the initial ICE gasoil hedge into a jet fuel hedge for the same period:

$$\text{ICE gasoil swap} + (\text{jet fuel swap} - \text{ICE gasoil swap}) = \text{jet fuel swap}$$

Pros. DreamAir can take advantage of expected developments on the jet fuel physical markets (e.g., expected increases in jet fuel production from new or upgraded refineries) or from reductions in demand (e.g., reductions in air traffic linked to events such as the economic crisis, the severe acute respiratory syndrome (SARS) epidemic of 2003 and volcanic ash closing airspaces in 2010). As a result of this two-stage strategy, DreamAir may be able to lock in the price of jet fuel at a cheaper relative price compared with buying jet fuel directly in stage one.

Cons. If the expected market events do not materialize and jet fuel does not become cheaper than gasoil, DreamAir will end up locking the price of jet fuel at a level that is relatively more expensive than what would have been obtained by buying a jet fuel swap directly in stage one.

Payoff analysis Swap market situation on 1 June 2014:

Gasoil	Jet fuel
Swap Jan15–Dec15	
650	750

For the period January 2015 to December 2015 DreamAir buys gasoil swaps at 650\$/MT, taking the view that the jet fuel differential (currently at 750 – 650 = 100\$/MT) will come down in the next three months.

Swap market situation on 15 September 2014:

Gasoil	Jet fuel
Swap Jan15–Dec15	
750	800

The jet fuel market differential has moved as expected, the energy complex has moved up, but jet fuel is now relatively cheaper compared with gasoil. DreamAir can now complete its hedging transaction as follows:

1. DreamAir sells the January 2015 to December 2015 gasoil swap at 750\$/MT, realizing a gain of 100\$/MT.
2. DreamAir buys the January 2015 to December 2015 jet fuel swap at 800\$/MT, realizing an overall gain of 50\$/MT (100\$/MT of gain on the gasoil transaction – 50\$/MT loss on the increased cost of jet fuel).

ICE Brent and Gasoil Crack: Optimizing Relative Value *Situation.* DreamAir needs to put in place a hedging programme for a large volume of jet fuel, but in order to minimize liquidity costs, it decides to initially put a hedging position using either ICE Brent or ICE gasoil. The ICE gasoil positions can then be rolled into jet fuel by using the jet differential strategy described in the previous section.

Strategy. DreamAir's CFO believes that ICE gasoil is relatively too expensive compared with ICE Brent. DreamAir initially enters into a swap transaction on ICE Brent for a tenor of 18 months. After this initial transaction, it continues to monitor the relative value between ICE Brent and ICE gasoil, called the 'crack' and expressed as the differential between gasoil (quoted in \$/MT but converted to \$/bbl using a fixed volume conversion factor of 7.45) and Brent (quoted in \$/bbl):

$$\text{ICE gasoil crack swap (\$/bbl)} = \text{ICE gasoil swap}/7.45 - \text{ICE Brent swap}$$

If the CFO's view of the oil markets is correct and this crack reduces over time, DreamAir will enter into further transactions, buying the ICE gasoil crack and effectively transforming the initial ICE Brent hedge into an ICE gasoil hedge for the same hedging period.

Pros. DreamAir can take advantage of expected positive developments in the crude and middle distillate markets. As a result of this strategy, DreamAir has built up a position in ICE gasoil at a better level than they would have obtained if they had locked an ICE gasoil swap at the beginning of the hedging programme.

Cons. If the ICE gasoil crack increases over time, DreamAir will end up locking the price of the ICE gasoil swap at a more expensive level than they would have obtained by buying a ICE gasoil swap directly in stage one.

Payoff analysis Swap market situation on 1 June 2014:

ICE Brent (\$/bbl)	ICE gasoil (\$/MT)
Swap Jan15–Jun16	
80	710

DreamAir buys the January 2015 to June 2016 ICE Brent swap at \$80/bbl and takes the view that ICE gasoil crack (currently at $710/7.45 - 80 = \$15.3/\text{bbl}$) will come down in the coming months.

Swap market situation on 15 November 2014:

ICE Brent (\$/bbl)	ICE gasoil (\$/MT)
Swap Jan15–Jun16	
93	792

The gasoil and Brent markets have moved as expected and the energy complex has moved up, but gasoil is now relatively cheaper than Brent. DreamAir can now complete its hedging transaction as follows:

1. DreamAir buys the January 2015 to June 2016 ICE gasoil crack swap at 13.30\$/bbl.
2. The gasoil crack swap added to the existing ICE Brent swap creates an actual position on ICE gasoil at a level of 80\$/bbl (original ICE Brent swap) + 13.3\$/bbl (new ICE gasoil crack swap) = 93.3\$/bbl. Using a conversion factor of 7.45, this is equivalent to an ICE gasoil swap at 695\$/MT – hence, 15\$/MT better than if DreamAir had closed the ICE gasoil swap at the original level on 1/6/2014.

ICE Brent Three Ways – When There are Credit Line Constraints *Situation.* DreamAir wants to put in place a two-year hedge to protect against an increase in oil prices (see Figure 1.4). To minimize liquidity and transaction costs, DreamAir chooses to execute the trade using ICE Brent and, in selecting the structure, needs to keep in mind two constraints:

1. Limited budget for paying premiums for options.
2. Limited credit lines available from counterparty banks.

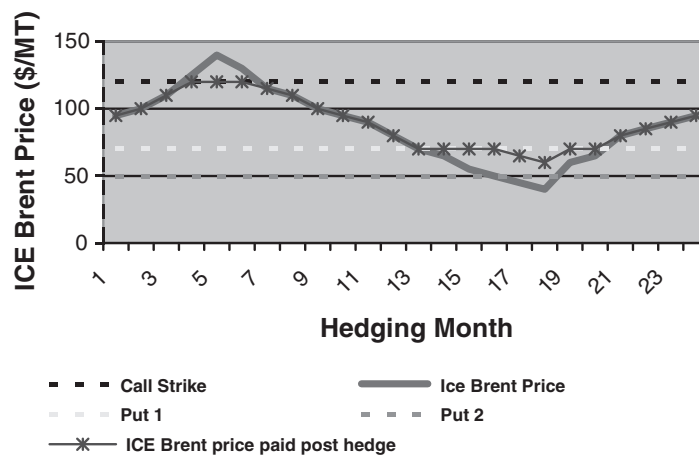


FIGURE 1.4 ICE Brent three ways

Strategy. To successfully put in place the required protection against the potential increase of ICE Brent prices and to satisfy the constraints above, DreamAir will have to do the following:

1. Buy a call option on ICE Brent (e.g., at a strike of 120\$/bbl for a premium of 3.5\$/bbl).
 - The call option provides protection for price increases above 120\$/bbl.
2. Sell a put option on ICE Brent (e.g., at a strike of 70\$/bbl for a premium of 1.5\$/bbl).
 - The put option partially finances the cost of the call option.
3. Buy a put option on ICE Brent (e.g., at a strike of 50\$/bbl for a premium of 0.5\$/bbl).
 - The second put option locks the maximum amount DreamAir will ever have to pay in case the first put option is exercised. This reduces DreamAir's credit risk since the maximum exposure (e.g., the maximum amount DreamAir can be asked to pay to the hedge provider under this strategy) is now capped at $70 - 50 = 20$ \$/bbl \times number of hedged barrels.

Pros. The overall cost of the structure is $3.5 - 1.5 + 0.5 = 2.5$ \$/bbl, cheaper than just buying the call option at 120\$/bbl, and provides the same upside oil price protection. In case of an extreme drop in oil prices, DreamAir is locked by the first put option only up to the strike of the second put option (partial downside price reparticipation). The credit line consumption from this structure is lower than that which would have originated from a simple collar (e.g., call at 120\$ with put at 70\$) since the maximum payout of the 70\$ put is capped at 20\$/bbl.

Cons. The structure is more expensive than a simple collar equivalent, which would have cost $3.5 - 1.5 = 2$ \$/bbl.

ICE Brent Knock-Out Swaps: Cheaper (and Riskier) *Situation.* DreamAir wants to enter into a 24-month swap on ICE Brent but the current swap market is deemed too high (see Figure 1.5).

Strategy. DreamAir needs to sell some of the price upside to finance a better swap level. This can be done by entering into a knock-out swap and whenever the monthly settlement is

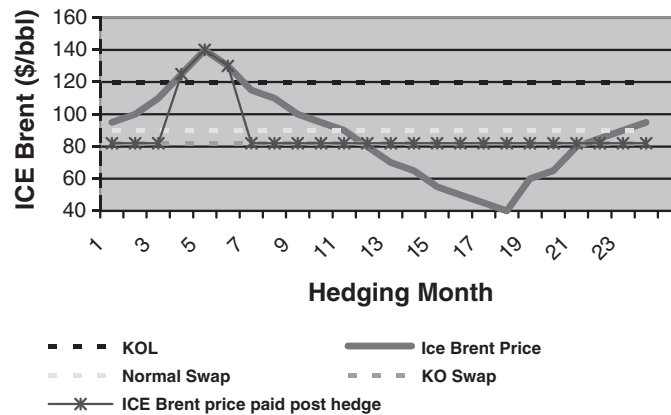


FIGURE 1.5 ICE Brent knock-out swap

above a certain strike level, the knock-out level (KOL), the swap settlement will be suspended for that specific month.

Pros. In exchange for giving up price protection above the KOL, DreamAir is able to enter into a swap level better than the one that would have been obtained using a normal swap structure.

Cons. DreamAir loses the whole swap protection whenever the monthly ICE Brent settles above the KOL.

1.2.3 Shipping: Risk Profile and Hedging Strategies

1.2.3.1 Introduction: The Shipping Industry The shipping industry encompasses a vast universe that can broadly be classified as follows:

1. Transport of people – ferries, cruise ships.
2. International transport of goods – bulk carriers, tankers and container ships.
3. Service ships – dredgers and tugboats.
4. Local transport of goods – barges and coasters.
5. Military ships.

The use of risk management tools is not confined to particular areas of the shipping industry, although the majority of activity comes from shipping companies active in the international transportation of goods. The cost of the ship's fuel (commonly referred to as *bunker fuel* in the industry) is anywhere between 25% and 50% of an average ocean-going vessel's operating costs (e.g., not including chartering costs).

The costs of operating a vessel incurred during a charter primarily consist of the following:

1. Fuel.
2. Crew's wages and associated costs.
3. Insurance premiums.
4. Lubricants, spare parts, repair and maintenance costs.
5. Port charges.

To provide risk management services to the shipping sector, it is important to understand that the ship owner is not necessarily the one paying the fuel bill. There are four basic contractual agreements used in the shipping industry:

1. A *voyage charter* is the hiring of a vessel and crew for a voyage between a load port and a discharge port. The charterer pays the vessel owner on a per ton or lump sum basis. The owner pays the port costs (excluding stevedoring), fuel costs and crew costs.
2. A *time charter* is the hiring of a vessel for a specific period of time. The owner still manages the vessel but the charterer selects the ports and directs where the vessel goes. The charterer pays for all the fuel that the vessel consumes, in addition to port charges and a daily hire to the vessel owner.
3. A *bareboat charter* is an arrangement for the generally long-term hiring of a vessel whereby no administration or technical maintenance is included as part of the agreement. The charterer pays for all operating expenses, voyage expenses, port expenses and hull insurance.
4. A *demise charter* shifts the control and possession of the vessel. The charterer takes full control of the vessel along with any of its legal and financial responsibilities.

A ship's engine room typically contains several engines for different purposes. The main engines, or propulsion engines, are used to turn the ship's propeller and move the ship through the water. They typically burn heavy fuel oil or diesel and can sometimes switch between the two. There are many propulsion arrangements for motor vessels, some including multiple engines, propellers and gearboxes.

The propulsion technology most used on modern ships is based on the 'diesel cycle reciprocating' engine. The rotating crankshaft can power the propeller directly for slow-speed engines (<450 rpm), via a gearbox for medium- and high-speed engines or via an alternator and electric motor in diesel-electric vessels. The reciprocating marine diesel engine first came into use in 1903, quickly displacing the less efficient steam turbine technology.

The majority of modern ships use oil distillate products to power ship engines. The greater part of the world's commercial fleet (wet and dry cargoes, container ships, some cruise ships and ferries) uses fuel oil as fuel, while the rest uses gasoil as the main fuel (mostly high-speed ferries), natural gas (liquefied natural gas (LNG) tankers) or nuclear-powered steam engines (mostly military ships). Bunker consumption represents a little more than 50% of the world's total fuel oil production, roughly equivalent to 4 million barrels per day of the roughly 7 million barrels of fuel oil produced daily (as of 2010). Because bunker fuel contains a large percentage of sulphur (between 1% and 5%) it is, for environmental legislation reasons, typically used only in ocean-going ships' primary or main engines once in international waters.

Bunker fuel is technically any type of fuel oil used aboard ships. It gets its name from the containers on ships and in ports in which it is stored, which used to be coal bunkers in the days of steam engines but are now bunker fuel tanks. Bunker fuel in the shipping industry can also be referred to by other names:

1. Heavy oil.
2. #6 oil.
3. Resid (as in residual oil product).
4. Bunker C.

5. Blended fuel oil.
6. Furnace oil and other locally used names.

The International Standards Organization (ISO) has issued marine fuels standards (ISO 8217) and introduced some uniformity to the international marine fuel markets. Bunker fuel has the following characteristics:

1. Its colour is always black, dark brown or at least very dark. This colour arises from the asphaltenes in the crude oil.
2. Bunker is generally viscous, especially when first produced at the refinery. Certain residuals are actually solid at ambient temperatures.

The following are the two main factors identifying fuel oil.

1. *Sulphur content.* The most commonly traded marine fuels have a sulphur content of 1% (low-sulphur fuel oil, or LSFO) and 3.5% (high-sulphur fuel oil, or HSFO). The higher the sulphur content, the cheaper the fuel oil. The introduction of more stringent environmental regulations by the International Maritime Organization (IMO) has been progressively reducing the sulphur content in the bunker by issuing Marine Pollution (MARPOL) regulations, with the following limits being phased in:
 - (a) Reduction of the maximum sulphur content in the bunker used by members of the IMO to 3.5% by 2012 and to 0.5% by 2015.
 - (b) Creation of sulphur emission control areas (SECAs) where the maximum sulphur content in the bunker cannot be higher than 1% (March 2010), dropping to 0.1% by 2015. Vessels entering a SECA will have to switch to a bunker of lower sulphur quality (e.g., have a separate bunker for LSFO) or blend the bunker fuel sulphur levels down to under the SECA sulphur limits before entering the area. As of June 2010, the SECAs are the Baltic Sea, the UNITED KINGDOM North Sea and the California coast.
2. *Viscosity* (measured in centistokes, or cst). Fuel oils of 180 cst and 380 cst are the most commonly traded. The higher the value in centistokes, the higher the viscosity. A higher viscosity means cheaper fuel oil, because it makes the fuel more difficult for engines to burn.

The most commonly used marine fuels are colloquially referred to as intermediate fuel oils (IFOs). The reason they are called intermediate is that they can contain up to 7% middle distillates, used as 'cutter stock' to lower the viscosity of heavy fuel oil. Generally, IFOs are named after their viscosity at 50°C (viscosity is temperature dependent, such that the higher the temperature, the lower the viscosity), which is the normal handling temperature for marine fuels to reduce viscosity and allow for the pumping of the fuel into fuel tanks and engine rooms. The most commonly used IFOs are called IFO 180 cst and IFO 380 cst.

The pricing of fuel oil can be referenced to three different prices:

1. According to Bunkerwire, which refers to pricing in specific ports where fuel oil of different grades and qualities are mixed together. The Bunkerwire price is the equivalent of a retail price, paid by the shipping companies for filling up.
2. Cargo prices are a wholesale price for deliveries of 200,000 barrels or more.

3. Barge prices are a wholesale price for deliveries of up to 50,000 barrels. Barges generally go for a premium compared with cargoes, since they involve smaller volumes and can deliver to more destinations.

Fuel oil is also used for power generation. Hence, in certain locations, it is important to consider the effect of the activity of utilities over the price of a bunker. For example:

1. Whenever the price of natural gas becomes too expensive compared with the price of fuel oil, then utilities may consider increasing the use of fuel oil to generate electricity. The increased fuel oil demand results in increased bunker prices for shippers.
2. If the prices of emission certificates in Europe drop, then utilities have an incentive to use more fuel oil for power generation (fuel oil is more polluting than natural gas), hence affecting the cost of bunkers for shippers.

The shipping industry is also a consumer of diesel (marine diesel), used in the auxiliary engines of large ships. It is used when a vessel is close to shore (diesel is less polluting than fuel oil) or for manoeuvring in a harbour. Auxiliary engines also generate electricity for a ship while in port.

1.2.3.2 Product Specifications

Europe, Middle East and Africa Regions The main fuel oil references generally used by shipping companies for risk management purposes are published by Platts:

1. Fuel Oil 3.5% Barges (Platts considers parcels of 2000 to 5000 MT FOB in Rotterdam), in USD/MT.
2. Fuel Oil 3.5% Cargoes CIF NWE (Platts considers parcels of 25,000 MT delivered CIF NWE basis Rotterdam), in USD/MT.
3. Fuel Oil 3.5% Cargoes FOB MED (Platts considers parcels of 25,000–30,000 MT delivered FOB basis Italy), in USD/MT.

Quality. Platts generally considers fuel oil with a 3–4% sulphur content and a viscosity of around 380 cst.

For risk management transactions, shipping companies also use crude oil whenever the volume is too large or the tenor is too long to be accommodated within the liquidity of fuel oil references. The main alternative references used by European-based shipping companies are as follows:

1. ICE Brent (USD/bbl), based on the daily settlement price of the ICE Brent futures contract.
2. Fuel oil crack (USD/bbl) = fuel oil × conversion factor (MT to bbl) – ICE Brent, generally a negative number since fuel oil trades at a discount to crude.

Asian Region The main references generally used by shipping companies for risk management purposes are published by Platts:

1. Singapore 180 cst, in USD/MT.
2. Singapore 380 cst, in USD/MT.

Quality. Platts generally considers fuel oil with a sulphur content of up to 5%.

Shipping companies also use other crude oil and oil product references whenever the volume is too large or the tenor is too long to be accommodated within the liquidity of fuel oil references. The main alternative reference used by Asian-based shipping companies is:

- ICE Brent in USD/bbl, based on the daily settlement price of the ICE Brent futures contract.

Americas Region The main references generally used by shipping companies for risk management purposes are published by Platts:

- Fuel Oil 1% US New York Harbour Cargoes (NYHC), in USD/bbl.

Shipping companies also use other crude oil and oil product references whenever the volume is too large or the tenor is too long to be accommodated within the liquidity of the fuel oil references. The main alternative reference used by shipping companies based in the Americas is:

- NYMEX WTI (USD/bbl), based on the daily settlement price of the NYMEX WTI futures contract.

1.2.3.3 Risk Management Strategies for the Shipping Industry European and American shipping companies generally adopt less complex hedging tactics compared with the aviation industry and their structures tend to be mostly plain vanilla and for short to medium tenors. As seen for the aviation industry, there are many variables affecting the implementation of a risk management programme. There are also some shipping-industry-specific elements that should be considered.

1. Many shipping companies are privately owned and managed by the founder or the founder's successors. This often makes the decision process cumbersome and sub-optimal when implementing risk management decisions.
2. Shipping customers can be divided broadly into owners and charterers, where owners buy ships and rent them on short- or long-term leases to charterers. The fuel costs are borne by the company operating the ship. Hence, owners generally have no exposure to oil prices since this is paid by the charterers operating the ships. Sometimes shipping companies are structured into two divisions, one operating as an owner and the other as a charterer.
3. For insurance, tax and liabilities management reasons, shipping companies are often divided into management and operational subsidiaries. This may make the process of opening a credit line for trading purposes difficult due to the perceived weakness of the counterpart from the credit point of view.
4. Based on observations of the behaviour of market participants, some generic conclusions on risk management behaviour can be drawn.
5. Small to medium shipping companies (e.g., with a yearly consumption of up to 250,000 MT of fuel oil) tend to implement and execute risk management strategies with the following characteristics:
 - (a) Short to medium maturities (e.g., less than two years).
 - (b) Mainly based on the use of swaps.
 - (c) Limited exposure to basis risk.

6. Medium to large shipping companies (with a consumption of 250,000 MT and above) generally have a dedicated team for the structuring, implementation and execution of a hedging programme, and their strategies have the following characteristics:
 - (a) Short to long maturities (up to five years), depending on the product they use (e.g., short maturities for fuel oil quotes and long maturities for crude oil quotes).
 - (b) Use of a combination of swaps, plain vanilla options and exotic structures.
 - (c) Active management of basis risk.
7. On a regional basis, European and American shipping companies tend to use exotic structures less compared with Asian-based shipping companies.

Fuel Oil Capped Swaps: A Cheaper Swap *Situation.* A containers shipping company, call it SeaHorse, has a strategic hedging programme in place where one of the provisions is that at any time at least 75% of the forecasted bunker consumption over the next 12 months needs to be at a fixed price at a level not higher than 10% of the budgeted bunker price for the calendar year (see Figure 1.6). SeaHorse's forecasted consumption over the next 12 months is 500,000 MT. The budgeted bunker price for the next calendar year is 325\$/MT, and the swap price for bunker (using a 3.5% Fuel Oil FOB Barges reference) for the next calendar year is 375\$/MT.

Strategy. SeaHorse buys a swap for the next calendar year on a Fuel Oil 3.5% FOB Barges reference for $500,000 \times 75\%/12 = 31,250$ MT per month at \$375/MT and at the same time sells a call option for the next calendar year on Fuel Oil 3.5% FOB Barges at 475\$/MT for 25\$/MT. The premium of the option is deducted from the level of the swap. Hence, SeaHorse has effectively entered into a swap at 350\$/MT (capped at 475\$/MT). This is within the $325 + 10\% = 357.5$ \$/MT limit defined by the hedging policy.

Pros. SeaHorse has reached its targeted hedging level (as long as the market does not move above the call strike level).

Cons. As a result of selling the call option, SeaHorse loses the protection of the swap whenever the market settles above the strike level of the call option. It is important to remember that the customer is not completely losing its price protection, since even in the event that the fuel oil market moves above the strike level of the call option, SeaHorse will benefit from a

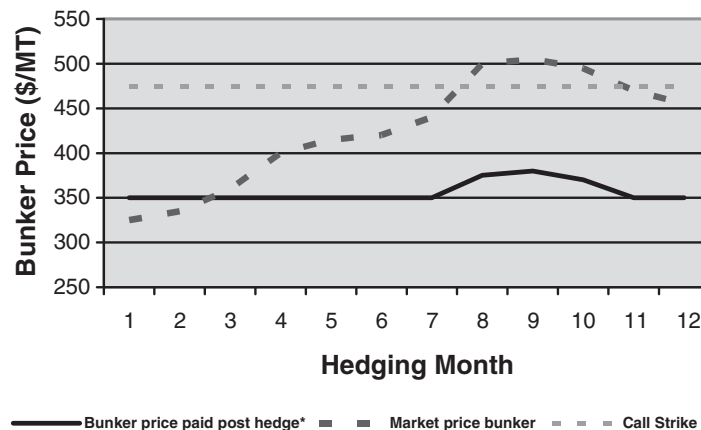


FIGURE 1.6 Fuel oil capped swap

cash flow from the risk management structure equal to the difference between the call option's strike and the swap level.

Payoff analysis Swap and option markets situation on 1 June 2014:

FO 3.5 FOB swap (\$/MT)	FO 3.5 FOB call @ 475 (\$/MT) Jan15–Dec15
375	25

SeaHorse buys a January 2015 to December 2015 fuel oil 3.5% barges swap at 375\$/MT and SeaHorse sells a call option on fuel oil 3.5% barges for the period January 2015 to December 2015 at a strike of 475\$/MT for 25\$/MT.

The average fuel oil price during February 2015 is 330\$/MT:

FO 3.5 FOB swap (\$/MT)	FO 3.5 FOB call @ 475 (\$/MT) Feb15
-45	Premium +25\$/MT

SeaHorse pays 330\$/MT to its physical supplier but also has to pay 45\$/MT from the swap and receives +\$25\$/MT from the option's premium. The actual cost of fuel for SeaHorse is then $330 + 45 - 25 = 350$ \$/MT.

The average fuel oil price during May 2015 is 405\$/MT:

FO 3.5 FOB swap (\$/MT)	FO 3.5 FOB call @ 475 (\$/MT) May15
+30	Premium +25\$/MT

SeaHorse pays 405\$/MT to its physical supplier but receives +30\$/MT from the swap and +25\$/MT from the option's premium. The actual cost of fuel for SeaHorse is $405 - 30 - 25 = 350$ \$/MT.

The average fuel oil price during August 2011 is \$495/MT:

FO 3.5 FOB swap (\$/MT)	FO 3.5 FOB call @ 475 (\$/MT) Aug11
+120	Premium +25\$/MT Settlement -20\$/MT

SeaHorse pays 495\$/MT to its physical supplier but receives +120\$/MT from the swap and +25\$/MT from the option's premium. SeaHorse also pays 20\$/MT from the call option being exercised. The actual cost of fuel for SeaHorse is $495 - 120 - 25 + 20 = 370$ \$/MT (e.g., above the target level but still cheaper than the market price).

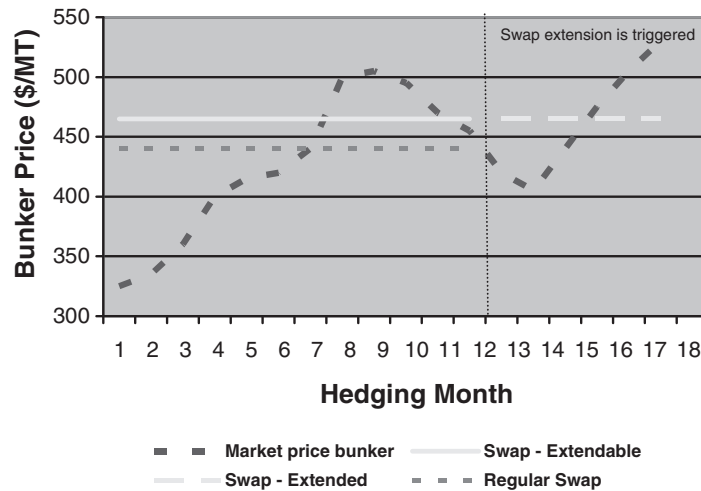


FIGURE 1.7 ICE Brent extendable swap

Brent Extendable: Accommodating Operational Issues *Situation.* SeaHorse has entered into a contract to transport goods for a customer from Hong Kong to Los Angeles. The contract is at a fixed price for one year with an option (for the customer) to extend it for another six months at the same rate (see Figure 1.7). SeaHorse is exposed to the bunker's price volatility (priced on a Singapore 380 IFO reference) and would like to lock in the profitability of the contract by locking the bunker's cost with a structure reflecting the potential time extension feature.

Strategy. SeaHorse can enter into an extendable swap structure on Singapore 380 where it would fix the price for a period of 12 months at a certain level with the right (to be exercised by SeaHorse before the end of the 12th month) to extend the maturity of the swap by an extra six months at the same level as that of the original 12-month structure. SeaHorse will exercise the option back to back, with its customer exercising its right to extend the shipping contract.

Pros. SeaHorse is able to match the risk deriving from the potential extension of the contract with a swap matching the extendibility of the shipping contract. In case the shipping contract is not extended beyond the 12th month, SeaHorse will not extend the swap and has no further obligations under the swap.

Cons. There is a cost associated with granting optionality to extend the swap beyond the 12th month for an extra six months. This cost is embedded in the level of the swap. Hence, a 'regular' 12-month swap will be at a better level compared with a 12-month swap with the option to extend for an extra six months.

1.2.4 Land Transportation: Risk Profile and Hedging Strategies

1.2.4.1 Introduction: Land Transportation and Exposure to Oil Prices The land transportation industry includes local and national road passenger services, passenger and freight railways, and commercial haulage. The economics are similar to that seen in the sections dedicated to the shipping and aviation industries, although the indexes used for risk

TABLE 1.3 Diesel sulphur content breakdown

	Sulphur content (ppm)
High-sulphur diesel	ppm > 500 (ppm > 0.05% by weight)
Low-sulphur diesel	15 < ppm < 500 (0.0015% < ppm < 0.05% by weight)
Ultra-low-sulphur diesel (ULSD)	10 < ppm < 15 (0.0010% < ppm < 0.0015% by weight)
Sulphur-free diesel	ppm < 10 (ppm < 0.0010% by weight)

management purposes are different. The oil products relevant to this industry are those used as fuel for the engines of buses, trucks and train engines, that is, diesel and occasionally gasoline.

Diesel is essentially the same product as gasoil, and from a practical standpoint there are only a few differences:

1. Diesel fuel, for road use, has a lower sulphur content than gasoil.
2. Gasoil is dyed with red dye.
3. During winter months, diesel fuel is cut or diluted with kerosene to improve its performance.

Demand for gasoline and diesel has a certain seasonality and tends to peak in summer during the so-called 'driving season'. *Diesel fuel* is the term used for fuels suitable for compression engines, also known as diesel engines, developed by Rudolph Diesel in 1892. Compression engines operate at a much higher pressure than gasoline engines and function without a spark plug. Diesel engines also offer the following advantages when compared with gasoline engines:

1. Diesel gets a higher mileage per gallon (20–30%) due to high compression and energy density.
2. Diesel, being a heavier hydrocarbon, has a higher energy content.
3. Diesel fuel is burned in a high-pressure/high-temperature environment, resulting in more efficient burning compared with gasoline.
4. Diesel engines are structurally easier to maintain and have a longer lifespan than gasoline engines.

The main feature examined when discussing and identifying diesel fuel with a customer is its sulphur content, identified in ppm. See Table 1.3.

Motor gasoline is the result of blending hydrocarbons from the naphtha family. The key specifications for gasoline are its octane rating, volatility, aromatics, olefins, lead and methyl tertiary butyl ether (MTBE) content.

1.2.4.2 Product Specifications The main oil references generally used by land transportation companies for risk management purposes are published by Platts and Argus.

Europe, Middle East and Africa Regions

1. ULSD 10 ppm CIF NWE (USD/MT).
2. Diesel 10 ppm Barges FOB ROT (USD/MT).

3. 10 ppm ULSD FOB MED Cargoes (USD/MT).
4. 50 ppm ULSD FOB MED Cargoes (USD/MT).
5. ULSD 10 ppm CIF MED Cargoes (USD/MT).
6. Gasoline Euro Bob Oxy NWE Barges (USD/MT).
7. Premium unleaded gasoline 10 ppm Cargoes CIF NWE (USD/MT).
8. Premium unleaded gasoline 10 ppm Cargoes FOB NWE (USD/MT).
9. Premium unleaded gasoline 10 ppm Cargoes FOB MED (USD/MT).
10. Premium unleaded gasoline 10 ppm FOB Barges ARA (USD/MT).

Asian Region

1. Singapore Mogas 92 unleaded Mean of Platts Singapore (MOPS, in USD/bbl).
2. Singapore Gasoil Reg 0.5% Sulphur (USD/bbl).

Americas Region

1. ULSD US Gulf Coast (USGC) pipeline (USDc/gal).
2. Gasoline Reformulated Blendstock for Oxygenate Blending (RBOB) (based on the daily settlement price of the NYMEX gasoline futures contract, (USDc/gal)).

1.2.4.3 Risk Management Strategies for the Land Transportation Industry The land transportation industry can be divided into two subsections:

1. Regulated business, including metropolitan and some regional bus companies and regional train companies. These businesses often operate on a long-term concession basis from the government or local authority and operate in a regulated tariff environment. Hence, they need to protect their revenue margin by locking the variable costs (such as fuel) as much as possible. These companies are inclined to have very high hedging ratios for tenors as long as the tenor of the concession. Typical hedging ratios in this scenario are in the region of 75% or more for tenors of anywhere between 3 and 10 years.
2. Unregulated business, including regional and international bus and train passenger companies and road and train goods haulage. These businesses operate with dynamics more similar to those seen for shipping and aviation companies. Their hedging programmes follow the principle of a hedging envelope over a maximum period of five years, and its implementation will be on the back of budgeted fuel prices and fuel price market movements. A typical hedging envelope for a land transportation company is
 - (a) up to 75% of expected fuel consumption for one year forward
 - (b) up to 50% of expected fuel consumption for two years forward
 - (c) up to 25% of expected fuel consumption for three years forward.

Diesel Differentials and Rolling Hedges: Optimizing the Liquidity of Financial Markets Situation. A regional train company, Railmore, has won a seven-year concession for the London–Cardiff line, operating with diesel trains. The concession has a limited provision for fuel surcharge and Railmore needs to make sure the profit margin built into the concession price is not eroded by potential increases in the price of diesel. The fuel supply contracts are indexed to ULSD 10 ppm CIF NWE with an expected yearly consumption of 120,000 MT. After consultation with hedging counterparts, it becomes clear that there is no financial

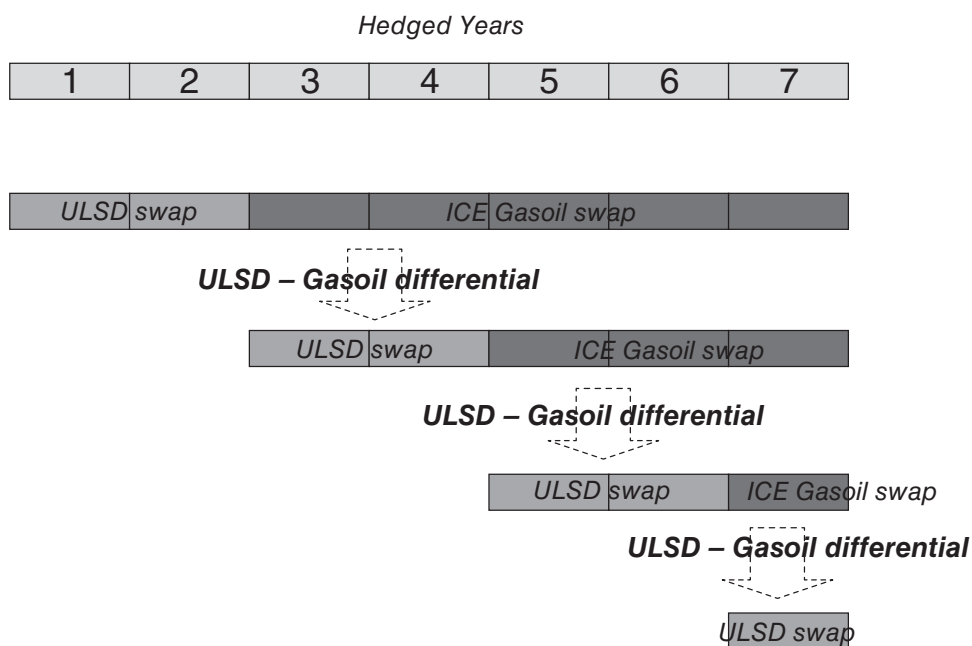


FIGURE 1.8 Rolling hedge structure

derivatives market for that ULSD reference for that tenor. The recommended strategy in this case is to enter into a two-step hedging strategy, also known as a rolling hedge (see Figure 1.8), where the company enters into a long-term hedge based on a liquid index correlated to ULSD 10 ppm CIF NWE (e.g., ICE gasoil) and into a short-term hedge based on ULSD 10 ppm CIF NWE.

Strategy. Railmore will initially enter into two swap transactions:

1. A swap on ULSD 10 ppm CIF NWE for 10,000 MT per month for two years.
2. A swap on ICE gasoil for 10,000 MT per month for five years, starting at the beginning of the third year.

Every month (or quarter) during the life of the hedging programme, Railmore will convert the forward ICE gasoil swap into ULSD 10 ppm CIF NWE swaps by buying the ULSD–gasoil differential (see the second hedging strategy for the aviation industry). This process will be repeated until all the outstanding volumes are covered by the ULSD swap:

$$\text{ULSD CIF NWE swap} - \text{ICE gasoil swap} = \text{ULSD CIF NWE differential}$$

Pros. By tapping the right liquidity pools, Railmore is able to lock in the long-term price level for gasoil, a product highly correlated to ULSD, and in the short to medium term the price for ULSD CIF NWE. Railmore can also take advantage of potentially favourable relative movements of ULSD against gasoil (e.g., a reduction in the ULSD differential). The ULSD price risk is effectively translated into a ULSD differential price risk.

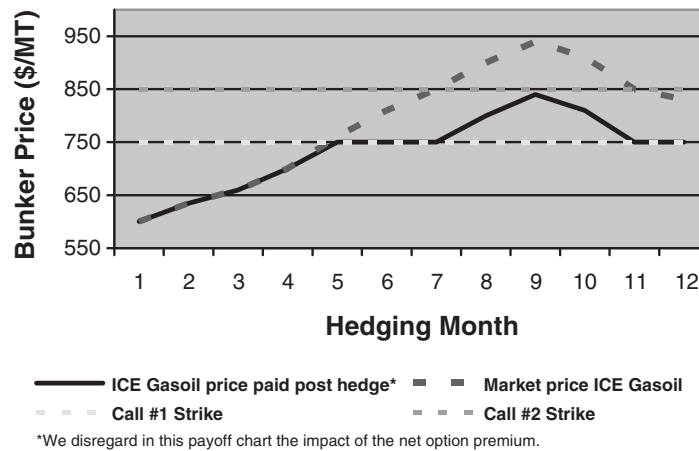


FIGURE 1.9 Gasoil call spread

Cons. This is not a perfect risk management structure, since during the life of the hedge the ULSD differential may move against Railmore (e.g., it may go up), resulting in the erosion of the rail concession contract's profitability.

Gasoil Call Spreads: Reducing the Cost of Option Strategies *Situation.* Railmore also operates a regional bus service and wants to protect against a perceived potential increase in the price of gasoil. The financial director decides against using swaps because the market is in steep contango and the forward levels are perceived to be too high when compared with the spot price of gasoil.

Strategy. Railmore enters into a call spread structure for the next year, where it buys a call option on ICE gasoil at a certain strike (strike #1 = \$750/MT) and sells a call option on ICE gasoil at another strike (strike #2 = \$850/MT), with strike #1 < strike #2 (see Figure 1.9).

Pros. Railmore gets full protection against price increases above strike #1 and partial price protection against price increases above strike #2. When gasoil prices move above strike #2, Railmore will always receive a net benefit equal to strike #2 – strike #1, compared with a no-hedge situation. The cost of this hedging strategy is lower than the simple purchase of a call option with strike #1 since the premium earned for strike #2 reduces the overall cost of the hedging structure.

Cons. This structure provides only partial market risk protection in case the gasoil markets move firmly above strike #2.

Payoff analysis The option market situation as of 1 June 2014 is as follows: Railmore buys a January 2015 to December 2015 ICE gasoil call at 750\$/MT and sells ICE gasoil call at 850\$/MT. The net premium paid is $-45 + 20 = -25$ \$/MT:

ICE GO +call @ 750 (\$/MT)	ICE GO –call @ 850 (\$/MT)
–45	+20

The average gasoil price during February 2015 is 625\$/MT:

ICE GO +call @ 750 (\$/MT)	ICE GO –call @ 850 (\$/MT)
Feb15	
0	0

None of the call options are exercised. Railmore is effectively paying 625\$/MT for its gasoil plus the net premium of 25\$/MT for a total of 650\$/MT, thus worse than the spot market level.

The average gasoil price during the month of July 2015 is 800\$/MT:

ICE GO +call @ 750 (\$/MT)	ICE GO –call @ 850 (\$/MT)
Jul15	
+50	0

Railmore exercises the option at \$750, with the short second option not exercised. It is thus effectively paying 800\$/MT for its gasoil plus the net premium of 25\$/MT minus the settlement of the option (–50\$/MT), for a total of 775\$/MT, thus better than the spot market level.

The average fuel oil price during September 2015 is 925\$/MT:

ICE GO +call @ 750 (\$/MT)	ICE GO –call @ 850 (\$/MT)
Sep15	
+175	–75

Railmore exercises the option at 750\$/MT, with the short second option being exercised at 850\$/MT. It is effectively paying 925\$/MT for its gasoil plus the net premium of 25\$/MT minus the settlement of the first option (–175\$/MT) plus the settlement of the second option (+75\$/MT), for a total of 850\$/MT, thus better than the spot market level.

1.2.5 Utilities: Risk Profile and Hedging Strategies

1.2.5.1 Introduction: Utilities and Exposure to Oil Prices At the centre of nearly all power stations is a generator, a rotating machine that converts mechanical energy into electrical energy through the relative motion created between a magnetic field and a conductor. The energy source harnessed to turn such generators varies widely and depends chiefly on which fuels are easily available and the types of technology the power company can access.

Utilities have two different kinds of exposure to oil prices; namely, direct on the cost side and indirect on the cost and revenue side.

1. Direct exposure occurs when utilities use oil products as a combustible for power generation in thermal power stations. The fuels used are fuel oil and, to a less extent, gasoil.
 - (a) In thermal power stations, mechanical power is produced by a heat engine that transforms thermal energy, produced by the combustion of fuel oil or gasoil generating steam via a boiler, into rotational energy.

- (b) Fuel-oil-based power plants are still used around the world, although due to their high operational costs, low efficiency and high environmental impact, their numbers have been declining over the past 10 years and they are progressively being replaced by natural gas-fired plants.
 - (c) Gasoil-based power plants are less common. They are generally small and are typically used as back-up generation capability or whenever there is a need for small generation capabilities in remote areas (e.g., small islands or remote mining operations). In this context, gasoil has higher operational costs than fuel oil and similar environmental impact issues.
2. Indirect exposure occurs when utilities buy or sell gas (pipeline or LNG) or electricity, where prices are linked to oil products. Oil products generally used for energy pricing are fuel oil, gasoil and crude oil.
 - Indirect exposure can come in different shapes and forms. There are many different oil-linked pricing formulas for electricity and gas (pipeline and LNG), often including foreign exchange (FX) components and occasionally factors such as inflation and other macroeconomic indexes.
 3. The actual exposure of an average utility company is fairly complex to calculate and represent, because in addition to direct and indirect exposure to oil products, it must also account for exposure to electricity and gas prices not linked to oil products, as well as exposure to fuels other than oil, such as coal and biofuels.

1.2.5.2 Product Specifications

Europe, Middle East and Africa Regions The main oil references generally used by utility companies for risk management purposes are published by Platts and include the following:

1. Fuel Oil 3.5% FOB Barges ARA (USD/MT).
2. Fuel Oil 3.5% Cargoes CIF NWE (USD/MT).
3. Fuel Oil 3.5% Cargoes FOB MED (USD/MT).
4. Fuel Oil 1% FOB NWE (USD/MT).
5. Fuel Oil 1% Cargoes CIF NWE (USD/MT).
6. Gasoil 0.1% Cargoes FOB NWE (USD/MT).
7. Gasoil 0.1% Cargoes CIF MED (USD/MT).
8. Gasoil 0.1% Cargoes CIF NWE (USD/MT).

In most cases exposure to these products derives from the fact that natural gas (used for power generation) is priced in many European markets by using pricing baskets containing the products above.

Utilities also use other crude oil and oil product references whenever the volume is too large or the tenor is too long to be accommodated within the liquidity of fuel oil or gasoil references. The main alternative references used by Europe-based utilities are the following:

1. ICE Brent (USD/bbl), based on the daily settlement price of the ICE Brent futures contract.
2. ICE gasoil (USD/MT), based on the daily settlement price of the ICE gasoil futures contract.
3. NYMEX WTI (USD/bbl), based on the daily settlement price of the NYMEX WTI futures contract.

4. Fuel oil crack (USD/bbl) = fuel oil/6.35 (conversion factor MT to bbl) – ICE Brent.
5. Gasoil crack (USD/bbl) = gasoil/6.35 (conversion factor MT to bbl) – ICE Brent.

Asian Region The main oil references generally used by utility companies for risk management purposes are published by Platts and include the following:

1. Singapore 180 cst (USD/MT).
2. Singapore 380 cst (USD/MT).
3. Singapore Gasoil Reg 0.5% Sulphur (USD/bbl).

Utilities also use other crude oil and oil product references whenever the volume is too large or the tenor is too long to be accommodated within the liquidity of fuel oil or gasoil references. The main alternative references used by Asian-based utility companies are the following:

1. ICE Brent (USD/bbl), based on the daily settlement price of the ICE Brent futures contract.
2. NYMEX WTI (USD/bbl), based on the daily settlement price of the NYMEX WTI futures contract.

Americas Region The main oil references generally used by utility companies for risk management purposes are published by Platts or NYMEX and include the following:

1. Residual fuel oil 1% CIF NWE York Harbour (USD/bbl).
2. NYMEX HO (USDc/gal), based on the daily settlement price of the NYMEX heating oil futures contract.

Utilities also use other crude oil and oil product references whenever the volume is too large or the tenor is too long to be accommodated within the liquidity of fuel oil or gasoil references. The main alternative reference used by Americas-based utility companies is

- NYMEX WTI, based on the daily settlement price of the NYMEX WTI futures contract.

1.2.5.3 Risk Management Strategies for the Utilities Industry Utilities are generally exposed to the full spectrum of energy price risks, from oil to natural gas, from electricity to coal and emissions certificates. They therefore tend to be among the largest and most experienced consumers of risk management products, with dedicated teams and well-defined risk management policies in place. For the purposes of this chapter, we focus only on transactions related to oil and oil product prices.

Gas Formula Swaps: Hedging an Oil Pricing Basket with Swaps *Situation.* A Belgian utility, Distriplus, has a portfolio of long-term pipeline gas supply contracts from Russia and Norway that are indexed to a basket of oil products. The total volume is 10 TWh (terawatt hours) per year, with the following pricing structure:

$$P_{\text{gas}} (\text{€c/MWh}) = 0.022 \times P_{\text{GO}} + 0.058 \times P_{\text{FO}}$$

where

- P_{gas} is the price in euro cents per megawatt hour (MWh) in a certain delivery month period
- P_{FO} is the monthly average Fuel Oil 3.5% FOB Barges (in \$/MT) daily settlement price during the P_{gas} delivery month period, published by Platts and converted into euros based on the monthly average of the daily euro and US dollar rates
- P_{GO} is the monthly average Gasoil 0.1% Cargoes FOB NWE (in \$/MT) daily settlement price during the P_{gas} delivery month period, published by Platts and converted into euros based on the monthly average of the daily euro and US dollar rates.

Distriplus pays its gas supplier every month based on the formula above, but for the next calendar year (e.g., 2015) it sells a total of 3 TWh to its customer on a fixed price basis. This exposes Distriplus to the risk that the price paid to the supplier will move above the price received in the fixed price contract.

Strategy. Distriplus will set the fixed price level based on the forward value for 2015 of the formula. The formula will then be hedged by its gasoil, fuel oil and FX components.

Step 1. Calculate the volume equivalents of fuel oil and gasoil for 3 TWh (3,000,000 MWh) of gas:

1. $\text{FO} = 0.058 \times 3,000,000 \text{ MWh} = 174,000 \text{ MT}$ over the calendar year $\Rightarrow 14,500 \text{ MT}$ per calendar month (pcm).
2. $\text{GO} = 0.022 \times 3,000,000 \text{ MWh} = 66,000 \text{ MT}$ over the calendar year $\Rightarrow 5500 \text{ MT}$ pcm.

Step 2. Using swaps, Distriplus hedges the underlying fuel oil and gasoil exposure (in euros per MT):

1. FO swap January 2015 to December 2015 for 14,500 MT pcm = 260 €/MT.
2. GO swap January 2015 to December 2015 for 5500 MT pcm = 519 €/MT.

Step 3. The pricing of the swap level for the formula for the period January 2015 to December 2015 is

$$P_{\text{gas}} = 0.058 \times 260 + 0.022 \times 519 = 26.50\text{€c/MWh}$$

Pros. Distriplus covers its pricing risk between the floating gas purchase price and its fixed gas sale price and locks in a margin.

Cons. If Distriplus decides not to hedge and the fuel oil and gasoil prices become cheaper during the life of the contract, Distriplus would be able to make a potentially larger margin.

1.2.6 Refineries: Risk Profile and Hedging Strategies

1.2.6.1 Introduction: What is a Refinery? In its basic structure, a refinery operation is composed of a distillation column (atmospheric or vacuum), where crude oil enters and the exiting oil products are gases (e.g., butane), gasoline, naphtha, kerosene, gasoil, fuel oil and residues. The distillation process is generally referred to as separation and it is the first step in the refinery process.

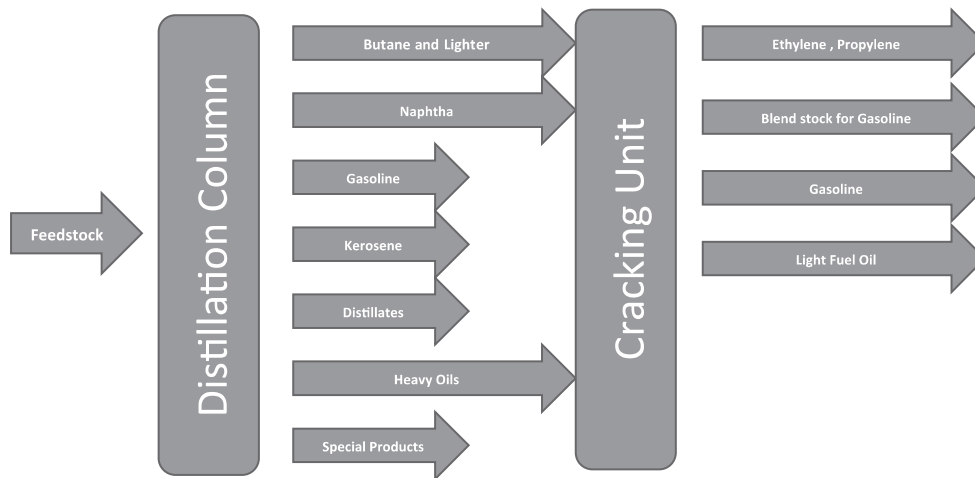


FIGURE 1.10 Distillation + cracking refinery

The section on crude oil and oil products at the beginning of this chapter shows the basic structure of a distillation column, but most modern refineries are more complex in structure than a simple distillation column. This is because over the years production technologies have been developed to maximize the production (yield improvement) of high-value products such as gasoline and jet fuel, as opposed to low-value products such as fuel oil and bitumen.

One of the most common ways of improving a refinery's yield is to extend the distilling column refining process with a 'cracking' process (see Figure 1.10). This involves processing naphtha, some light products and the heavy products produced by the distilling column with heat and pressure (thermal cracking) and/or placing them in contact with a catalyst (a chemical substance that facilitates a reaction) to promote cracking (catalytic, or cat cracking). The output of this process is the production of more gasoline, better quality fuel oil and light products for the petrochemical production process.

A variation and improvement of the cat cracking process is the hydrocracking process (see Figure 1.11). This involves technology similar to that in cat cracking, but with the addition

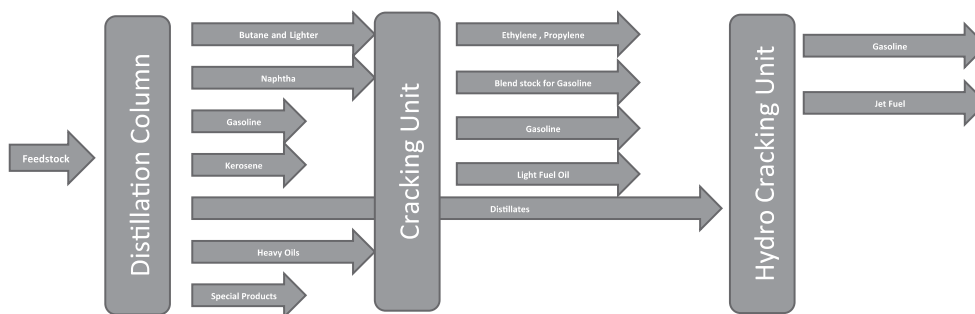


FIGURE 1.11 Distillation + cracking + hydro refinery

of hydrogen. This further improves the yield in terms of the production of gasoline and other high-end products (such as jet fuel).

The cracking process is part of the conversion process. The following are other elements of the conversion process:

1. Coking, a thermal cracking process specifically for the heavy-residue products of the refinery that yields additional naphtha, gasoline blend stock and coke (a product used as fuel in energy-intensive industries).
2. Combining and modifying, another process aimed at creating high-value-added products but this time by joining together smaller hydrocarbon molecules to produce larger, more valuable ones.

After the conversion, there are further steps in the refinery process:

1. Treatment/enhancement, involving the removal or reduction of unwanted elements such as sulphur and nitrogen.
2. Blending, where several semi-finished products are blended together to meet certain market specifications; for example, blending straight-run gasoline with other high-octane products to obtain a gasoline ready to be sold at the pump.

Oil refineries are large-scale plants, processing from about a hundred thousand to several hundred thousand barrels of crude oil per day. Because of their high capacity, many of the units are operated continuously at steady state, or approximately steady state, for long periods of time (from months to years). This high capacity also makes process optimization and advanced process control very desirable.

Refineries with secondary processing units typically have two modes of operation:

1. Maximum production of gasoline in the summer, during the so-called driving season.
2. Maximum production of middle distillates in the winter, during the so-called heating season.

All oil refineries are configured differently, according to the product needs and seasonality of their target market and according to the slate of crude oil feedstock they will likely end up buying. Complex, modern and large refineries can produce large amounts of gasoline and kerosene from heavy oil crude, while smaller, older refineries cannot produce as much high-value products from the same barrel of crude oil.

1.2.6.2 Product Specifications Refineries, by their very nature, are active across the full spectrum of oil and refined oil products, and the lists below present only the most active references at the time of this writing.

Europe, Middle East and Africa Regions The main oil references generally used by refineries for risk management purposes are the following and are published by Platts, Argus or are referenced to ICE futures contracts:

1. Fuel Oil 3.5% FOB Barges ARA (USD/MT).
2. Fuel Oil 3.5% Cargoes CIF NWE (USD/MT).

3. Fuel Oil 3.5% Cargoes FOB MED (USD/MT).
4. Fuel Oil 1% FOB NWE (USD/MT).
5. Fuel Oil 1% Cargoes CIF NWE (USD/MT).
6. Gasoil 0.1% Cargoes FOB NWE (USD/MT).
7. Gasoil 0.1% Cargoes CIF MED (USD/MT).
8. Gasoil 0.1% Cargoes CIF NWE (USD/MT).
9. ULSD 10 ppm CIF NWE (USD/MT).
10. Diesel 10 ppm FOB NWE (USD/MT).
11. Diesel 10 ppm Barges (USD/MT).
12. 10 ppm ULSD FOB MED Cargoes (USD/MT).
13. 50 ppm ULSD FOB MED Cargoes (USD/MT).
14. Gasoline 10 ppm Cargoes CIF NWE (USD/MT).
15. Premium Gasoline 10 ppm Cargoes FOB NWE (USD/MT).
16. Gasoline Euro Bob Oxy NWE Barges (USD/MT).
17. Premium Gasoline 10 ppm Cargoes FOB MED (USD/MT).
18. Premium Gasoline 10 ppm FOB Barges ARA (USD/MT).
19. Naphtha CIF NWE (USD/MT).
20. ICE Brent (USD/bbl), based on the daily settlement price of the ICE Brent futures contract.
21. ICE gasoil (USD/MT), based on the daily settlement price of the ICE gasoil futures contract.
22. Urals MED (USD/bbl) based on the Platts assessment.

Asian Region The main oil references generally used by refineries for risk management purposes are the following and are published by Platts or are referenced to ICE, Dubai Mercantile Exchange (DME) or NYMEX futures contracts:

1. Singapore 180 cst (USD/MT).
2. Singapore 380 cst (USD/MT).
3. Singapore Gasoil Reg 0.5% Sulphur (USD/bbl).
4. Singapore Kerosene (USD/bbl).
5. Singapore Gasoline 92 Unleaded MOPS (USD/bbl).
6. Singapore Naphtha FOB (USD/bbl).
7. NYMEX WTI (USD/bbl), based on the daily settlement price of the NYMEX WTI futures contract.
8. ICE Brent (USD/bbl), based on the daily settlement price of the ICE Brent futures contract.
9. DME Oman crude (USD/bbl), based on the daily settlement price of the Oman futures contract.

Americas Region The main oil references generally used by refineries for risk management purposes are the following and are published by Platts or NYMEX:

1. Residual Fuel Oil 1% CIF New York Harbour (USD/bbl).
2. NYMEX HO (USDc/gal), based on the daily settlement price of the NYMEX heating oil futures contract.
3. ULSD 15 ppm USGC Pipeline (USDc/gal).

4. Gasoline RBOB (USDc/gal), based on the daily settlement price of the gasoline NYMEX futures contract.
5. NYMEX WTI (USD/bbl), based on the daily settlement price of the NYMEX WTI futures contract.

1.2.6.3 Risk Management Strategies for the Refinery Industry Risk management activity in a refinery is closely linked to the planning of crude oil purchasing and its processing schedule to satisfy both specification and demand with the highest profit. The decision variables are crude oil supply purchase decisions, processing, inventory management and blending over various time periods. The lengths of these periods must be decided upon based on business cycles.

Most refineries are continuously involved in a full range of pricing risk management transactions, from short-term crude oil relative value optimization (more on this in Section 1.3) to short- to medium-term enhancement of the relative value of crude oil versus certain products (refinery crack swaps, similar in concept to the gasoil crack swaps in the section on aviation) to term locking in of the operational margin via the use of refinery margin swaps.

Refinery Margin Swaps: Locking the Forward Margin *Situation.* A refinery in Europe would like to take advantage of the favourable relative forward value of oil products versus crude oil and lock it in using financial OTC swaps.

Strategy. As seen in the previous section, refinery inputs are a blend of several kinds of crude oil and the output is comprised of different oil products. The large number of crude oil and oil products physical references used in the refinery process is unmatched by the relatively limited number of liquid OTC financial swap references. To find an effective hedge structure, the refinery needs to identify what OTC-traded products represent the best proxy for its crude and product slates. For the purpose of this example, we can assume the following.

1. The crude oils' slate supply is all indexed against the ICE Brent futures contract plus (or minus) certain premiums (or discounts).
2. The products' slate output can effectively be represented using the following proxy basket of OTC swaps:
 - (a) 20% Fuel Oil 3.5% Barges
 - (b) 30% Gasoil 0.1% Cargoes FOB NWE
 - (c) 15% Jet Cargoes FOB NWE
 - (d) 20% Premium Gasoline 10 ppm Cargoes FOB NWE
 - (e) 15% Naphtha CIF NWE.
3. As seen before, the conversion from barrels (volume) to metric tonnes (weight) depends on the specific gravity, or density, of the oil or oil product. The lighter the oil or oil product, the more barrels per tonne. We assume the following conversion factors:
 - (a) barrels per MT of fuel oil
 - (b) barrels per MT of gasoil and jet fuel
 - (c) barrels per MT of gasoline
 - (d) 8.90 barrels per MT of naphtha.
4. If the refinery wants to lock in its refinery margin for 2015 for a volume of 100,000 barrels per month, it has to enter into the following transactions:
 - (a) Buy a calendar 2015 monthly settled swap on ICE Brent for January 2015 to December 2015 for 100,000 barrels per month.

- (b) Sell the following monthly settled swaps for January 2015 to December 2015
- (i) $20\% \times 100,000/6.35 = 3150$ MT per month of 3.5% Fuel Oil Barges
 - (ii) $30\% \times 100,000/7.45 = 4025$ MT per month of Gasoil 0.1% FOB NWE
 - (iii) $15\% \times 100,000/7.45 = 2015$ MT per month of Jet Cargoes FOB NWE
 - (iv) $20\% \times 100,000/8.33 = 2401$ MT per month of Premium Gasoline 10 ppm Cargoes NWE
 - (v) $15\% \times 100,000/8.90 = 1685$ MT per month of Naphtha CIF NWE.
- (c) The difference between the values of the crude oil swap and the basket of oil product swaps is the forward crack, which is generally measured in barrels.

Pros. By locking in the forward margin, the refinery is able to reduce the volatility of its operational margin.

Cons. The refinery may miss out on further potential positive movements in the margin level and there is an element of basis risk between the hedging instrument and the actual economics of the refinery that needs to be carefully evaluated and monitored.

1.2.7 Industrial Consumers: Risk Profile and Hedging Strategies

1.2.7.1 Introduction: Energy-Intensive Manufacturing and Oil Prices This section discusses energy-intensive manufacturers with direct or indirect exposure to oil prices. These are typically paper mills, steel and aluminium mills, cement mills, ceramic and glass manufacturers, and any other industrial process requiring the production of large amounts of heat or steam. Direct exposure to oil markets comes from using fuel oil in furnaces or boilers or gasoil for localized power generation. Indirect exposure comes from using natural gas priced on a basket of oil products in the industrial process.

1.2.7.2 Product Specifications

Europe, Middle East and Africa Regions The main oil references generally used by manufacturing companies for risk management purposes are published by Platts and include the following:

1. Fuel Oil 3.5% Barges (USD/MT).
2. Fuel Oil 3.5% Cargoes CIF NWE (USD/MT).
3. Fuel Oil 3.5% Cargoes FOB MED (USD/MT).
4. Fuel Oil 1% Cargoes CIF NWE (USD/MT).
5. Gasoil 0.1% Cargoes FOB NWE (USD/MT).
6. Gasoil 0.1% Cargoes CIF MED (USD/MT).

Asian Region The main oil references generally used by manufacturing companies for risk management purposes are published by Platts and include the following:

1. Singapore 180 cst (USD/MT).
2. Singapore 380 cst (USD/MT).
3. Singapore Gasoil Reg 0.5% Sulphur (USD/bbl).

Americas Region The main oil references generally used by manufacturing companies for risk management purposes are the following and are published by Platts and NYMEX:

1. Residual Fuel Oil 1% CIF New York Harbour (USD/bbl).
2. NYMEX HO (USDc/gal), based on the daily settlement price of the NYMEX heating oil futures contract.
3. NYMEX WTI (USD/bbl), based on the daily settlement price of the NYMEX WTI futures contract.

1.3 OIL PHYSICAL MARKET HEDGING AND TRADING

1.3.1 The Actors, Futures and OTC Prices

The implementation of hedging strategies to protect against the movement of oil prices is an issue for many different industrial sectors. Corporate hedging strategies are not homogeneous across industrial sectors, and even within the same industrial sector the hedging strategies are substantially different across market participants, but they are usually implemented by a risk manager operating within a financial or supply department. However, there are other actors besides industrial risk managers active in the energy market. Indeed, we can rely on the presence of at least the following:

1. Speculators who attempt to gain from anticipated changes in the prices of commodities or financial instruments. Speculators aim primarily for a quick profit from a short-term trading strategy.
2. Traders who trade on different oil benchmarks. These traders are focused on gaining from their view. Therefore, they create different positions through a combination of the different derivatives described below.
3. Risk managers who trade the same type of financial derivative products as traders. However, risk managers are dedicated to optimizing the cost and results of their hedging strategies.

Contrary to expectations, risk management is not about the elimination of risk but concerns its management. Financial derivatives provide a powerful tool for limiting the risks that individuals and organizations face in the ordinary conduct of their business. Successful derivative risk management requires a thorough understanding of the principles that govern the pricing of financial derivatives that can save costs and increase returns.

For the sake of simplicity, both traders and risk managers are identified as traders. Traders can build portfolios and strategies by using and combining at least the following instruments:

1. Forwards are agreements where one party promises to buy an asset from another party at some specified time in the future and at some specified price. No money changes hands until the delivery date or the maturity of the contract.
2. Futures contracts are very similar to forward contracts. Futures contracts are usually traded through an exchange, which standardizes the terms of the contracts. The profit or loss from the futures position is calculated every day and changes in this value are paid from one party to the other. Thus, futures contracts involve a gradual payment of funds from initiation until expiry.

3. A swap is an exchange of a fixed price of a crude oil benchmark for a floating average of the same benchmark.
4. An option is an instrument that gives to the holder (buyer) the right to buy or sell a defined underlying at a certain price.

The energy market provides two main opportunities to create a profit:

1. Variations of oil prices – by way of an example, the movement of crude oil from \$80/bbl to \$85/bbl.
2. Variations of the differential, that is, the movement between two different oil benchmarks – by way of an example, the movement of the difference between European crude oil and American crude oil.

As a consequence, any energy underlying is calculated according to the following equation:

$$\text{final price} = \text{futures price} + \text{differential}$$

Thus, traders are generally focused on implementing strategies on flat prices and differentials separately.¹

The flat prices are mostly traded on regulated markets, based on standardized contracts and defined rules. On the contrary, the differential risk is usually traded on OTC markets, which are based on bilateral negotiations. In these markets, the types of contracts and products traded are defined case by case. The prices are assessed by agencies on the basis of the information provided by different traders.

Futures contracts are usually traded through an exchange on a standardized contract. The most active exchanges are:

1. NYMEX, based in New York.
2. ICE, based in London.

The profit or loss from the futures position is calculated every day and the change in this value is paid from one party to the other. Thus, futures contracts involve a gradual payment of funds from initiation until expiry. This process is managed by a clearing house, which is a financial institution that stands between the parties to ensure that all market participants honour their trade settlement obligations. The clearing house secures market activity by the utilization of a margin methodology based on the following:

1. The initial margin or original margin is the amount necessary to start to trade.
2. The variation margin is the amount paid periodically (generally daily) by the market participant, according to the marking to market of their open position.²

¹*Flat price* is a trading term that indicates the overall price of a commodity. The fluctuation between \$80/bbl and \$85/bbl of a futures on crude oil is defined as a flat price variation.

²Mark-to-market or fair value accounting refers to accounting for the fair value of an asset or liability based on the current market price of the asset or liability.

The initial margin should be considered the insurance necessary to guarantee the clearing house and its members from variations in price within a trading day. The variation margin is the mechanism necessary to restore the initial margin.

The futures contract is standardized, particularly for the following features:

1. Type of contract (physical or cash delivery).
2. Contract unit (barrel, metric tonnes, gallons, etc.).
3. Underlying (Brent, WTI, gasoil, etc.).
4. Trading hours (between 7:00 p.m. and 5:00 p.m. Chicago time, between 5:00 p.m. and 4:15 p.m. Chicago time, etc.).

Table 1.4 shows the specifications of the two contracts.

Table 1.4 compares the main futures contract. WTI was created on 02/01/1981 in New York by New York Mercantile, which was the first international energy regulated market. In recent years the rivalry between ICE Brent and NYMEX WTI has increased due to:

1. The development of a better electronic platform by ICE.
2. The rise of Far East demand.

However, the two contracts are very similar, except for settlement type. The difference between a physical delivery and a cash delivery is important, particularly for

1. US traders
2. arbitrageurs.

Physical delivery could be a risk for traders who have no physical asset to perform it (such as storage, pipeline capacity, etc.). For this reason, in recent years ICE has developed a WTI cash-settled contract. The futures contract is traded on ICE and, except for the price levels and expiry dates, which equal those of the NYMEX WTI, has the same features as ICE Brent.

Table 1.4 describes the settlement price for a futures contract, which is the closing price of the trading day for the futures, and it is necessary to mark the price of the market futures at the close. The settlement price is the official closing price of the exchange. However, NYMEX and ICE publish several other markers.

A marker is necessary to indicate the price of the futures at a defined period of the day. In this example, ICE Brent futures are characterized by several markers:

1. The ICE Brent futures crude afternoon marker is calculated by the weighted average of trades completed between 4:29 and 4:30 p.m. London time.
2. The ICE Brent futures crude Singapore marker is calculated by the weighted average of trades completed between 8:29 and 8:30 a.m. London time.

Markers represent points of contact between the regulated and OTC markets. The OTC markets are based on bilateral negotiations. In these markets, the types of contracts and products traded should be defined case by case between traders. The prices are

TABLE 1.4 A comparison of contract specifications between ICE Brent futures and NYMEX WTI

Specifications	ICE Brent futures	NYMEX WTI
Trading hours	UK hours. Monday to Friday. Open 1:00 a.m. (11:00 p.m. on Sundays). Closed 11:00 p.m. London time. Chicago hours. Monday to Friday. Open 7:00 p.m. (5:00 p.m. on Sundays). Closed 5:00 p.m. the following day.	New York hours. Sunday to Friday. Open 6:00 p.m. Closed 5:15 p.m., with a 45-minute break each day, beginning at 5:15 p.m. Chicago hours. Sunday to Friday. Open 5:00 p.m. Closed 4:15 p.m., with a 45-minute break each day, beginning at 4:15 p.m.
Comparison	WTI has longer trading hours.	
Listed contracts	A maximum of 72 consecutive months will be listed. In addition, six contract months comprising of June and December contracts will be listed for an additional three calendar years. Twelve additional contract months will be added each year on the expiry of the prompt December contract month.	Consecutive months are listed for the current year and the next five years. In addition, the June and December contract months are listed beyond the sixth year. Additional months will be added on an annual basis after the December contract expires.
Comparison	WTI has more listed contracts.	
Expiration date	Trading shall cease at the end of the designated settlement period on the business day (a trading day that is not a public holiday in England or Wales) immediately preceding either (i) the 15th day before the first day of the contract month, if such 15th day is a business day or (ii) if such 15th day is not a business day, the next one.	Trading in the current delivery month shall cease on the third business day prior to the 25th calendar day of the month preceding the delivery month. If the 25th calendar day of the month is not a business day, trading shall cease on the third business day prior to the last business day preceding the 25th calendar day.
Comparison	Both contracts have defined expiry dates.	
Price quotation	US dollars and cents per barrel.	US dollars and cents per barrel.
Daily margin	All open contracts are marked to market daily.	All open contracts are marked to market daily.
Settlement price	The weighted average price of trades during a 3-minute settlement period from 7:27 to 7:30 p.m. London time.	The weighted average price of trades during a 3-minute settlement period from 7:27 to 7:30 p.m. London time.
Minimum fluctuation	\$0.01 per barrel.	\$0.01 per barrel.
Contract security	ICE Clear Europe acts as the central counterparty for trades conducted on the London exchanges. This enables it to guarantee the financial performance of every contract registered with it by its members (the clearing members of the exchanges) up to and including delivery, exercise and/or settlement. ICE Clear Europe has no obligation or contractual relationship with its members' clients who are non-member users of the exchange markets or non-clearing members of the exchanges.	The CME Clearing House acts as the central counterparty for trades conducted on the CME exchanges. This enables it to guarantee the financial performance of every contract registered with it by its members (the clearing members of the exchanges) up to and including delivery, exercise and/or settlement. The CME Clearing House has no obligation or contractual relationship with its members' clients who are non-member users of the exchange markets or non-clearing members of the exchanges.
Comparison	No difference	
Settlement type	Cash	Physical

assessed by agencies on the basis of the information provided by different traders. The main agencies are

1. Platts
2. Argus
3. ICIS Heren.

The prices are calculated according to the methodology published on these agencies' respective websites.³

Of these agencies, the most important for crude oil and oil product assessment is Platts. Platts has defined a methodology called market on close (MOC). According to this methodology, Platts calculates the price of each commodity, considering the value of the physical cargo and derivatives traded during a defined period of the day. It is not the goal of this chapter to describe this calculation. However, the methodology is fundamental in pricing each physical and derivative contract based on an OTC benchmark.

Platts calculates its assessments during three defined periods:

1. The Singapore window, between 8:00 and 8:30 London time.
2. The European window, between 16:00 and 16:30 London time.
3. The US window, between 19:00 and 19:30 London time.

The MOC methodology provides an assessment based on the market condition of the futures market at the end of the window period. For this reason ICE decided to launch a series of their markers, the main ones of which were introduced above.

1.3.2 The Most Commonly Used Financial Instruments

Energy markets and financial markets have the following instruments in common, which are the most frequently utilized in trading strategies:

1. Futures traded in regulated markets.
2. Swaps traded in OTC markets.
3. Options.

The use of options is mainly a feature of risk manager strategies, which were considered previously. Trader strategies based on options are not a matter of concern for this chapter.

The distinction between futures and swaps is fundamental to evaluate the different trading strategies that could be selected. A swap agreement is a derivative where two counterparties exchange one stream of cash flows against another stream, calculated by reference to an underlying (e.g., a securities index, bond currencies, interest rates, commodities and even more intangible items). A swap represents a customized financial instrument that allows the

³The assessment methodologies of Platts, Argus and ICIS Heren are published at www.platts.com, www.argusmedia.com and www.icis.com, respectively.

trader to open a position on a quantity or a benchmark that is not possible to execute in the futures market. The underlying of the swap could be:

1. One of the futures markers indicated above.
2. One of the prices assessed and released by the agencies (Platts, Argus or ICIS Heren).

Traders combine futures and swaps with different underlyings to implement their strategies and maximize profit based on their market view. The combinations differ according to

1. Crude oil trader strategies.
2. Product trader strategies.

The differences are related to the different parts of the industry involved with crude oil and oil products. Crude oil is a commodity important for

1. Arbitrage.
2. Storage.
3. Refinery operations.

Oil products are important for

1. Arbitrage.
2. Storage.
3. Petrochemicals.
4. Utilities.
5. Automotive companies.
6. Industrial sectors.

1.3.2.1 Crude Oil The crude oil markets are characterized by a great number of benchmarks, the main ones being the following:

1. The ICE Brent futures is the benchmark for European crude oil markets and it is listed on the ICE exchange in London. The future contracts traded are monthly based. The contract does not settle with physical delivery.
2. The NYMEX WTI future is the benchmark for the US crude oil markets and is listed on the NYMEX in New York. The future contracts traded are monthly based. The contract settles with physical delivery.
3. The BFOE 21 days is a physical forward contract traded on the OTC markets of the North Sea.⁴ The contract is similar to a futures and settles with physical delivery.
4. Dated Brent is the main benchmark for the OTC European, African and Mediterranean crude oil markets.

⁴21-day BFOE involves the actual cash market trade in the cheapest-to-deliver crude from the Brent, Forties, Osenberg and Ekofisk market. This historically was Brent itself, but that has changed with time to make Forties the cheapest-to-deliver crude oil more often than not. The 21-day BFOE index is used to compile the Brent Index on a daily basis and then used to cash-settle the Brent futures contract.

5. Exchange for physical (EFP) is a price that indicates the difference between the ICE Brent futures and the BFOE of the same delivery.
6. Dated to frontline (DFL) implies a differential between the daily Platts Dated Brent assessment for dated or physical cargoes and the ICE settlement for the front-month ICE futures for that day.
7. A contract for difference (CFD) implies a differential between the daily Platts Dated Brent assessment for dated or physical cargoes and the BFOE daily Platts assessment for that day.

The following equations are fundamental to understanding the trading strategies implemented in the European crude oil markets:

$$\begin{aligned} \text{Dated Brent} &= \text{BFOE}_{t_1} + \text{differential} \\ \text{BFOE}_{t_1} &= \text{ICE Brent}_{t_1} + \text{EFP}_{t_1} \\ \text{Dated Brent swap}_{t_1} &= \text{ICE swap Brent}_{t_1} + \text{DFL}_{t_1} \end{aligned}$$

The Brent frontline swaps are calendar monthly swaps based on the ICE Brent futures contract. The swap is calculated using mean-adjusted values for the number of trading days, and each futures contract spends as the front month. This is done by calculating the exact number of trading days within each month, which varies according to the calendar month:

$$\text{ICE swap}_{t_1} = (\text{ICE Brent futures}_{t_2} \times g_1 + \text{ICE Brent futures}_{t_3} \times g_2) / G$$

where g_1 is the number of business days between the start of the month and the day before the expiry of the first line, g_2 is the number of business days between the day before the expiry of the first line and the end of the month, and G is the total number of business days in the month ($g_1 + g_2$).

Below is an example of an ICE Brent swap relating to June 2014.

The June 2014 swap is made up of 21 business days. The expiry date of the ICE Brent future is 13 June 2014 and the delivery month is July 14 (June 14 + 1). The first line from 16 June to the end of the month is August 14 (June 14 + 2). Here ICE Brent July 14 is the first line for 10 business days and ICE Brent August 14 is the first line for 11 business days. On the basis of the rule on the expiry date of the futures introduced above, we have to consider ICE Brent August and not ICE Brent July; therefore, there are 9 business days relating to ICE Brent July and 12 to ICE Brent August.

On the basis of the above, the following equation is obtained:

$$\text{ICE swap June 14} = (\text{ICE Brent future July 14} \times 9 + \text{ICE Brent future August 14} \times 12) / 21$$

where $g_1 = 10$, the number of business days between the start of the month and the day before the expiry of the first line; $g_2 = 12$, the number of business days between the day before the expiry of the first line and the end of the month; and $G = (10 + 12) = 22$, the total number of business days in the month.

Suppose that:

1. The ICE Brent July 14 price is \$79.04/bbl.
2. The ICE Brent August 14 price is \$80.80/bbl.

Then the price of ICE Brent June 14 may be calculated as follows:

$$\text{ICE swap June 14} = (\$79.04/\text{bbl} \times 9 + \$80.80/\text{bbl} \times 12)/21 = 80.04\$/\text{bbl}$$

The ICE Brent swap is necessary to calculate the Dated Brent swap on the average of the month. To obtain the Dated Brent swap, the trader has to add the DFL to the ICE Brent swap, as indicated in the equation

$$\text{Dated Brent swap}_{t1} = \text{ICE Brent swap}_{t1} + \text{DFL}_{t1}$$

1.3.2.2 Products The product markets are characterized by too many different benchmarks to be listed in this chapter. The following futures and OTC benchmarks are defined, as utilized in the trading example:

1. The ICE gasoil future is the benchmark for European middle distillates and is listed on the ICE in London. The future contracts traded are monthly based. The contract settles with physical delivery.
2. The NYMEX heating oil futures is the benchmark for US middle distillates and is listed on the NYMEX in New York. The futures contracts traded are monthly based. The contract settles with physical delivery.
3. 10 ppm CIF MED is the main benchmark for the OTC Mediterranean middle distillate markets.⁵
4. The 10 ppm CIF MED differential is the differential between the daily Platts 10 ppm CIF MED assessment and the ICE settlement for the front-month ICE futures for that day.

The following equations are fundamental to understanding the trading strategies implemented in the European crude oil markets:

$$\begin{aligned} 10 \text{ ppm CIF MED} &= \text{ICE gasoil futures} + \text{differential} \\ 10 \text{ ppm CIF MED swap}_{t1} &= \text{ICE gasoil swap}_{t1} + 10 \text{ ppm CIF MED differential}_{t1} \end{aligned}$$

The gasoil frontline swaps are calendar monthly swaps based on the ICE gasoil futures contract. The swap is calculated using mean-adjusted values for the number of trading days, and each futures contract is the front month. This is done by calculating the exact number of trading days within each month, which varies according to the calendar month:

$$\text{ICE gasoil swap}_{t1} = (\text{ICE gasoil future}_{t1} \times g1 + \text{ICE gasoil future}_{t2} \times g2)/G$$

where $g1$ is the number of business days between the start of the month and the day before the expiry of the first line, $g2$ is the number of business days between the day before the expiry of the first line and the end of the month, and G is the total number of business days in the month ($g1 + g2$).

Below is an example of an ICE gasoil swap relating to June 2014.

The June 2014 swap is made up of 21 business days. The expiry date of the ICE gasoil futures is 12 June 2014 and the delivery month is June 14. The first line from 13 June to the

⁵10 ppm CIF MED means ULSD, a motor engine diesel with a sulphur content of 10 ppm. For the sake of clarity, we will continue to call it 10 ppm CIF MED.

end of the month is July 14 (June 14 + 1). Here ICE gasoil June 14 is the first line for nine business days and ICE Brent July is the first line for 12 business days. On the basis of the rule on the expiry date of the futures introduced above, it is necessary to consider ICE gasoil July and not ICE gasoil June; therefore, there are eight business days relating to ICE gasoil June and 13 relating to ICE gasoil July.

On the basis of the above, we obtain the following equation:

$$\text{ICE swap June 14} = (\text{ICE gasoil future June 14} \times 8 + \text{ICE gasoil future July 14} \times 13) / 21$$

where $g_1 = 8$, the number of business days between the start of the month and the day before the expiry of the first line; $g_2 = 14$, the number of business days between the day before the expiry of the first line and the end of the month; and $G = (8 + 14) = 22$, the total number of business days in the month.

Suppose that:

1. The ICE gasoil June 14 price is \$902.25/MT.
2. The ICE gasoil July 14 price is \$898.75/MT.

The price of ICE gasoil June 14 may be calculated as follows:

$$\text{ICE swap June 14} = (\$902.25/\text{MT} \times 8 + \$898.75/\text{MT} \times 13) / 21 = 900\$/\text{MT}$$

The ICE gasoil swap is necessary to calculate the 10 ppm CIF MED swap on the average of the month. To obtain the 10 ppm CIF MED swap, the trader has to add the 10 ppm CIF MED to the ICE gasoil swap, as indicated in the equation

$$10 \text{ ppm CIF MED swap}_{t1} = \text{ICE gasoil swap}_{t1} + 10 \text{ ppm CIF MED differential}_{t1}$$

1.3.3 How to Monitor and Manage Risk

A trader has the opportunity to set his own risk strategy according to the following limits:

1. A stop loss is the level at which a trader has to close a position to avoid further losses.⁶
2. A take-profit strategy is the level at which a trader has to close a position to collect the gains.
3. Value at risk (VaR) calculates the worst expected loss over a given horizon at a given confidence level under normal market conditions. It provides a single number summarizing the organization's exposure to market risk and the likelihood of an unfavourable move. It provides a predictive tool to prevent portfolio managers from exceeding risk tolerances that have been developed in portfolio policies. It can be measured at the portfolio, sector, asset class and security levels. Multiple VaR methodologies are available and each has its own benefits and drawbacks. The three main methodologies are parametric (also called analytical), historical simulations and Monte Carlo simulations. To illustrate, suppose a \$100 million portfolio has a monthly VaR of \$8.3 million with a 99% confidence level.

⁶JP Morgan, *Product and Service Risk Disclosure*.

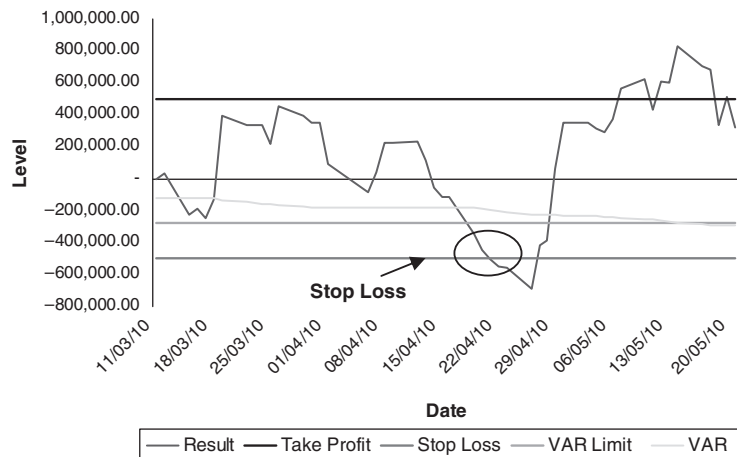


FIGURE 1.12 When the position hits the stop loss, the trader must close the position

The VaR simply means that there is a 1% chance of losses greater than \$8.3 million in any given month of a defined holding period under normal market conditions.⁷

The stop loss is the maximum level of loss that a trader can realize for a position. When the position has lost that amount, the trader must close the position and stop trading (see Figure 1.12).

The profit-taking strategy is the opposite of the stop-loss strategy and involves the level of profit a trader wants to realize for a position. When the position has gained that amount, the trader starts to close out the position and stops trading (see Figure 1.13).

The VaR is a measure of the maximum potential change in value of a portfolio of financial instruments with a given probability over a preset horizon. The VaR answers the question of how much one can lose with an $x\%$ probability over a given time horizon (see Figure 1.14).

If the position reaches the stop loss and VaR limits, the trader must close the position. The same types of obligation are not applicable when the strategy reaches the profit-taking level.

If the position does not hit any limits, the trader can decide to hold the position or to change it. The trader will decide according to his own view. If he strongly believes that his strategy will generate a profit he will hold it, otherwise he will close it and open another one (see Figure 1.15).

Below we have an example of how a monitoring system should be worked in the case of the following assumed variables:

- Underlying swap position indicated above at $-\$0.10/\text{bbl}$.
- VaR limit of \$275,000.
- Stop-loss strategy $-\$500,000$.
- Profit-taking strategy $+\$500,000$.

⁷Romain Berry, *Setting Up a Sound Risk Management Framework*, JP Morgan Investment Analytics and Consulting.

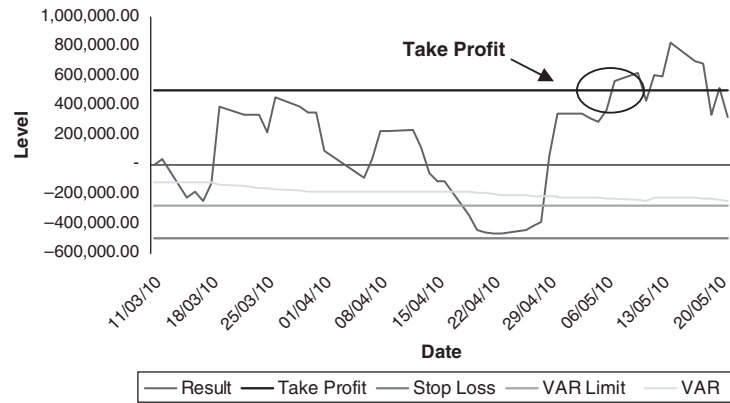


FIGURE 1.13 When the position hits the take profit, the trader must close the position

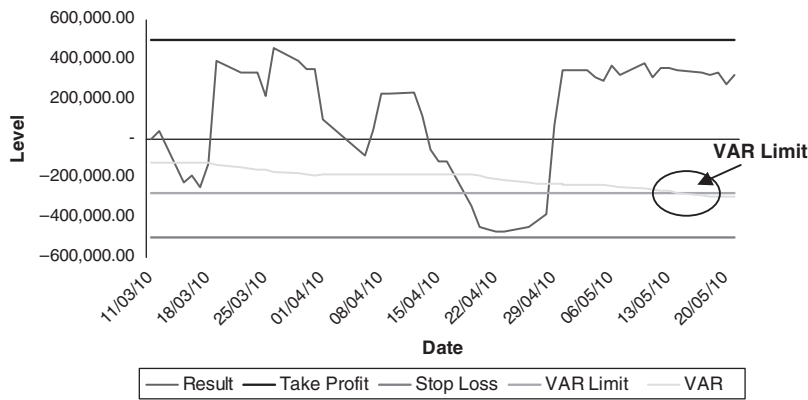


FIGURE 1.14 When the position hits the VaR limit, the trader must close the position

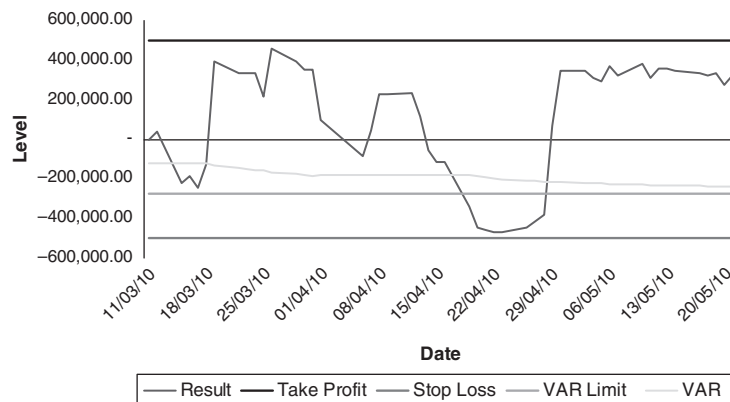


FIGURE 1.15 When the position does not hit any limits, the trader can elaborate another strategy

On this basis, a company can allow a trader to run the risk associated with the following strategies:

1. A wait-and-see strategy.
2. A breakdown strategy.

1.3.4 How to Create a Market View

The variables introduced above are influenced by the demand and supply of crude oil and refined products. The movement of demand is difficult to forecast but it is influenced by the seasons. For instance, the consumption of gasoline usually increases during the summer, with heightened consumer demand for travelling, while the consumption of heating oil is higher in the winter than the summer.

Reductions or increases in supply are easier to forecast because of their direct connection to the oil industry. The production of crude oil, and therefore its supply in the market, should be influenced by the following factors:

1. The decisions of Organization of the Petroleum Exporting Countries (OPEC) and non-OPEC producers to increase or reduce the production of crude oil.
2. The release of strategic reserves (US reserves are called the strategic petroleum reserve, or SPR).
3. Natural events (hurricanes, earthquakes, etc.).

The above example has an impact on the following price differentials:

1. Time spread structure.
2. Differential level.

In the analysis of a time spread, two market situations emerge (Figure 1.16):

1. *Contango*. This is the situation where today's price is lower than that of a subsequent period (weeks or months ahead). This is the classic situation in which an increase in price is expected. It is generally connected to current excess supplies in the physical markets.
2. *Backwardation*. This is the situation where today's price is higher than that of a subsequent period (weeks or months ahead). This is the classic situation in which a decrease in the price is expected. It is generally connected to current excess demand in the physical markets.

The differential level is the movement between two prices related to two different benchmarks or underlyings.

The most well-known differential is the spread between Dated Brent and ICE Brent first line, which is characterized by high volatility as indicated in Figure 1.17.

For instance, if OPEC and non-OPEC producers decide to increase the production of crude oil or the United States decides to release the SPR, the supply of crude oil will increase. The prices of physical crude oil benchmarks will drop and the contango structure will increase, because traders will expect demand to require a certain period to adjust and, as in any other market, if there is an excess of supply, current prices will start to drop.

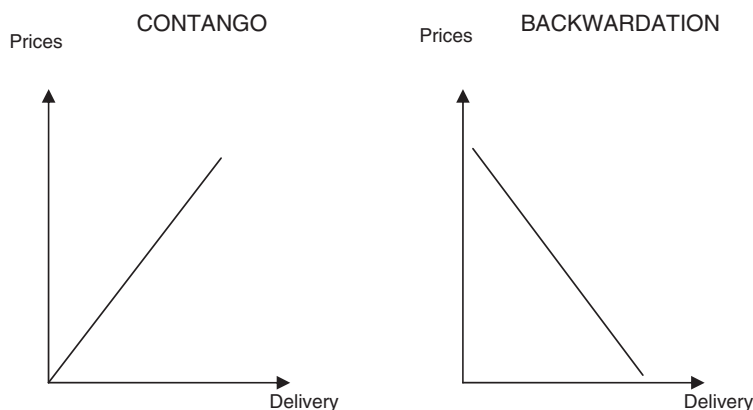


FIGURE 1.16 An example of contango and backwardation

On the contrary, if OPEC and non-OPEC producers decide to reduce the production of crude oil, the United States decides to increase the SPR or a hurricane stops production at the crude oil facilities in the Gulf of Mexico, the supply of crude oil will decrease. The prices of physical crude oil benchmarks will rise and the contango structure will decrease, because traders will expect demand to require a certain period to adjust and, as in any other market, if there is an excess of demand, current prices will start to rise.

The demand for crude oil is mainly influenced by the following:

1. Refinery maintenance, which is the period when a refinery is closed to carry out the maintenance of plants.
2. Refinery runs, which is the percentage of a refinery's total capacity that is active in a certain period.
3. Natural events.

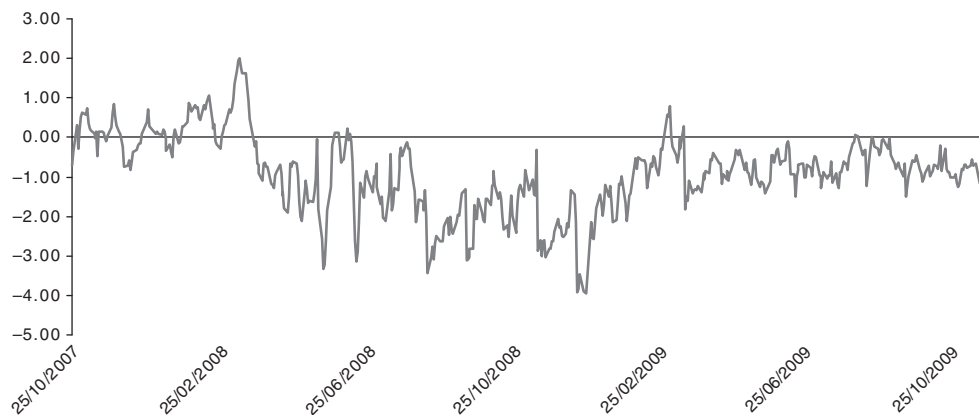


FIGURE 1.17 Sample of spread between the Dated Brent and ICE Brent first line
Source: Reuters.

TABLE 1.5 The main increase and supply events and their impact on crude oil and product prices

	Event	Impact on demand/supply	Price movement
Crude oil	Oil producers increase production	Increase in supply	Reduction
	Refineries reduce runs	Decrease in demand	Reduction
Crude oil	Oil producers reduce production	Decrease in supply	Increase
	Refineries increase runs	Increase in demand	Increase
Products	Refineries increase runs	Increase in supply	Reduction
	Decrease of industrial production	Decrease in demand	Reduction
Products	Hurricane stops refinery production in the Gulf of Mexico	Decrease in supply	Increase
	Increase of industrial production	Increase in demand	Increase

For instance, if US refineries decide to increase the production of products (i.e., the runs increase from 85% to 87%), the demand for crude oil will increase. The prices of physical crude oil benchmarks will increase and the contango structure will decrease, because traders will expect the supply to require a certain period to adjust and, as in any other market, if there is an excess of demand, current prices will start to increase.

On the contrary, if US refineries decide to reduce the production of products (i.e., the runs decrease from 85% to 83%), or decide on an extraordinary period of maintenance or a hurricane stops refinery activity in the Gulf of Mexico, the demand for crude oil in the market will decrease. The prices of physical crude oil benchmarks will decrease and the contango structure will increase, because traders will expect the supply to require a certain period to adjust and, as in any other market, if there is an excess of supply, current prices will start to decrease.

The events set out above affect not only the demand and supply of crude oil but also that of refined products. In addition, the events described have different impacts in different areas. The closure of a refinery in the United States has a strong impact on crude oil demand and the supply of products in the United States whereas the impact in Europe is minor and unimportant in the Far East.

The different impacts in the different geographical areas justify the greater importance of arbitrage trading strategies in the commodity market than in the equity and FX markets. Table 1.5 summarizes the most common events and their impacts on the level of the differentials (physical and swap) and the shape of the forward curve of crude oil prices. For the sake of simplicity, the events are identified as either having a reducing or an increasing effect on prices.

1.3.5 Trading Strategies to Maximize a Market View

1.3.5.1 Introduction This section describes possible trading strategies and how a trader can maximize a market view. The examples are divided as follows:

1. Crude oil hedging and crude oil storage (contango capture) strategies.
2. Arbitrage.
3. Product hedging and product storage strategies.

Each of these examples is introduced by means of a brief description of the hedging strategy involved. The hedging strategy is the right combination of financial derivatives that lets the trader neutralize risk and lock in a certain result. Knowledge of how to minimize or eliminate risk is necessary in order to mitigate effectively against all of the risk that goes against the particular market view.

1.3.5.2 Crude Oil Strategy

Hedging a Physical Crude Oil Cargo *Situation.* On 15 May 2014 a trader buys a cargo of 630 kb crude oil from a producer in the North Sea area.⁸ The buy price is the average over June 2014 of the Dated Brent. The sell price of the cargo is 80.04\$/bbl.

Strategy. The trader expects an increase in prices and decides to enter into two swap transactions for 630 kb each. The trader fixes the price of the ICE Brent swap (i.e., at 80.04\$/bbl) and the DFL (i.e., at -50 cts/bbl). This way the trader locks in a margin against his or her physical operation, as indicated in Table 1.6.

However, the trader can hedge the risk by using a portfolio combination of swaps and futures. According to the equations introduced earlier, the trader knows that

$$\begin{aligned} \text{Dated Brent swap}_{t_1} &= \text{ICE Brent swap}_{t_1} + \text{DFL}_{t_1} \\ \text{ICE swap}_{t_1} &= (\text{ICE Brent future}_{t_2} \times g_1 + \text{ICE Brent future}_{t_3} \times g_2) / G \end{aligned}$$

Strategy. The ICE June swap is calculated according to the above equation, yielding

$$\text{ICE swap June 14} = (\text{ICE Brent future July 14} \times 9 + \text{ICE Brent future August 14} \times 12) / 21$$

Therefore, the ICE June swap is comprised of:

1. 270 lots of ICE Brent July.
2. 360 lots of ICE Brent August.

For this reason the trader buys 270 lots of ICE Brent July (i.e., at \$79.04/bbl) and 360 lots of ICE Brent August (i.e., at \$80.80/bbl) for an average buy price of the future of \$80/bbl:

$$\text{June dated Brent swap} = \text{June ICE Brent swap} + \text{June DFL}$$

TABLE 1.6

		COST	PROFIT
Physical		Avg. June 14 of Dated Brent	80.04\$/bbl
	ICE Brent Swap	80.04 \$/bbl	Avg. June 14 of ICE Brent
Hedge			Avg. June 14 of Dated Brent
	DFL Swap	Avg. June 14 of ICE Brent	50 cts/bbl
RESULT			50 cts/bbl

⁸1 kb = 1000 barrels.

TABLE 1.7

		COST	PROFIT
Physical			80.04 \$/bbl
	Future July	Avg. June 14 of Dated Brent	
	Future Aug	270 lots @ 79.04 \$/bbl	
	Average	360 lots @ 80.80 \$/bbl	
		80.04 \$/bbl	?
Hedge			Avg. June 14 of Dated Brent
	DFL Swap	Avg. June 14 of ICE Brent	50 cts/bbl
TARGET RESULT		50 cts/bbl	

Therefore, the trader buys a fixed swap on June DFL at a price of -0.50 cts/bbl. The portfolio leads to the trader's risk profile indicated in Table 1.7. Without any further action, the trader runs the risk that the average of the June settlement prices of ICE Brent will be lower than \$80.04/bbl.

Therefore, during June, the trader will sell 30 lots per day at the ICE Brent settlement price, following the programme indicated in Table 1.8. By selling every day 1/21 of the total 630,000 barrels, the trader will be able to replicate the average of June's ICE Brent settlement prices.

TABLE 1.8

Trade Date	Lots	Expiry Date
02/06/2014	30	July14
03/06/2014	30	July14
04/06/2014	30	July14
05/06/2014	30	July14
06/06/2014	30	July14
09/06/2014	30	July14
10/06/2014	30	July14
11/06/2014	30	July14
12/06/2014	30	July14
13/06/2014	30	Aug14
16/06/2014	30	Aug14
17/06/2014	30	Aug14
18/06/2014	30	Aug14
19/06/2014	30	Aug14
20/06/2014	30	Aug14
23/06/2014	30	Aug14
24/06/2014	30	Aug14
25/06/2014	30	Aug14
26/06/2014	30	Aug14
27/06/2014	30	Aug14
30/06/2014	30	Aug14
Total Lots	630	

TABLE 1.9

		COST	PROFIT
Physical		Avg. June 14 of Dated Brent	80.04 \$/bbl
	Future July	270 lots @ 79.04 \$/bbl	
	Future Aug	360 lots @ 80.80 \$/bbl	
	Average	80.04 \$/bbl	Avg. June 14 of ICE Brent
Hedge			Avg. June 14 of Dated Brent
	DFL Swap	Avg. June 14 of ICE Brent	50 cts/bbl
RESULT		50 cts/bbl	

In this selling strategy, the average sell prices of the futures are equivalent to the monthly average of June's ICE Brent. The result of this strategy is exactly the same as that presented above, shown here in Table 1.9. For the sake of simplicity, no cost related to futures execution is assumed and it is further assumed that there are no bids or offers for swaps.

Crude Oil Storage or Contango Capture The most common practices are land storage and floating storage. For the sake of simplicity, the following identifies all land storage and floating storage as simply storage.

Storage is the practice of taking advantage of a price differential between two different time periods by using a combination of physical deals, physical facilities (storage or vessels) and derivatives. It is a widespread practice in physical and financial commodity trading. Such deals take advantage of a particular market situation, where there exists an excess of supply in which the spot prices are lower than the forward prices and the shape of the forward curve shows a steep contango. Since a large majority of the risk can be hedged, these deals carry a limited amount of commodity price risk.

For the sake of clarity, the following example does not consider the physical differential of the different crudes but only hedgeable underlyings. Typical storage activity for a cargo of crude oil is described below.

Situation. A trader buys, on 25 June 2014, a crude oil cargo of Forties with a bill of lading (b/l) of 23 July 2014⁹ (and stores it for resale on 12 December 2014). The buy price is the average for Dated Brent over the week from 21 to 25 July, the cost of the storage is equal to \$2/bbl and the sell price is the average over the month of December for Dated Brent.

The storage cost generally involves:

1. The physical cost to store the crude and rent the tank.
2. The financial cost of paying for the crude oil cargo in July and reselling it in December.
3. Possible loss of crude oil in storing and loading operations (loss).

For the sake of simplicity, these costs are considered to be linear and equal to 40 cts per month; therefore, the total cost from 23 July to 30 December is \$2/bbl.

⁹A bill of lading is generated by a shipper; it details a shipment of merchandise, gives title to the goods and requires the carrier to deliver the merchandise to the appropriate party.

TABLE 1.10

		COST	PROFIT
Physical		Avg. Dated Brent from 21 to 25 of July	Avg. December 14 of Dated Brent
		Storage Cost – 2 \$/bbl	
Hedge Strategy 1	Dated Brent Swap	80 \$/bbl	Avg. Dated Brent from 21 to 25 of July
Hedge Strategy 2	Dated Brent Swap	Avg. December 14 of Dated Brent	83 \$/bbl
RESULT		1 \$ bbl	

As discussed above, the trader executes an operation in the financial market that guarantees opposite flows of the physical contract. On 25 June, the trader executes the following operations:

1. Buys fixed at \$80/bbl and sells the average for Dated Brent over the week from 21 to 25 July 600 kb.
2. Sells fixed at \$83/bbl and buys the average over the month of December 2014 of Dated Brent for 600 kb.

On the basis of the combined operations above, the trader neutralizes any risk resulting from the fluctuation of prices and locks in a certain result, as indicated in Table 1.10.

In the following example, the market conditions change and the trader is interested in reselling the cargo before December.

Situation. A trader buys, on 25 July 2014, a crude oil cargo b/l 23 July 2014 and stores it for resale on 30 December 2014. The trader has already hedged the cargo but on 25 October 2014 sells it b/l 30 November 2014 because the market conditions are favourable. The buy price is the average month over July for Dated Brent, storage costs equal \$2/bbl and the sell price expected is the average over the month of December for Dated Brent, but the sell price realized is the average over the month of November for Dated Brent + \$1/bbl. In addition, the storage costs are lower, at \$1.60/bbl, because the product is sold one month in advance.

On 25 June the trader executes the following operations:

1. Buys fixed at \$80/bbl and sells the average for Dated Brent over the week from 21 to 25 July for 600 kb.
2. Sells fixed at \$83/bbl and buys the monthly average over the month of December 2014 of Dated Brent for 600 kb.

On 25 October the trader executes the following operations:

1. Sells fixed at \$82.75/bbl and sells the monthly average over the month of November 2014 of Dated Brent for 600 kb.
2. Buys fixed at \$83.5/bbl and buys the monthly average over the month of December 2014 of Dated Brent for 600 kb.

TABLE 1.11

		COST	PROFIT
Physical		Avg. Dated Brent from 21 to 25 July Storage Cost – 1.6 \$/bbl	Avg. December 14 of Dated Brent
Hedge Strategy 1	Dated Brent Swap	80 \$/bbl	Avg. Dated Brent from 21 to 25 July
Hedge Strategy 2	Dated Brent Swap	Avg. December 10 of Dated Brent	83 \$/bbl
Hedge Strategy 3	Dated Brent Swap	Avg. November 14 of Dated Brent	82.75 \$/bbl
Hedge Strategy 4	Dated Brent Swap	83.5 \$/bbl	Avg. December 14 of Dated Brent
RESULT		1.65 \$/bbl	

On the basis of the combined derivative operations, the trader neutralizes any risk resulting from fluctuations in prices and locks in a certain result higher than the \$1/bbl locked in on 25 June. Table 1.11 summarizes the details.

Arbitrage Opportunities: Geographical Arbitrage on Products and Crude Oil The following describes the most important arbitrage possibilities.

Arbitrage is the practice of taking advantage of a price differential between two or more markets by using a combination of physical deals and derivatives. It is a widespread practice in both the trading of financial instruments (especially Forex and international interest rates) and in commodity trading. Such deals take advantage of a particular market situation that presents itself irregularly, in which the commodity markets in a certain area place a higher premium on a commodity than the market in another area. Since a large majority of the risk can be hedged, these deals carry a limited amount of commodity price risk.

Typical major flows of arbitrage on oil-related commodities include the following:

1. Procure gasoil in the United States and move it to/sell it in European markets.
2. Procure crudes in West Africa on a Brent-related price base and sell in US markets at WTI-related prices.
3. Procure middle distillates in the Far East (Japan, Korea) and move them to/sell them in European markets.
4. Procure naphtha or fuel oil in European markets and move them to/sell them in the Middle East or the Far East.

These flows can form, depending on specific circumstances, a significant part of the activities of major oil and trading companies. However, the major flows are changing on the basis of the evolution of the supply and demand of crude oil and products. The following example tries to describe the main problems faced by a trader the moment he or she wants to take advantage of an arbitrage.

The characteristics of arbitrage opportunities are the following.

1. *Limited duration.* Arbitrages, being related to differences in market indices, 'open' and 'close' irregularly, according to the fluctuations of relative markets. Therefore, arbitrage

opportunities require a very rapid approach to lock them in. As an example, the arbitrage between Brent and WTI crudes has exhibited this recent historical trend.

2. *Involvement of multiple factors with different time scales.* A typical commodity arbitrage opportunity involves a physical buy, a physical sale, the structuring of a derivatives hedge/lock-in operation and chartering a ship. All these factors have different time dynamics, as follows:
 - (a) The derivatives operation (1) is essentially instantaneous in terms of execution; (2) can span several months and even exceed one year.
 - (b) Physical deals can require several days to assemble and must be executed within defined time frames before loading or delivering the cargo (a few weeks for crudes, 5 to 15 days for other products).
 - (c) The shipping component can require several days to charter, which is typically done relatively close to the actual date of travel (both in the case of a spot charter and in the case of dispatching a controlled ship, since scheduling is done as close as possible to the actual travel dates). Shipping operations, to an extent, may also be covered with derivatives (through freight forward agreements, or FFAs).

To understand better the hedging scheme connected with arbitrage strategies, we analyse the following:

1. The variables that concur with the result of the strategy.
2. The opportunities of a physical trader who is in charge of selling a cargo of West African Crude oil.
3. The possible result.

In fact, a trader must consider many different variables to implement an arbitrage, as indicated here:

1. ΔWTI = physical differential at which the physical trader sells the cargo in the United States.
2. ΔFOB = physical differential at which the physical trader buys or sells the cargo.
3. Freight = cost of the vessel to deliver the crude oil.
4. Other cost = lightening, loss, etc.
5. Financial cost = cost of the holding storage and FX hedging.
6. Paper result t_0 = for example, the differential at t_0 between Dated Brent and WTI.

For the sake of clarity, a strategy connected with the different geographical benchmarks (i.e., WTI and Dated Brent) is considered here. All other costs are defined just as transportation costs.

Situation. A trader buys, on 25 June 2014, a crude oil cargo of 1000 kb b/l 30 July 2014. The buy price is the average over the month of July for Dated Brent + \$1/bbl (ΔFOB). The trader can choose one of the following strategies:

1. Sell the cargo FOB at the Dated Brent average for July + ΔFOB .
2. Buy the cargo FOB on a Dated Brent basis and sell it delivered to the United States on a WTI basis.

TABLE 1.12

	COST	PROFIT
Physical	Avg. July 14 of Dated Brent + 1 \$/bbl	
Physical		Avg. July 14 of Dated Brent + 1.5 \$/bbl
RESULT		0.5 \$/bbl

In the first case the trader makes a profit if the buy price is lower than the sell price. There is no risk in this operation which could be eliminated with derivatives. The trader knows the quality of his or her own cargo and the demand of the market for that specific crude oil, but there are no derivatives to hedge the physical differentials of the different types of crude oil.

In the second case, the trader obtains a profit if the following holds:

$$(\text{Paper result } t_0) - \text{Transportation cost} + \Delta\text{WTI} - \Delta\text{FOB}_1 > \Delta\text{FOB}_1 - \Delta\text{FOB}_2$$

Situation. A trader buys, on 25 June 2014, a crude oil cargo of 1000 kb b/l 30 July 2014. The buy price is the average month of July for Dated Brent + \$1/bbl (ΔFOB). The trader can choose one of the following strategies:

1. Sell the cargo at the Dated Brent average for July + \$1.5/bbl (ΔFOB).
2. Sell the cargo in the United States at the price of the NYMEX October WTI of 20 August 2014.

In the first case the trader can lock in a certain margin of \$0.5/bbl, as indicated in Table 1.12.

In the following case the trader decides that it is more profitable to deliver the cargo in the United States. Therefore, the trader implements the following trading strategies:

1. Buys fixed at \$80/bbl and sells the monthly average over the month of July 2014 of the Dated Brent for 1000 kb.
2. Sells 1000 lots of NYMEX October futures at \$84/bbl.
3. Buys 1000 lots of NYMEX October futures at the 20 August 2014 settlement price.
4. Fixes the cost to deliver the crude oil cargo in the United States at \$2/bbl.
5. The physical differential at which the physical trader sells the cargo in the United States (ΔWTI) is 10 cts/bbl.

The result of this strategy is \$1.1/bbl, which is higher than the 50 cts/bbl obtainable by reselling the crude oil cargo in the area. The results are summarized in Table 1.13.

1.3.5.3 Product Strategy

Hedging a Physical ULSD Cargo *Situation.* A trader buys, on 15 May 2014, a cargo of ULSD 10 ppm of 31.5 kt from a refinery in Italy. The buy price is the average for June 2014 of ULSD 10 ppm CIF MED. The sell price of the cargo is \$935/MT.

Strategy. The trader expects an increase in prices and decides to enter into two swap transactions of 31.5 kt each and fixes the price of the ICE gasoil swap (i.e., at \$900/bbl) and

TABLE 1.13

		COST	PROFIT
Physical		Avg. July 1 of Dated Brent + 1 \$/bbl	
Physical		Transportation Cost 2 \$/bbl	NYMEX October WTI 20/08/2010 + 0.1 \$/bbl
Hedge Strategy 1	Dated Brent Swap	80 \$/bbl	Avg. Dated Brent of July
Hedge Strategy 2	NYMEX Future	1000 lots of NYMEX October WTI @ 20/08/2010	1000 lots of NYMEX October WTI @ 84
RESULT			1.1 \$/bbl

the ULSD 10 ppm CIF MED differential (i.e., at \$30/MT). In this way the trader locks in a margin against his or her physical operation, as indicated in Table 1.14.

However, the trader can hedge the risk by using a portfolio combination of swaps and futures. According to the equations introduced earlier, the trader knows that

$$10 \text{ ppm CIF MED swap}_{t1} = \text{ICE gasoil swap}_{t1} + 10 \text{ ppm CIF MED differential}_{t1}$$

$$\text{ICE gasoil swap}_{t1} = (\text{ICE gasoil future}_{t1} \times g1 + \text{ICE gasoil future}_{t2} \times g2) / G$$

Strategy. The ICE June swap is calculated according to the above equation, yielding

$$\text{ICE swap June 14} = (\text{ICE gasoil future June 14} \times 8 + \text{ICE gasoil future July 14} \times 13) / 21$$

Therefore, the ICE June swap is comprised of:

1. 120 lots of ICE gasoil June.
2. 195 lots of ICE gasoil July.

For this reason the trader buys 120 lots of ICE gasoil June (i.e., at \$902.25/MT) and buys 195 lots of ICE gasoil July (i.e., at \$898.75/MT) for an average buy price of the swap of \$900/MT:

$$\begin{aligned} \text{June 10 ppm CIF MED swap} &= \text{June ICE gasoil swap} \\ &+ 10 \text{ ppm CIF MED differential June swap} \end{aligned}$$

TABLE 1.14

		COST	PROFIT
Physical		Avg. June of 14 ppm CIF MED	935 \$/bbl
Hedge	Average 10 ppm CIF MED differential	900 \$/mt Avg. June 14 of ICE Gasoil	Avg. June 14 of ICE Gasoil Avg. June of 14 ppm CIF MED
RESULT		30 \$/mt	5 \$/mt

TABLE 1.15

		COST	PROFIT
Physical		Avg. June of 10 ppm CIF MED	935 \$/bbl
Hedge	Future June	120 lots @ 902.25 \$/mt	
	Future July	195 lots @ 898.75 \$/mt	
	Average	900 \$/mt	?
	10 ppm CIF MED differential	Avg. June of ICE Gasoil	
		30 \$/mt	Avg. June of 10 ppm CIF MED
RESULT		5 \$/mt	

Therefore, the trader buys a fixed swap on June 10 ppm CIF MED differential swap at the price of \$30/MT. The portfolio gives the trader the risk profile indicated in Table 1.15. Without any further action, the trader runs the risk that the average June settlement price of ICE gasoil will be lower than \$900/MT.

Therefore, during June the trader will sell 15 lots per day at the ICE gasoil settlement price, following the programme indicated in Table 1.16. By selling every day 1/21 of the total

TABLE 1.16

Trade Date	Lots	Expiry Date
02/06/2014	15	June14
03/06/2014	15	June14
04/06/2014	15	June14
05/06/2015	15	June14
06/06/2014	15	June14
09/06/2014	15	June14
10/06/2014	15	June14
11/06/2014	15	July14
12/06/2014	15	July14
13/06/2014	15	July14
16/06/2014	15	July14
17/06/2014	15	July14
18/06/2014	15	July14
19/06/2014	15	July14
20/06/2014	15	July14
23/06/2014	15	July14
24/06/2014	15	July14
25/06/2014	15	July14
26/06/2014	15	July14
27/06/2014	15	July14
30/06/2014	15	July14
Total Lots	315	

TABLE 1.17

		COST	PROFIT
Physical		Avg. June 14 of 10 ppm CIF MED	935 \$/bbl
Hedge	Future June	120 lots @ 902.25 \$/mt	
	Future July	195 lots @ 898.75 \$/mt	
	Average	900 \$/mt	Avg. June of ICE Gasoil
	10 ppm CIF MED differential	Avg. June 14 of ICE Gasoil	
		30 \$/mt	Avg. June of 10 ppm CIF MED
RESULT		5 \$/mt	

31,500 metric tonnes, the trader will be able to replicate the average of June's ICE gasoil settlement prices.

With this selling strategy, the average sell prices of the futures are equivalent to the monthly average over June of the ICE gasoil price. The result of this strategy is exactly the same as that presented above, shown here in Table 1.17. For the sake of simplicity, the costs related to the futures execution are not considered and it is further assumed that there are no bids or offers for swaps.

Product Storage or Contango Capture As we have already seen in the crude oil section, the most common practices are land storage or floating storage. For the sake of simplicity, the following identifies both land storage and floating storage as simply storage.

Below is an example of typical storage activity for a cargo of diesel.

Situation. A trader buys, on 25 June 2014, a diesel cargo with b/l 23 July 2014 and stores it for resale on 30 December 2014. The buy price is the average for 10 ppm CIF MED over July, the cost of storage is equal to \$5/MT and the sell price is the average over December for 10 ppm CIF MED.

The storage costs generally comprise the following:

1. The physical cost to store the diesel and rent the tank.
2. The financial cost to pay for the diesel oil cargo in July and resell it in December.
3. Possible loss of diesel in storing and loading operations (loss).

For the sake of simplicity, these costs are considered to be linear and equal to \$2 per month; therefore, the total costs from 23 July to 30 December are \$10/MT.

As discussed above, the trader executes an operation in the financial market that guarantees opposite flows of the physical contract. On 25 June the trader executes the following operations:

1. Buys fixed at \$900/MT and sells the average for 10 ppm CIF MED over July for 33 kt.
2. Sells fixed at \$920/MT and buys the monthly average over December of 10 ppm CIF MED for 33 kt.

TABLE 1.18

		COST	PROFIT
Physical		Avg. July 14 of 10 ppm CIF MED Storage cost – 10 \$/mt	Avg. Dec 14 of 10 ppm CIF MED
Hedge Strategy 1	10 ppm CIF MED	900 \$/mt	Avg. July 14 of 10 ppm CIF MED
Hedge Strategy 2	10 ppm CIF MED	Avg. Dec 14 of 10 ppm CFI MED	920 \$/mt
RESULT		10 \$/mt	

On the basis of the combined operations above, the trader neutralizes any risk resulting from fluctuations of the prices and locks in a certain result, as outlined in Table 1.18.

In the following example, the market conditions change and the trader is interested in reselling the cargo before December.

Situation. A trader buys, on 25 June 2014, a crude oil cargo b/l 23 July 2014 and stores it for resale on 30 December 2014. The trader has already hedged the cargo but on 25 October 2014 sells it b/l 30 November 2014 because the market conditions are favourable. The buy price is the average over July for 10 ppm CIF MED, with storage costs of \$10/MT. The sell price expected is the average over December for 10 ppm CIF MED, but the actual sell price realized is the average over November for 10 ppm CIF MED. In addition, the storage cost is lower, at \$8/MT, because the product is sold one month in advance.

On 25 June the trader executes the following operations:

1. Buys fixed at \$900/MT and sells the average for the 10 ppm CIF MED over July for 33 kt.
2. Sells fixed at \$920/MT and buys the monthly average over December for 10 ppm CIF MED for 33 kt.

On 25 October the trader executes the following operations:

1. Sells fixed at \$920/MT and sells the monthly average over November of 10 ppm CIF MED for 33 kt.
2. Buys fixed at \$915/MT and buys the monthly average over December for 10 ppm CIF MED for 33 kt.

TABLE 1.19

		COST	PROFIT
Physical		Avg. July 14 of 10 ppm CIF MED Storage cost – 8 \$/mt	Avg. Nov 14 of 10 ppm CIF MED
Hedge Strategy 1	10 ppm CIF MED	900 \$/mt	Avg. July 14 of 10 ppm CIF MED
Hedge Strategy 2	10 ppm CIF MED	Avg. Dec 14 of 10 ppm CIF MED	920 \$/mt
Hedge Strategy 3	10 ppm CIF MED	Avg. Nov 14 of 10 ppm CIF MED	920 \$/mt
Hedge Strategy 4	10 ppm CIF MED	915 \$/mt	Avg. Dec 14 of 10 ppm CIF MED
RESULT		17 \$/mt	

On the basis of this combination of derivative operations, the trader neutralizes any risk resulting from fluctuations in the prices and locks in a certain result of \$17/MT higher than the \$10/MT locked in on 25 June. See Table 1.19.

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