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Preface – A Century of Flight

For many centuries, men have dreamed of flight. More than 500 years ago, Leonardo da Vinci imagined machines, which imitated the physics of birds. He drew plans and built models, but none of his creations actually flew. They remain as a reminder of his ingenious imagination. A lot of others tried different approaches thereafter. Most failed and some even paid with their life while trying their flying machines. Inspiration, little knowledge and mainly bravery were the main contributors in the advancement of the science of flight.

December 17, 1903 marked the cornerstone of modern aviation. The Wright Brothers became the first to fly an engine-powered, heavier-than-air machine achieving both controlled and sustained flight. From there on, it took 16 years for the first non-stop flight across the Atlantic¹, and another 28 years for the first man and airplane to break the sound barrier². In the 1930s, the American propeller-driven Douglas DC-3 became the first aircraft that was profitable enough to carry passengers exclusively. Previous fixed-wing aircrafts mainly transported cargo, while airships were the only transport to carry passengers over great distances. In 1949 the first jet airliner, the de Havilland Comet, was build and entered service three years later. Sud Aviation, Tupolev, Boeing, Douglas and Convair followed shortly with their own jets. The year 1969 saw the first flight of two very distinctive iconic aircrafts. On the one hand, the Concorde³, the only supersonic commercial airliner that ever went into commercial passenger service. It remained in the skies for 27 years. The events of the tragic Concorde crash on July 25, 2000 was only the trigger that led to the retirement of an already ailing Concorde program on November 26, 2003. An uneconomic aircraft simply has no place in a world with rising fuel costs. On the other hand, there was the Boeing 747, at that time the largest ever built passenger airplane carrying up to 400, and

¹ Vickers Vimy flown by British aviators John Alcock and Whitten Brown on June 14-15, 1919.

² Bell XS-1 flown by Captain Charles Yeager on October 14, 1947.

³ The Concorde went into service in 1976.

later even more, people. It remained being the world's largest passenger aircraft for almost 40 years until the maiden flight of the Airbus A380⁴ on April 27, 2005. In the early days of aviation, the challenges aviators faced were more centered on the science of flight, being better and faster were things that mattered most. Today, though science is still important in the ways that it contributes to innovation and new inventions, economics has become the number one challenge in aviation. Inventions have become rather rare and scientists have focused most of their time innovating current technologies as most present aircraft designs are still based on technologies that existed 40 years ago.

⁴ Airbus A380 is certified for up to 853 passengers.

1 Introduction

The booming and glamorous years of the airline industry are long gone and during the last two decades, many airlines have seen more downs than ups. Many legacy airlines have gone bankrupt, merged with other airlines to stay in business or been taken-over. New low-cost airlines have emerged trying a different approach, but not every one of those has been successful.

Increasing world demand is pushing up the cost of fossil fuels, a finite resource our world cannot sustain. As the world's population approaches seven billion people and more players enter the global economy, demand for fuel is growing at an unprecedented rate. Labor costs used to be the largest operating expense for airlines, but constantly increasing oil prices have made fuel the largest cost factor for almost every airline. Controlling costs is the key to survival, but oil prices are out of an airline's control. One of the solutions to this problem is fuel hedging; an investment position intended to offset potential losses.

This paper tries to provide more data on the surrounding factors of the main topic of jet fuel hedging. The first part will look at the aviation and oil industry. An analysis about the oil market will give an insight to factors that influence oil prices. The main part will describe the basics of financial hedging instruments and how airlines can utilize them to protect against volatile oil prices. Finally, Southwest Airlines is used as an example to illustrate fuel hedging in the real world.

If not stated otherwise, the data provided in this paper will focus on the aviation industry in the United States.

2 The Aviation Industry

The aviation industry is one of the largest and still growing industries. In today's increasingly globalized world air travel is the driving force not only for tourism, but also economic growth, world trade and for international investment. There are over 2000 airlines worldwide operating more than 23,000 aircraft. Over the past 30 years, world air travel has grown on average around 5% a year. About 56 million jobs worldwide are supported by the aviation industry, which with gross domestic product of around US\$2.2 trillion is a big part of the world economy. Air transport goes beyond tourism and trade. It enables markets to interconnect and is critical to modern businesses with globalized supply chains.

The industry is growing and it is growing fast. New airplanes are making air travel more affordable and convenient to travel further to new destinations. The rapid growth of international trade and investment has greatly contributed to the growth of air travel. Fast growing countries like China and India are experiencing booms in the air travel sector due to rising prosperity. In addition to these expanding countries, more and more low-cost carriers are emerging around the world. Traditional legacy carriers are compelled to replace older less capable and less efficient airplanes due to rising fuel costs. Boeing forecasts the delivery of 33,500 new airplanes with a value of US\$4.0 trillion and an addition of 460,000 pilots and 650,000 maintenance technicians, until the year 2030 and Boeing's projections has always tended to be more conservative.

Global events, such as regional political turmoil, natural disasters and debt crises are repeatedly affecting the global economic. Nevertheless, the aviation industry has proven in the past that it has the resilience to manage and maintain profitability. What the industry fears the most is the threat from persistent high and volatile oil prices.

2.1 Deregulation

The historic development of the aviation industry can be roughly separated into two time periods, prior to and after deregulation. The United States was the first country to go this way in 1978 and the European Union followed much later in 1997. Deregulation allowed airlines to offer services within another country's domestic market. Bilateral "Open Skies Agreements" allow for even further liberalization of rules and regulations between two nations. These agreements would allow both sides to launch commercial flights from each other country's airports.

Today, most U.S. domestic airlines have undergone cost restructuring in order to survive in a new low cost and low fare environment. Competition is fierce and it has brought down many airlines. Despite some country's nationalist sentiments toward its flag carriers, many have formed alliances and partnerships ranging from marketing agreements, code sharing to franchises and equity transfers. These kinds of team play allow airlines to access more customers by linking their networks together. However, Airlines still need to keep their expenditures low and constantly improve their products in order to survive.

2.1.1 United States

Since the end of World War II in 1945, the commercial aviation industry in the United States has grown dramatically. While in 1945, major airlines only flew 3.3 billion revenue passenger miles⁵, by the time of deregulation in the 1970s the number had already increased to 130 billion revenue passenger miles. A decade later revenue passenger miles tripled. In 1996, the United States alone accounted for 33% of global revenue passenger miles.

Competition was low and airlines were virtually protected by the government. However, heavy regulation throughout the system was the price to pay. The

⁵ Revenue passenger mile or kilometer is a transportation industry metric that illustrates the total number of miles traveled by paying passengers. It is calculated by multiplying the distance traveled by the number of paying passengers.

situation for the aviation industry in the United States was quite unique, in that there was no other industry of comparable size that was subject to this extent of regulation. At that time, the Federal Civil Aeronautics Board (CAB) was in control over all domestic air transport. Routes were considered public utility and so the CAB set all fares, routes and schedules. The CAB also controlled the market entry of new airlines.

Then, in 1976, congress passed a new law that would dismantle regulation and allow a free market system to form. The “Airline Deregulation Act” changed a lot in the airline business. Airlines were no longer protected from competition and found themselves in a much more high-stakes environment where bigger profits could as well be achieved. Fares became cheaper and more affordable than ever before, and airlines expanded beyond their existing networks with new routes and services. Many new start-ups seized the opportunity, entered the new free market, caused immense competition leading to even lower prices, and increased passenger volume. Legacy carriers had no choice but to respond with aggressive price tactics and additional capacity to maintain their route domination. However, without government protection many airlines started to struggle with their business. Airliners were faced not only increased competition, but also labor conflicts, declining unit revenues, highly volatile and increasing fuel-prices.

With the lowered barriers of deregulation, a new major development entered the airline industry, the low-cost airline. The first one in the United States to provide no-frills flights at lower prices was Southwest Airlines, which started their business in 1971. Southwest Airlines proved that the low-cost business model could be successful and it still is today. Even legacy carriers introduced no-frills divisions in order to compete, but most of these airline subdivisions proved to be very short lived and sometimes even a financial burden. Low-cost airlines benefit from simpler operations having lower operating and overhead costs. Legacy airlines, being outperformed in terms of profit and operating margins by various low-cost carriers, have since been seriously troubled by the low-cost competition.

The biggest winner in the end was the air passengers. Air travel demand soared in the coming decades because of declining ticket prices and increasing point-to-point flights. By the 1980s, almost 50% of all flights globally were flown within the United States only.

2.1.2 Europe

On the other side of the big pond, deregulation occurred much later in the 1990s, but had similar effects. Only after 1992, European airlines were allowed for the first time to offer scheduled services between other EU countries. However, this new freedom was only in effect within the EU. EU airlines operating within the borders of the United States and vice versa was still not allowed. Then, in 1996, the United States and the United Kingdom began negotiating “Open Skies” agreements between the two countries. Even though other countries followed and signed the Open Skies or other bilateral agreements, as of now the skies are still not entirely open.

European legacy carriers were also not spared from low-cost competition, most notably Ryanair and Easyjet. They have been expanding aggressively due to their cost advantages. This trend has dramatically reduced passenger revenues in the European domestic markets and has negatively affected the standards of airline service. In both North America and Europe, it has become much more difficult to make reasonable profits.

2.1.3 Asia-Pacific

The deregulation movement has reached in the Asia-Pacific region occurred even later. Nonetheless, deregulation is in full progress. It has allowed carriers to find new ways to expand beyond their own borders to satisfy increasing demand. Low-cost airlines are also emerging offering services to new markets at lower fares. Many legacy carriers have formed their own low-cost subdivisions under a new brand in order to compete alongside this trend. There is strong evidence that Asian airlines are going to grow even more rapidly in the near future.

Two events in the last two decade have greatly shaped this region, the Asian financial crisis in 1997/1998 and the SARS outbreak in 2002/2003. The financial crisis was felt by the majority of airlines in the region. In contrast, Airlines from the rest of the world were more of less unaffected. The Association of Asia Pacific Airlines (AAPA) reported a total loss of US\$1.21 billion of all 18 member airlines in 1997 and 1998. On the bright side, Asian carriers recovered remarkably fast from

the financial crisis. Only two years later all but two member airlines, namely Malaysia Airlines and Royal Brunei Airlines, have started to make profits again and brought in a total profit of US\$1.88 billion. The outbreak of SARS in Hong Kong was an event on a different scale. During the epidemic, Cathay Pacific, flag carrier of Hong Kong, lost a staggering US\$3 million a day. Within a month, it has lost almost 70% of its passengers.

2.1.4 Low-Cost Airlines

Low-cost airline or carrier are airlines that offer flights at generally lower fares. They usually operate a single type of aircraft with a single class configuration to reduce operating and maintenance costs. The lost revenue from cheap ticket fares is made up by charging for extras like food, baggage, priority boarding or preferred seating. Low-cost airlines have expanded across all regions of the world. While many legacy carriers still struggle with profits and declining demand, low-cost carriers have found a way to earn more profits.

Low-cost airlines are not a new development. They have existed for over 40 years now. Southwest Airlines has pioneered the idea of no-frills services and that with great success. Today, it remains being one of the most successful and the largest low-cost airline in the world.

2.2 Oil Crises

The 1980s were great for airlines, air travel was booming and passenger numbers were skyrocketing. Then, in 1989, things changed and passenger numbers tumbled for the first time in U.S. aviation history. The Gulf War and the global economic recession severely damaged the aviation industry and caused billions of lost dollars. From 1990 to 1994, world airlines accumulated a total net loss of US\$20.4 billion. Iconic American airlines like Pan American became insolvent and vanished, others like Continental Airlines and TWA went into government backed

Chapter 11⁶ bankruptcy protection as a last resort. On the other side of the Atlantic, European airlines were also struggling. During this time, the European Union had to subsidize several European airlines to help them overcome the crisis. Olympic Airways, TAP Air Portugal, Iberia, Air France und Air Lingus were altogether granted \$8.94 billion in bailout money between the years 1992 and 1997. Three of them were successfully privatized, while TAP and Olympic were still fighting with major losses. Asian airlines were the least impacted by the Gulf War.

The United States is a very large country with a huge population with a corresponding large airline industry, and as such, it has always had an immense demand for oil. Consequently, it is easy to understand that when an oil crisis occurs the country is hit hard every single time. Events like the 1967 Oil Embargo⁷, the 1973 Oil Crisis⁸, the 1979 Second Oil Crisis⁹ and the 1990 Oil Price Shock¹⁰, and finally the 2000s Energy Crisis¹¹, are all linked to recessions with soaring oil prices that followed afterwards. Fortunately, the last oil price shock lasted for only nine months and was less extreme than previous incidences.

After a quick recovery, the 1990s became the longest period of economic growth in U.S. history. The oil price dropped from a peak price of US\$46 per barrel to lower much more moderate prices. The average price for a barrel in the 1990s was only US\$23.73.

As a natural response to the economic growth of the 1990s demand for oil also increased dramatically. Between 1995 and 2000 airlines all over the world accumulated almost US\$40 billion in net profits. However, many airlines were still operating a large number of older aircraft types. They were very inefficient and

⁶ Chapter 11 is a chapter in the United States Bankruptcy Code that allows business (sole proprietorship or corporation) to reorganize while in debt.

⁷ 1967 Oil Embargo began in June 6, 1967 and was a direct protest against countries like the United States and the United Kingdom that supported the Israel military in the Six-Day War (Third Arab-Israeli War).

⁸ Oil embargo by the Organization of Arab Petroleum Exporting Countries (OAPEC consisting of Arab OPEC members, Egypt, Syria and Tunisia) in response to U.S. support for Israel in the Yom Kippur War (Fourth Arab-Israeli War).

⁹ During the Iranian Revolution oil exports were severely disrupted. Despite production increases by Saudi Arabia and other OPEC nations, a widespread panic in the U.S. resulted in a boycott of Iranian imports under President Jimmy Carter which drove prices far higher than expected.

¹⁰ The Iraqi invasion of Kuwait on August 2, 1990 caused another spike in the oil price, but compared to previous incidences, this crisis only lasted for nine months due to the United States military's rapid intervention.

¹¹ The 2000s energy crisis was mainly caused by high demand in conjunction with low supply, financial speculators artificially inflating the oil market and devaluation of the U.S. Dollar.

costly to operate, but now airlines had the money to sell those aircrafts and buy newer more advanced and more fuel efficient aircraft types such as the at that time newly developed twin-engine 777 from Boeing.

However, after a record low of \$10.82 per barrel (WTI Crude Oil) in December 1998, fuel prices began to rise again and in 2000, the economic upswing began to recede again. Even though the oil price has naturally increased over the decades, its development has never been very constant. This is a major cause for losses in airline operational profits. Many airlines were only able to maintain their overall profits by selling older aircrafts and investing in other branches like information technologies and telecommunications.

2.3 Terrorism

On Tuesday morning, September 11, 2001 airplanes hijacked by members of Al-Qaeda hit the World Trade Center in New York and the Pentagon in Washington. The economy was abruptly brought to a standstill. Trading at the New York Stock Exchange was stopped. For the first time in American history all flights over U.S. airspace were grounded for a total of four days. During these days and the following months, airlines incurred huge losses. Only eleven days after the terrorist attack, on September 22, 2001, United States Congress passed a new law in response to the situation. The “Air Transportation Safety and System Stabilization Act” was quickly passed to help the already troubled airline industry. Major airlines such as United, Delta Air Line, Northwest Airlines and US Airways had entered bankruptcy protection. In total US\$30 billion were lost within five years. In addition, over US\$15 billion in wages were cut and 100.000 employees were laid-off. The United States Congress authorized US\$4.6 billion, basically taxpayer’s money, to over 400 U.S. airlines. Almost US\$10 billion were provided as loan guarantees. In order to get to the money, airlines had to go through rigorous yearlong reviews conducted by the Department of Transportation and the Government Accountability Office. The received payments were subject to income tax, but none had to be paid back.

The majority of people see the events of 9/11 as the main trigger for the recession that followed afterwards. However, some market analysts believe that any kind of sudden and substantial increase in the price of oil, such as the 1999 spike, would lead to an economic downturn approximately 18 months later. Therefore, even if 9/11 never had happened a recession, probably a rather short one, would have come nonetheless. Another theory suggests that a recession without 9/11 could have been completely avoided despite other economic failures such as the collapse of the speculative dot-com bubble and many other failed business investments.

During the year 2000, the WTI crude oil price pretty much varied between US\$25-US\$36 per barrel. After 9/11, prices began to fall for a few months due to reduced demand, but soon reached former levels again. Three years later, oil prices started moving upwards again. It was not until the oil price hit a record-breaking US\$145 per barrel in July 2008, when the price started to fall again.

3 Crude Oil

Crude oil is a naturally available, but non-renewable flammable fossil fuel. It contains a variety of elements like carbon, hydrogen and sulfur, which originate from remains of animals and plants that lived millions of years ago. Crude oil can now be found in geological formations beneath the Earth's surface. In its purest form, crude oil has no practical function. Crude oil has to be refined into gasoline, diesel fuel, kerosene, and other products in order to be usable.

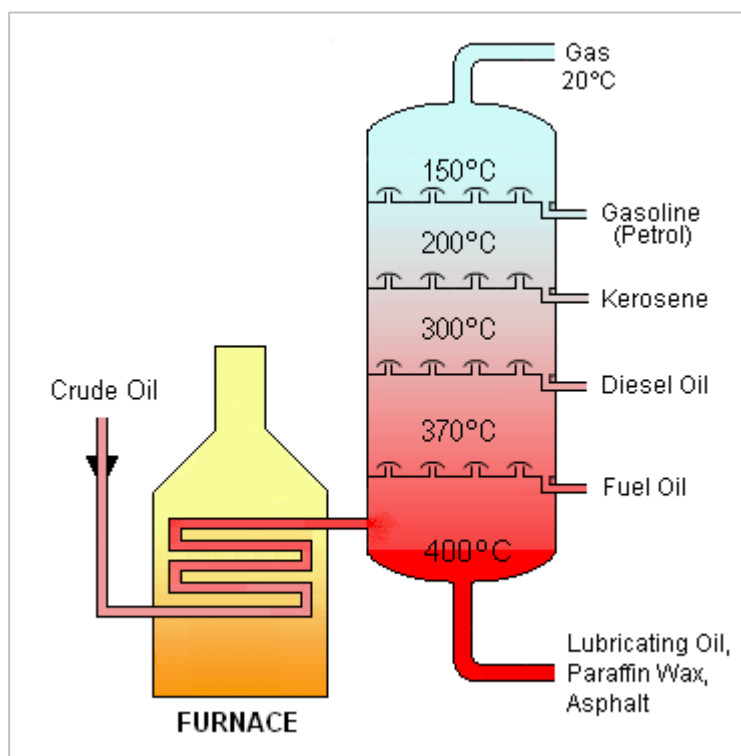
Finding new oil reservoirs is extremely difficult and very expensive. Geologists employed by oil companies, also called petroleum geologists, first perform seismic surveys to pinpoint any underground oil or gas deposits. Engineers then have to drill a hole into the earth to reach the crude oil using a rotary drilling rig. In 2006, the average cost for drilling oil within the United States was around US\$13.38/BOE¹²¹³ and US\$49.54/BOE for offshore developments. Onshore drilling costs have risen alongside oil prices. In 2000, the construction cost for an oil well was around US\$590.000. Nowadays, one single oil well costs roughly US\$4 million. After completing a well, the oil is forced to the surface by either natural drive (water, gas or gravity) or artificial lifts (pumps and gas injection). This is also called the production stage. Each of the recovery mechanisms can only recover a fraction, according to statistics about 25% to 95%, of the entire reservoir. In order to recover everything, more enhanced recovery techniques need to be applied. These are very costly and are only considered if the amounts of oil it will lift justify the expenses. Lifting costs in 2007 were about US\$11.25/BOE. The oil is then transported to its designated refinery via pipelines on land or using tankers across water. Pipelines are the most efficient way to transport crude oil or refined products from A to B.

¹² barrels of oil equivalent

¹³ (U.S. Energy Information Administration (EIA) n.d.)

Once at the refinery the crude oil runs through various complicated processes including physical separations and chemical reaction in order to obtain different products using. Essentially, crude oil is boiled in a furnace. The crude oil separates according to different boiling points and sets on different levels inside the distillation unit. The main products that can be acquired through this process are gas liquids, gasoline, heating oil, diesel fuel, and kerosene, residual fuel oil and asphalt.

Figure 3.1 Oil distillation



Source: (Wikipedia 2012)

These are also classified as top, middle and bottom of the barrel products according to their setting level. The middle of the barrel products like heating oil, diesel fuel and kerosene all share similar characteristics to jet fuel. Their prices are highly correlated and are therefore most commonly used by airlines in fuel hedging. Crude oil is usually sold and traded in barrels, whereas refined products are most commonly priced in US gallons. One barrel of crude oil equals to 42 US gallons or 159 liters. The most common refined products are fuels. Utilizing additional complex chemical processes, oil refiners can obtain more products like wax, sulfur, lubricants or alkenes. Currently, there are over 2000 specified end products.

3.1 Crude Oil Benchmarks

Crude oil is classified by the geographic location where it is found and produced, its density, also known as “API gravity”, and its sulfur content. There are primarily two types of crude oil which themselves again feature two different opposing

characteristics. First, there is light crude oil, which is low in density, and then there is heavy crude oil, which is high in density. The amount of sulfur defines the second characteristic, “sweet” if it contains little and “sour” if it contains a lot. Each drilling location has its own particular characteristics and therefore demands a different price for its oil. Because of the variety of grades and drilling locations all over the world, benchmarks are used to facilitate oil trading. Benchmarks are also known as oil markers and blends, and there are currently about 161 different ones. Notable blends used for pricing references throughout the world are for example West Texas Intermediate (WTI), Brent Blend, Dubai-Oman, OPEC¹⁴ Reference Basket, Tapis, Minas and Midway Sunset Heavy. Transportation costs from the drilling location to the refinery add to the spread between these blends.

3.1.1 West Texas Intermediate (WTI)

West Texas Intermediate is also known as Texas light sweet because of its relatively low density and low sulfur content. It is lighter and sweeter than Brent. For these reasons, it is ideal for producing gasoline and diesel fuel. WTI’s crude oil is pumped up from oil fields within the United States, mostly in the Midwest and Gulf Coast region. The oil is transported to the city of Cushing, Oklahoma via pipelines and stored there. Cushing is the main hub for WTI pricing. Expiring oil contracts at the New York Mercantile Exchange (NYMEX) are settled and delivered there.

3.1.2 Brent Blend

Brent crude oil is a light crude oil and is sourced from the Brent oil field in the North Sea. However, due to the depletion of the Brent oil field, other oil fields named Forties, Oseberg and Ekofisk (BFOE) were later added to form the current oil marker. The quality is a little bit less than WTI, but it is still a high quality crude oil. It is mostly refined in Northwest Europe and serves as the main benchmark for

¹⁴ Organization of Petroleum Exporting Countries

petroleum and middle distillates in continental Europe, Africa and the Middle East. Two thirds of globally traded crude oil is priced using Brent. Since 2005, Brent has been traded on the electronic Intercontinental Exchange (ICE). Just as many other oil contracts Brent crude (LCO) is quoted in U.S. dollars at 1000 barrels per contract.

The Brent oil field was first explored by Shell UK Exploration on behalf of Exxon Mobil and Royal Dutch Shell. Shell originally named all of its oil fields after birds and in this case, the area was named after the Brent Goose.

3.1.3 Dubai-Oman

Dubai-Oman consists of, as the name suggests, two crude oils. On the one hand, Dubai Crude is a light sour crude oil produced in the United Arab Emirates. Its only refinery is situated in Jebel Ali, a port town situated 35 kilometers southwest of the city of Dubai. All of the Dubai's oil is exported to other countries. Omani Crude, on the other hand, is produced in the Sultanate of Oman, which is bordering the United Arab Emirates. In July 2007, the Dubai Mercantile Exchange (DME) was established to provide a new crude oil pricing benchmark using Omani crude for exports to the Asian market. Oman Crude Oil Futures Contracts (OQD) is offered at the exchange. The quality and geographical location has helped the Omani crude oil to become the new benchmark price for the Asian continent. Omani crude oil is not subject to any OPEC export destination restrictions, production quotas and cuts.

3.1.4 OPEC Reference Basket

The OPEC Reference Basket is a weighted average of crude oils produced by all oil exporting OPEC countries and consists of Saharan Blend (Algeria), Ecuador, Iran Heavy, Basra Light (Iraq), Kuwait Export, Es Sider (Libya), Bonny Light (Nigeria), Qatar Marine, Arab Light (Saudi Arabia), Murban (United Arab Emirates) and BCF 17 (Venezuela). Unlike Brent and WTI crude oils, the OPEC Reference Basket is a mixture of light and heavy crudes.

3.1.5 West Texas Intermediate vs. Brent

In the United States, WTI crude has always been priced and traded closely to Brent, typically at a premium of a few dollars over the price of Brent. It has been the main benchmark for trading oil not only in the United States, but also globally. However, in recent years, WTI has been losing its appeal to the global market and the spread between the WTI and Brent has widened more and more. The big price differential is a strong market signal of an inefficient market due to paying too much for imported oil from countries like Saudi Arabia, Nigeria and Venezuela. In 2011, WTI's price was finally overtaken by Brent.

The major downside of WTI as a benchmark is its location, which creates logistical problems. The loss in value of WTI is not attributed to a shortage in supply, because capacity is not a problem in the United States. WTI crude oil is piling up in Cushing, Oklahoma, the central delivery hub for NYMEX sweet crude oil futures contracts. Since Cushing is a landlocked hub, it remains an isolated market with only few commercial interconnections to the international markets. Generally, pipelines are the most efficient way to transport large amounts of oil, but the current pipeline network lacks capacity and only connects few areas within the central part of the country. The rest of the country has to be served by using trucks, which is far from economical. Only second to pipelines in terms of efficiency are oil tankers. One oil tanker can carry up to 550,000 metric tons of oil. Importing foreign oil is therefore sometimes cheaper for coastal areas than transporting it from Cushing. Because the United States is the biggest consumer of oil in the world, oil imports are inevitable. To satisfy America's great demand about 45% of foreign oil need to be imported, despite being the world's third largest oil producer and having a decreasing demand for oil. Currently new pipelines are being added to the American oil infrastructure, which will ease the situation and might even lower dependency on foreign oil in the future.

On the other side of the Atlantic, Brent is also dealing with problems of its own. The majority of the North Sea oil fields are depleting. Diminishing production rates are the main reason for Brent's high price. New oil fields are hard to find and drilling is getting more expensive. Brent has also been criticized for being illiquid and not transparent about its price determination process.

3.2 The Oil Market

Crude oil is the number one energy resource used by countries all around the world. Industrialized countries especially heavily rely on the commodity. In the year 2000, total crude oil consumption was 76.7 million barrels.

Table 3.1 Total petroleum consumption (thousand barrels per day)

Countries	2000	2011	population in millions	bbl/year per capita
United States	19.701,08	18.835,47	313,59	22,93
China	4.795,71	8.924,00	1.347,35	1,30
Japan*	5.515,43	4.479,59	127,61	15,78
India*	2.127,44	3.426,00	1.210,19	0,64
Saudi Arabia (OPEC)	1.537,10	2.986,00	27,14	20,67
Brazil	2.166,28	2.793,00	192,38	4,11
Russia	2.578,50	2.725,00	143,10	6,58
Germany*	2.766,75	2.413,84	81,86	12,34
Canada	2.013,91	2.229,28	34,80	21,12
South Korea*	2.135,33	2.227,17	48,58	16,04
Mexico	2.095,93	2.078,35	112,34	6,81
Iran (OPEC)	1.248,32	2.028,00	76,38	5,97
France*	1.999,60	1.824,02	65,35	11,17
United Kingdom	1.765,44	1.602,05	62,26	10,35
Italy*	1.853,77	1.455,48	59,46	11,38

Data: (U.S. Energy Information Administration (EIA) n.d.)

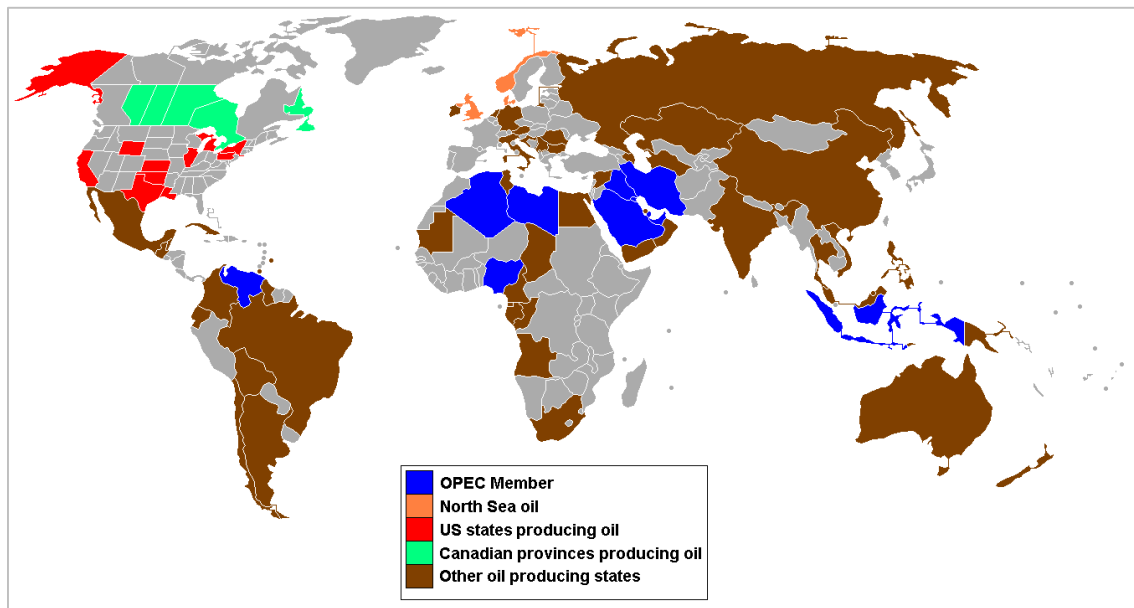
Population data: (Wikipedia 2012)

* Not a major oil producing country

A decade later, this number has risen to 87.3 million barrels a year. The United States, China, Japan and India, though the latter two are not a major oil producer, are the highest oil consuming nations.

Oil can be found all over the world. However, some places have more and some less. Countries in the Middle East, like Saudi Arabia, Iraq, Iran and others, have massive deposits of crude oil underneath their country. These are also the world's leading exporters of oil. The Middle East is not the only region that supplies oil. Russia, Venezuela and the United States also have strong supplies.

Figure 3.2 Oil Producing Countries



Source: (Wikipedia 2012)

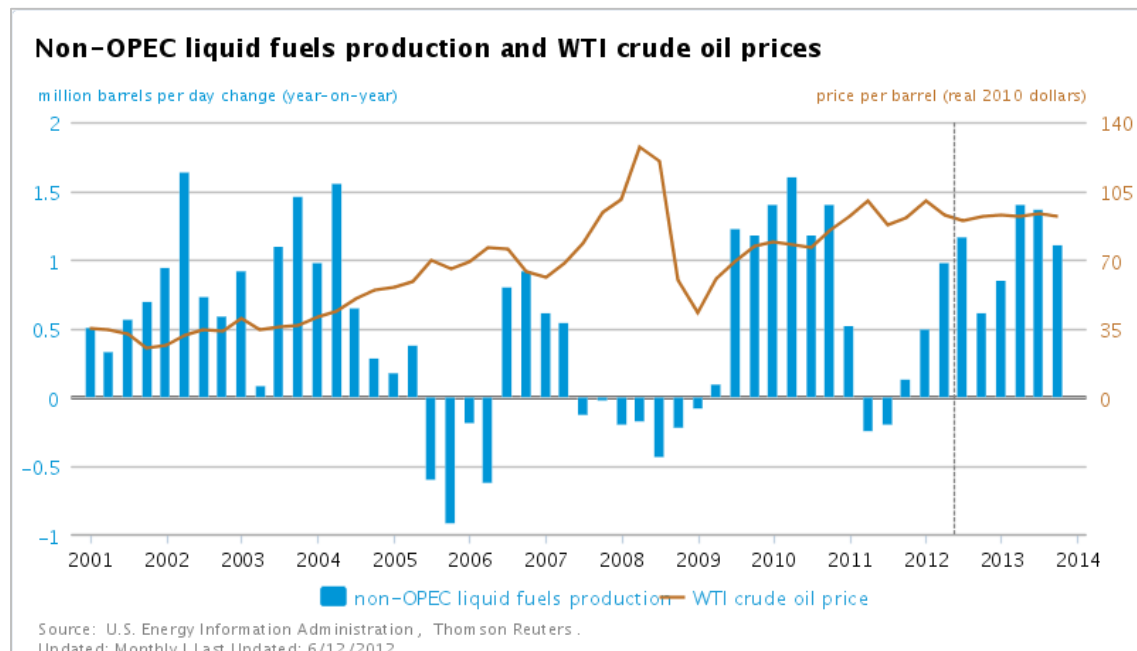
The oil market is a volatile and unpredictable marketplace. In its basic form, it is not unlike other commodity market and still relies on the same principles of supply and demand. However, a growing of financial and energy analysts say that the movements of the oil price can no longer be explained according to the principles of supply and demand. Some point their fingers towards OPEC's manipulative actions, yet others say that the main culprit are speculators.

3.2.1 Non-OPEC Supply

About 60% of world oil supply is produced in North America, regions of the former Soviet Union, the North Sea, and many other countries. These countries are not members of OPEC and are not subject to a central coordination. Oil production is independently controlled by each individual country. Most of, Non-OPEC oil is mostly produced by international or investor-owned oil companies (IOC), whereas OPEC's oil is produced by national oil companies (NOC). IOC's main goal is to increase shareholder value and make economical investment decisions. NOCs tend to have the same goal, but providing employment, infrastructure, or revenue for their nation is often more of a priority. As a result, non-OPEC oil production is

less restricted by governmental decisions and tends to be more responsive to changes in the market. Consequently, NOCs are often regarded as price takers.

Figure 3.3 Non-OPEC oil production compared to WTI crude oil prices



Source: (U.S. Energy Information Administration (EIA) n.d.)

Overall, non-OPEC oil production has a cost disadvantage when compared to OPEC oil production. The reason being that non-OPEC production sites are often situated in areas where finding and production costs are relatively high. This has led to alternatives, like deep-water offshore drilling and pursuing unconventional resources such as oil sands.

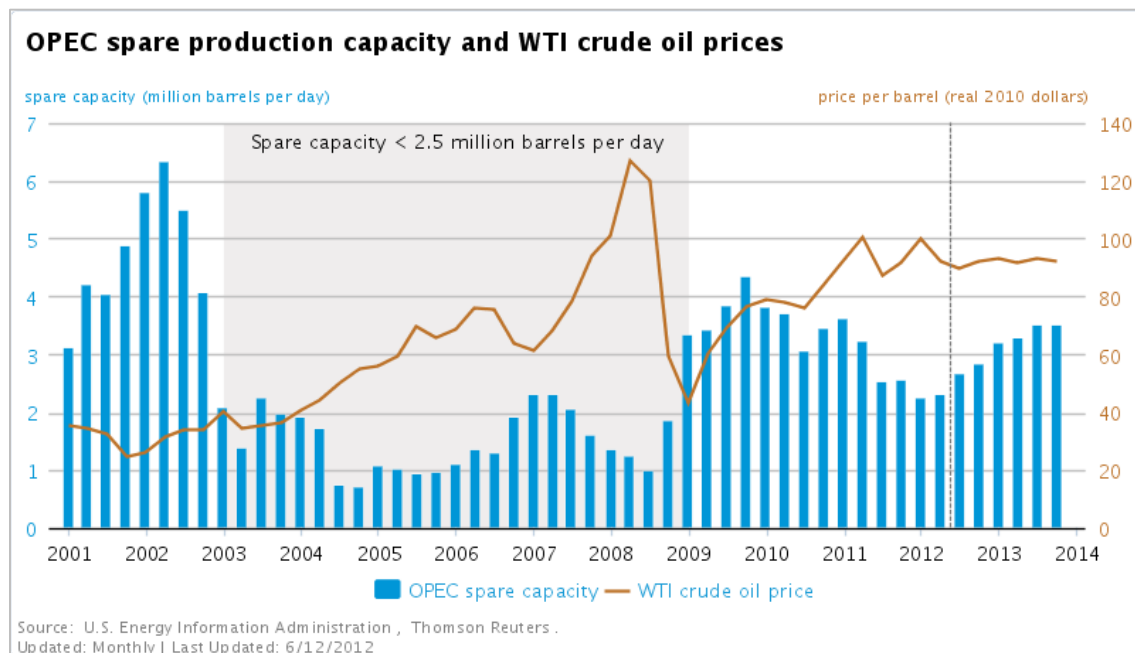
Non-OPEC suppliers produce at full capacity with little to nothing to spare. During times of high demand, NOC's inability to put out more oil when needed will put upward pressure on oil prices as global supply is not able to satisfy demand. In this kind of situation, the world would turn to the OPEC member countries and urge them to produce more oil in order to stabilize oil prices. Unfortunately, OPEC often sees this as an opportunity to manipulate prices for its own interests.

Another factor that can influence oil prices is the expectation about future supply. If oil production is less than expected, or if demand is higher than expected, then prices tend to go up.

3.2.2 OPEC Supply

The Organization of Economic Cooperation and Development currently has 34 member countries, including the United States, most of Europe and other developed countries. OPEC member countries supply 40% of the world's crude oil. OPEC oil represents about 60% of internationally traded crude oil. As a result, OPEC has the power to influence international oil prices.

Figure 3.4 OPEC spare production capacity and WTI crude oil prices



Source: (U.S. Energy Information Administration (EIA) n.d.)

OPEC countries do not produce at full capacity as the organization has imposed output quotas upon its members. The spare production capacity provides an indicator of OPEC's influence of the oil price. A low spare capacity will increase prices, because it will limit OPEC's ability to respond to demand. On the other hand, a high spare capacity suggests that OPEC is holding back oil for price management purposes. Usually, OPEC tries to maintain the oil price at a favorable level, though the individual member countries sometimes do not want to comply with their quotas and produce more in order to make more profit for themselves. This usually happens when oil prices are fairly high, but this behavior can also negatively affect oil prices.

Just like non-OPEC production, changes in expectation about future OPEC supply affect oil prices. The difference though is that OPEC's supply adjustments in response to market conditions are often slower.

3.2.3 Supply and Demand Balance

Inventories are used to balance supply and demand. Oil from overproduction can be stored for future use. When production output is too little, oil from inventories can be used to satisfy demand. Declining inventories are often connected to increasing oil prices. Normally, demand for refined products like heating oil and gasoline vary according to seasonal changes and inventories change accordingly. Historical data from the previous year is often used to better predict demand for the following year. Inventory levels are an important trigger for market expectations of futures contract prices. These tend to increase, when expectations indicate a strong future demand or weak future supply. Thus, producers are encouraged to build up more inventories. On the other hand, when expectations for present production decline or current demand suddenly increases, spot prices tend to increase relative to futures prices and inventories have to be used to fill in the gap. The relationship between prices and inventories can go either way. If futures prices increase relative to the current spot price level, producers will want to store more oil and sell this oil later at the expected higher price. Alternatively, if inventories are filling up indicating that supply surpasses current demand, spot prices will likely adjust downward to rebalance the market. Market participants and commercial companies with a physical interest in oil can use inventory levels as indicators for future trading. Member countries of the Organization of Economic Cooperation and Development (OECD) provide inventory data on a regularly basis. Information on other countries is often not complete, not updated on a regularly basis or not available at all. Moreover, oil is often stored on tankers at sea and with incomplete information, actual inventory levels might differ. This among other factors leads to further uncertainties in the oil market.

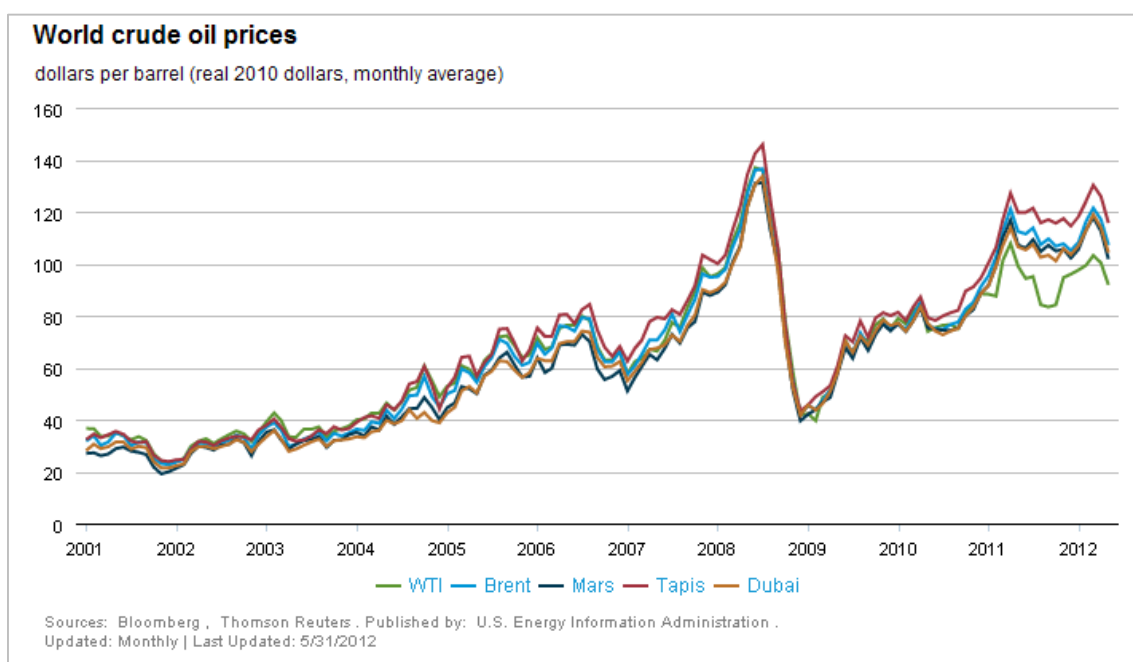
Apart from commercial inventories, countries usually maintain oil reserves for strategic reasons. In the United States, the U.S. Strategic Petroleum Reserve currently has more than 700 million barrels of oil stored, which can be drawn upon

by order of the President. The International Energy Agency holds about 1.6 billion barrels of oil in reserve that is dedicated for eventual emergencies.

3.2.4 Spot Prices

Crude oils from around the world have differences in grade and quality, but because oil markets are integrated globally, prices tend to move closely together.

Figure 3.5 World crude oil prices

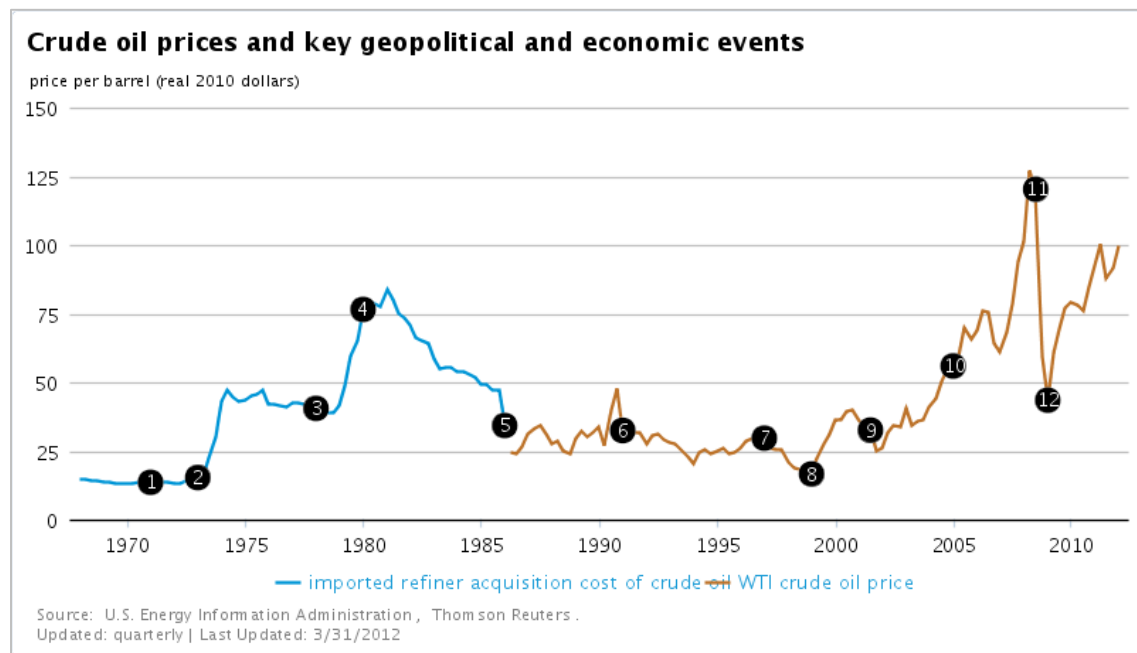


Source: (U.S. Energy Information Administration (EIA) n.d.)

The same goes for refined consumer products, which also have prices that tend to move together with crude oil prices with the exception of some having seasonal variations, product specific factors or production disruptions.

The supply and demand of oil both respond inelastic to price changes. The reason for this lies in our dependency of oil. Oil production capacities and equipment that rely on oil are relatively fixed in the near-term. Furthermore, alternative fuels are still being researched and it will take years until those become mainstream and available to the general public.

Figure 3.6 Crude oil prices and key geopolitical and economic events



- | | |
|---------------------------------------|--|
| 1: US spare capacity exhausted | 7: Asian financial crisis |
| 2: Arab Oil Embargo | 8: OPEC cuts production targets 1.7 mmbpd |
| 3: Iranian Revolution | 9: 9-11 attacks |
| 4: Iran-Iraq War | 10: Low spare capacity |
| 5: Saudis abandon swing producer role | 11: Global financial collapse |
| 6: Iraq invades Kuwait | 12: OPEC cuts production targets 4.2 mmbpd |

Source: (U.S. Energy Information Administration (EIA) n.d.)

Over the past 40 years, geopolitical and economic events throughout the world have had impact on the price of oil. Historically though, the Middle Eastern region has been a hotspot for conflicts and wars over other resources and land. In more recent times however, the interest has shifted toward the region's rich oil resources. Oil gives Middle Eastern nations great influence in world affairs. Saudi Arabia, for example, is by far the biggest oil producer in the world. In 2011, the country produced 35.06% of global crude oil, which translates to a daily output of 15.54 million barrels. And, western economies greatly rely on the vast oil resources in this region. As a result, oil-producing nations in the Middle East can restrict exports whenever they see fit, not uncommonly as an act of retaliation against the United States and its allies.

The Arab Oil Embargo in 1973-74, the Iranian revolution, the Iran-Iraq war in the late 1970s and early 1980s, and Iraq's invasion of Kuwait in 1990 were all events that have triggered major disruptions in the production of oil and have led to record

high oil prices. More recently, supply disruptions from political events have been witnessed in Iraq, Iran, Libya, Nigeria and Venezuela.

Inventories and spare capacities are ways to offset disruptions. If enough spare capacity is available, it is likely that the impact on prices will be less severe. If inventory levels are not sufficient, then both prices and uncertainty will increase.

Weather can also affect the oil production industry. Weather phenomena like hurricanes or extreme cold weather can completely shut down the production line.

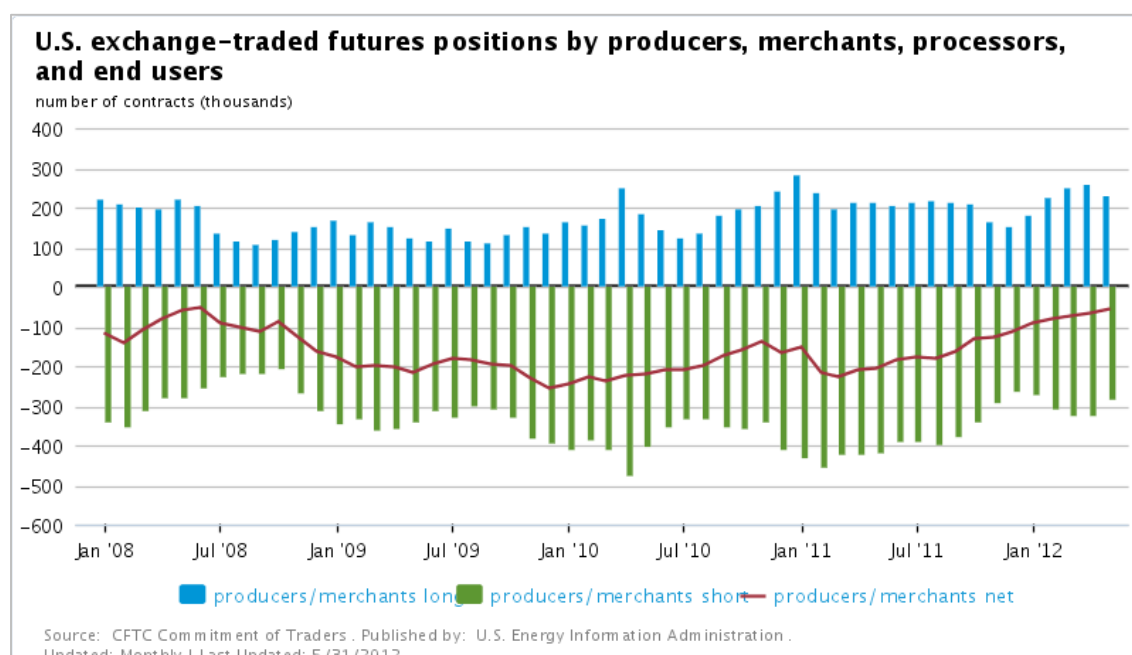
As a result, supply decreases and prices begin to move upwards. However, there is a difference between disruptions from weather-related and political events. Weather-related price spikes tend to be relatively brief with prices returning to previous levels as soon as the problem subsides.

3.2.5 Financial Markets

Financial markets are the place where participants can buy and sell physical quantities of oil. In addition, contracts for future delivery of oil and other energy derivatives are available to trade with as well. These markets are also able to influence the price of oil.

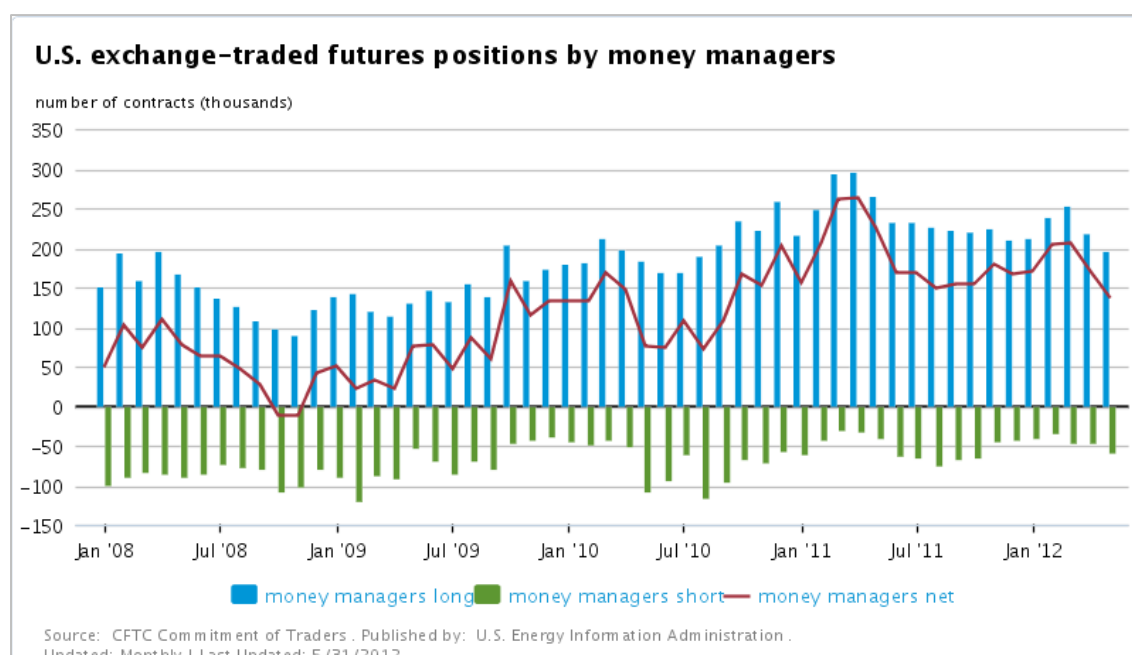
There is a range of different types of traders, with each having a different motivation. On the one hand we have commercial commodity and on the other non-commercial commodity trader. Commercial commodity traders are market participants who have interest in physical oil production, consumption or trade. These are mainly oil producers and airlines. Oil producers can sell futures to lock in a high price for its future output. Airlines can hedge oil price exposures by buying and selling energy derivatives, e.g. buy futures or options to lock in a low price or cap increasing prices for future fuel purchases.

Figure 3.7 Commercial commodity traded futures positions



Source: (U.S. Energy Information Administration (EIA) n.d.)

Figure 3.8 Non-commercial commodity traded futures positions



Source: (U.S. Energy Information Administration (EIA) n.d.)

Non-commercial commodity traders have no interest in physical oil. These traders use energy commodity for investment and diversification purposes. Banks, hedge funds, commodity trading advisors, and other money managers all fall into this category of traders. Energy commodities can be used as alternatives to equity and

bond investments to diversify portfolios or to hedge inflation risks. However, concerns have been raised about non-commercial commodity trading due to its amplifying effect on oil price movements.

According to data provided by the U.S. Energy Information Administration, producers, merchants, processors and end users in the United States usually enter more short positions than long positions, which results in a net short in futures positions on U.S. exchanges. On the contrary, money managers enter more long and less short positions in U.S. exchange-traded futures positions, thus resulting in a net long. Investors who are holding onto long positions expect prices to rise. Many of these investors hold “long only” index funds. They do not trade in the individual commodity on a daily basis, but instead buy index-style positions and hold these over a long period of time, rolling contracts forward to avoid physical delivery. Some market analysts voiced their concern about this kind of trading behavior. They believe that long-only index funds in oil markets have had a significant impact on the development of energy prices. However, no definite evidence has been found over the past few years. The global nature of trading energy-related derivatives makes analyzing trading activity much more intricate.

The correlation between the futures price of crude oil and other commodities like gold, copper, silver, or even soybeans, corn and wheat generally has risen in recent years, especially after the oil price spike in 2008. The same development could be observed with stocks, bonds and exchange rates, whereas prior to 2007 these financial markets only showed sporadic correlations with oil futures prices.

The correlation with financial markets is influenced by financial, physical and economic factors. Financial factors include growing interest in crude oil as an investment opportunity, thereby changing the financial money flow into and out of commodities. Economic factors are for example economic downturn or recovery.

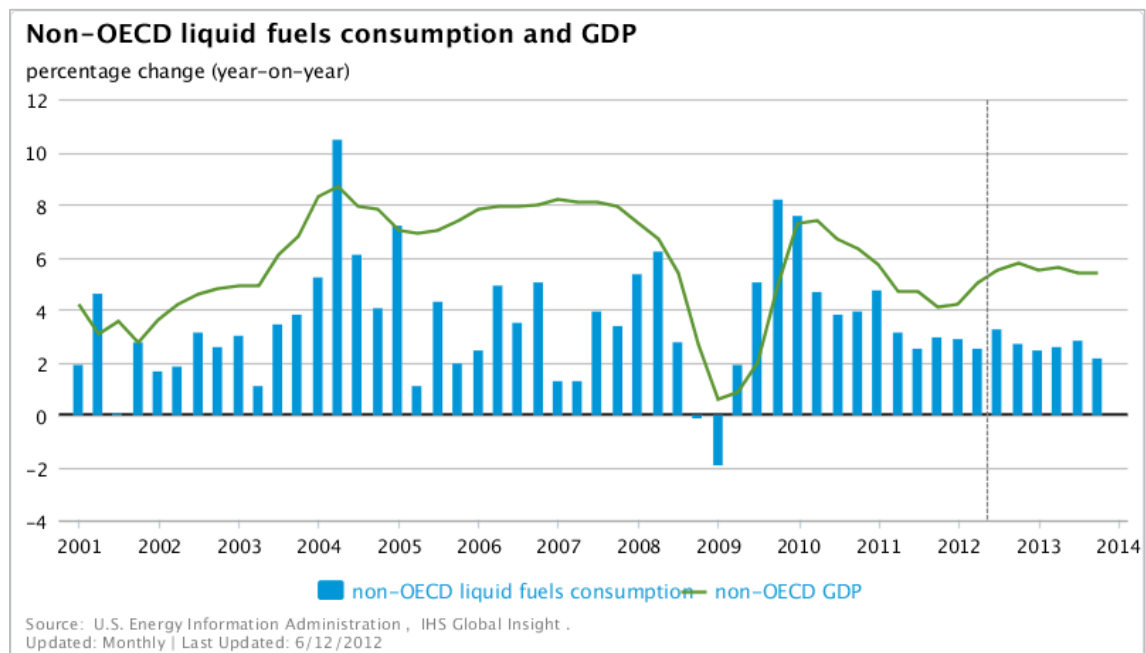
The correlation between oil futures prices and other financial markets have tended to move together, while oil prices have tended to move in the opposite directions of the dollar exchange rate and treasury bonds. Historically, stocks have always been the largest investment market. Economic factors can cause prices of stocks and commodities to move together. If macroeconomic conditions improve, companies earn more money, and demand for commodities rise as a result. Over the past decade, crude oil has exhibited similar risk/return characteristics to stocks. The second largest investment market is bonds. Bonds tend to be less risky and

less volatile with lower average returns. Bond prices and interest rates move in opposite direction, thus bond prices and crude oil prices tend to behave the same way. The exchange value of the U.S. dollar relative to other currencies also tends to move in opposite directions to crude oil prices. Since oil benchmarks are usually priced in U.S. dollars, a devaluation of the U.S. dollar decreases the effective oil price outside the United States. As a result, consumption for oil may increase and add upward pressure to oil prices. The U.S. dollar devaluation has also the potential to decrease effective profits of non-U.S. producers. Another downside is that it reduces the return on assets denominated in U.S. dollars, when measured in foreign currencies. Investors are more inclined to invest abroad. Finally, rising oil prices negatively affect the U.S. trade balance, which again can put downward pressure on the dollar.

3.2.6 Non-OECD Demand

In recent years, developing countries that are not members of the Organization of Economic Cooperation and Development have notably consumed more and more oil. Between 2000 and 2010, oil consumption rose by more than 40%. Countries like China, India and Saudi Arabia had the largest growth in oil consumption in the past few years. On the contrary, oil consumption in OECD countries has declined. The rising oil consumption in non-OECD countries reflect their rapid economic growth. Commercial and personal transportation, manufacturing processes and power generation require large amounts of oil. Consequently, the oil price tends to move in the same direction as economic growth and oil demand. Another factor that also increases oil consumption seems to be the growing population in many of the non-OECD countries.

Figure 3.9 Non-OECD consumption and economic growth



Source: (U.S. Energy Information Administration (EIA) n.d.)

When compared to industrialized countries, developing countries still largely depend on manufacturing industries. These require much more energy than service industries. Oil used in the transportation sector tends to increase rapidly as expanding economies need to move more people and goods. With rising incomes, people are more likely to buy cars. China has seen one of the most dramatic booms in car ownership during the last decade.

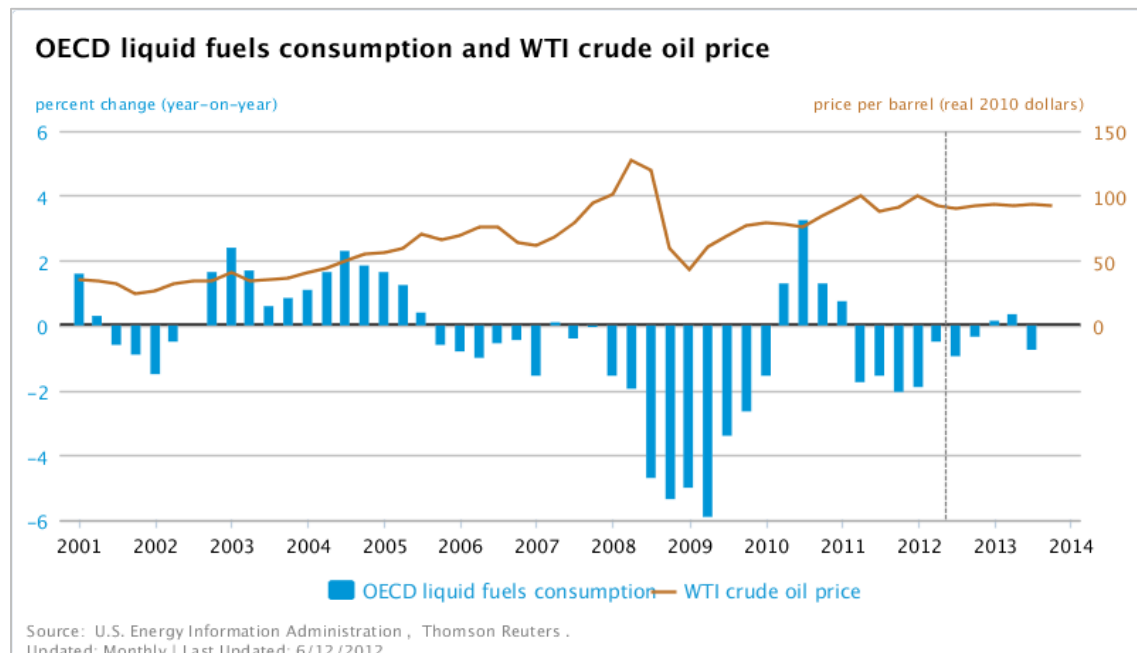
Current economic conditions are the main factors that influence oil prices, but future economic conditions can also have an immediate impact. If the economic outlook is good, oil markets will tighten in the future, resulting in higher future oil prices. This, in return, will create a situation where oil producers will limit their output or hold inventories. In addition, lower supplies tend to push current prices upward.

3.2.7 OECD Demand

All OECD countries combined have a slightly larger consumption of oil than non-OECD countries. However, OECD countries have much lower oil consumption

growth, while non-OECD countries have a higher and still increasing oil consumption growth.

Figure 3.10 OECD consumption and economic growth



Source: (U.S. Energy Information Administration (EIA) n.d.)

OECD oil consumption dramatically fell from 2006-2009 after prices rose. Consumption was especially low during the recession. The major impact on consumption can be attributed to the relatively slower economic growth of developed countries. Developed countries have a more mature transportation sector with a high number of vehicle ownership per capita. Because of this, the transportation sector in OECD countries usually accounts for the largest share of total oil consumption than in non-OECD countries. So, any economic conditions or policies in OECD countries that are linked to the transportation industry, like high fuel taxes and policies to improve fuel economy, will have a significant impact on total demand. Due to this, oil consumption tends to be held back despite times of high economic growth.

3.3 Oil Price Volatility

Fuel cost has always been a major concern for airlines. In the summer of 2008, the price of Brent crude oil almost hit the US\$150 per barrel mark partly due to low supply and high demand. Subsequently, fuel cost rose up to 40% of total airline expenses. Some airlines even feared that the oil price could reach as high as US\$200 per barrel. This did not happen, but the U.S. housing crisis accompanied by an overall reduction in the availability of credits had a major effect on oil prices. Apart from falling prices, the downturn in the U.S. economy caused a major drop in demand¹⁵ in times where supply levels were normal again. This caused havoc among airlines who expected prices to rise. These airlines had previously entered hedging contracts to protect against increasing prices, but now with prices being low, these airlines were losing a lot of money. Even Southwest Airlines, known for its successful hedging program, made the wrong bet this time. Moreover, this whole situation even developed into a full-fledged global recession shortly after, with oil prices dropping down to a low US\$40 per barrel level.

In 2011, energy commodity prices, especially those of crude oil and petroleum products started to increase again. Prices for natural gas, coal and electricity on the other hand declined. The trigger for the current fuel price increase can be traced back to 2010 and is mainly linked to political, economic and logistical factors. The Arab Spring¹⁶ and the Libyan civil war were both political events that stirred up the oil market. As most of the Arab countries are also members of the OPEC, the OPEC oil production capacity was greatly affected and the organization struggled to keep up an incremental supply. The loss of Libyan oil supply was particularly damaging. The other problem was demand. The economic growth in emerging markets increased demand for oil and forced prices even higher. Even though a lot of developed countries have had declining oil demand, for example due to the fact that people are driving less with more fuel efficient cars, global demand rose by 1.2% in 2011, and that also contributed to the surge in oil prices.

¹⁵ Petrol consumption dropped by 5% in 2008.

¹⁶ The Arab Spring is a revolutionary wave of demonstrations and protest occurring in the Arab region, which began on December 18, 2010.

So, why are oil prices so unstable and is the market price really justified? There are mainly three reasons.

3.3.1 Deregulation

The economic growth and globalization of the late 20th century has led to a still ongoing widespread deregulation movement around the world. Just like the airline industry, the energy market has been deregulated in the United States since the 1970s. The Emergency Natural Gas Act, which was signed in 1977, was passed as a direct response to the OPEC oil embargo in 1973. The idea was to raise the level of competition, thus increasing productivity and efficiency, and lowering prices. It would mean a free market without government control. However, it turned out to be too much freedom for some it seems. The general deregulation movement has without doubt good intentions in mind; however, it has not been without its controversies. Large energy suppliers are using the system to make more money, e.g. by manipulating supply output. As a result, instead of bringing lower prices to the wider public, prices become more volatile and the supply of energy even unreliable. Therefore, it comes to no surprise that a large number of deregulation advocates are people and organizations from the energy sector like Enron. They advertise the idea of “free market” and “consumer choice”, and donate millions of dollars of political campaign money, solely with their own business interests in mind.

3.3.2 OPEC

The Organization of Petroleum Exporting Countries, founded in 1960, is an intergovernmental organization made up of twelve oil-producing countries including Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates and Venezuela. As a cartel, OPEC's explicit purpose is to stabilize international oil markets by controlling oil supply. Each OPEC countries are subject to production quotas, which are continuously adapted to the current market situation. This allows OPEC to drive prices in either direction,

as it is responsible for around 44% of the world's oil supply. Furthermore, OPEC controls approximately 80% of global oil reserves.

OPEC's power over oil has often led to harsh criticism. A major one being that the organization is "adjusting" oil prices to maintain higher prices rather than to keep global supply and demand in balance. By manipulating supply, OPEC has the power to achieve prices that bring more profit. In 2009, OPEC could have driven rising prices down by increasing its supply quotas. Still, the majority of OPEC's member countries voted against it and chose to maintain production rates, thereby keeping supply low and prices high. Especially the Gulf States are able to very easily halt exports altogether as most of OPEC oil reserves are in their hands.

Then, there is the individual member nation. In a cartel, each member has an incentive to cheat in order to earn more profit by itself. This is a classic prisoner's dilemma scenario. The individual OPEC country produces more than the quota allows cashing in more money. However, if every member acts the same way, supply will rise, but prices will eventually resume their normal state and no one will profit from cheating.

3.3.3 Speculators

As basic economic principles states, the price of any good is at equilibrium of its demand and supply. However, the pricing of oil is beyond the fundamental of a simple supply and demand game. One main reason for this is the speculative factor in the oil market. Speculators buy or sell goods today with an expected future outcome. The problem with this is that it affects the price of the good today. Speculative buying increases prices as demand goes up, and on the other hand, selling decreases prices as demand goes down. Speculators who believe that the price of oil will be high in the future will certainly purchase more oil today or as soon as possible. Because of the sudden increase in demand, the current oil price will ultimately be driven upward.

Brian Wilson, former British Energy Minister under Tony Blair, once said that "the actual connection between the paper trading price of oil and anything that is

happening in the physical world is now extremely remote.”¹⁷ It simply does not add up when the world’s total consumption of oil is about 85 million barrels a day, but about over one billion barrels is involved in daily trading. Trading with oil is risky business, because no one knows, not even remotely, how much oil still is retrievable from the ground. Furthermore, the amount of oil that countries are storing is also unknown. Natural disasters, oil tankers running aground, hijackings and the geopolitical situation of the Middle East add to the volatility. This is also the main reason why speculators love the oil industry so much.

¹⁷ (IATA - International Air Transport Association 2009)

4 Jet Fuel

Jet fuel is a high quality fuel mixture of a large number of different hydrocarbons and based on kerosene. Almost all jet fuel is refined from crude oil, only a small percentage is made from oil sands. It is similar to diesel fuel, a middle of the barrel refinery product, and designed to power gas-turbine engines of modern aircrafts. The refining process is a complex combination mainly three processes, separation, upgrading and conversion. During the separation process (distillation) the crude oil is separated into two or more components based on its boiling point. The upgrading process (sweetening, hydro-treating, clay treatment) improve the material by using chemical reactions to remove any undesired components. During last conversion process (catalytic cracking, hydro-cracking), the material is fundamentally changed in its molecular structure to acquire the end product. The reason why jet fuel is used rather than gasoline is due to its combination of properties that are more suitable to aircrafts. Despite efforts to standardize jet fuel, there are still a handful of different types that are currently used. Each type has its own specification and differs in its composition. By combining different additives, properties can be achieved that e.g. reduce the risk of icing or explosions due to high temperatures. Currently, there are six types of kerosene based jet fuel blends that are used in commercial aviation around the world. Type Jet A and Jet A-1 are the most commonly used.

Jet A is a mixture of pure kerosene and anti-freeze additives primarily used in the United States since the 1950s. It is only supplied at airports throughout the United States and parts of Canada. Refineries can produce a few percent more Jet A than Jet A-1 from the same amount of crude oil. The United States have chosen this type, because of concerns about fuel price and availability.

Jet A-1 was developed by the major oil companies in response to the problems experienced by international airlines when buying fuel abroad. Jet A-1 has a lower

freezing point and is more suitable for long-range flights. Therefore, it has become the standard specification fuel used worldwide except in North America, China, and the Former Soviet Union. The British Ministry of Defence (MOD) and the American Society for Testing and Materials (ASTM) have jointly specified a requirement list for this type of jet fuel in order to ensure the same quality in each and every country.

Jet B is used for its enhanced cold-weather performance in Canada, Alaska and Siberia. Due to its lighter composition and much lower flash point, it is more dangerous to handle than Jet-A type fuels.

As with any carbon-based fossil fuel, carbon emissions are the main contributors to the global climate change caused by aviation. Two percent of global greenhouse emissions are caused by the aviation industry. While the car industry has introduced electrical and hydrogen powered vehicles, these technologies are not applicable to the aviation industry as an alternative to fossil fuel.

4.1 Jet Fuel in Flight Operations

The market for jet fuel is a supply oligopoly. There are only a handful of oil companies that set the prices. Most of the major mineral oil companies like Shell, BP or Mobil produce jet fuel. However, not every oil company can provide jet fuel at all airports. That is why sometimes multiple oil companies share oil depots at an airport. The spot price of jet fuel is publicly available and can be checked via the internet or telephone. The cash price that oil companies charge for their fuel at each airport are called “posted airfield prices”. However, pilots and airlines try to avoid buying fuel at posted airfield prices, the reason being that they are relatively expensive. Generally, pilots with smaller non-commercial airplanes have to resort to on the spot paying as they do not require such large volumes of fuel as commercial airlines or private jet companies do. Buying fuel on the spot can sometimes cost as much as twice the normal indexed jet fuel price.

Commercial airlines on the other hand have long running service agreements with oil suppliers to avoid posted airfield prices. Jet fuel at the home airport or network hubs is usually cheaper because of possible volume discounts. The prices that are negotiated between airline and fuel supplier are most of the time not disclosed. Airlines have to sign fuel agreements for all airports on their network. This is especially important for long-haul flights where an aircraft simply cannot carry enough fuel on board for its return flight. Therefore, airlines have no option other than to refuel the aircraft at the destination airport. If the airline has a fuel service agreement with the oil supplier at that particular airport it has two options depending on whichever is cheaper. Either, refill the aircraft from the airline's own depot or purchase the required amounts on the spot from the local jet fuel provider at the airport.

When it comes down to refueling each individual flight, pilots are the deciding factor. Every pilot starts in the flight center where he or she computes how much fuel to load for the upcoming flight. Fuel orders are radioed to the airline's operation center where it is then redirected to an available refueling truck driver. Every refueling job is well documented through receipts. Having a good flight crew is very critical for the airline, because their decisions will affect total costs. Flight crews receive information on current fuel prices prior each flight for precise fuel calculations. If they can calculate fuel-efficient flight plans and execute them accordingly, then money can be saved on behalf of their airline. As a standard airline procedure, service debit cards are given to flight crews. These are issued by the oil companies to pay for jet fuel. For unscheduled refueling at airports where no contracts exist between the local oil company and the airline only cash payments are accepted. For this rare situation, flight crews always carry some emergency cash with them.

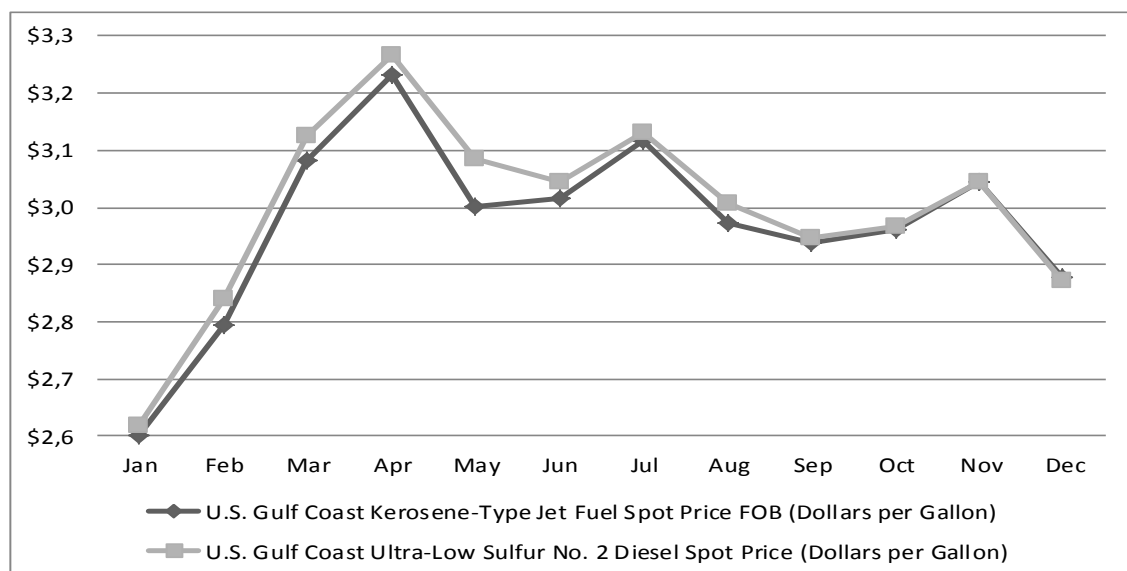
Even though the final decision on how much to refuel lies in the hands of the individual flight crew for each individual flight, it is the Chief Financial Officer (CFO) who manages the overall jet fuel usage and purchases for the company. Because of the large quantities an airline consumes, the CFO has to make decisions on how to buy jet fuel in the cheapest possible way and this is where fuel hedging comes in. Buying jet fuel for an airline is quite different compared to other energy commodity using non-airline companies, since those companies normally have a

dedicated fuel purchaser rather than a company's treasury department handling this kind of task.

4.2 Jet Fuel Price

Jet fuel is produced around the world. The price of jet fuel greatly depends on the production and delivery location. It also is highly correlated to diesel fuel and heating oil. Because of their similarities, spot prices of these three commodities follow more or less the same trend. The difference in price is usually a few cents.

Figure 4.1 Jet Fuel Spot Price vs. Diesel Fuel Spot Price



Data: (U.S. Energy Information Administration (EIA) n.d.)

As basic rule, the price of jet fuel is calculated by adding up the market price of crude oil, refining cost, distribution cost, charges, fees, taxes and the supplier margin. However, this is still not the price an airline pays, because the final price also depends on the airline's credit history, rating, purchase volume and location. As with any other product, supply and demand determines the market price of jet fuel. But, because of the logistics of oil production, supply is sometimes sluggish in response to sudden demand movements. The economic collapse in 2008 is a perfect example. While jet fuel prices were skyrocketing alongside other oil products, leisure and business passenger numbers tumbled, partly because of

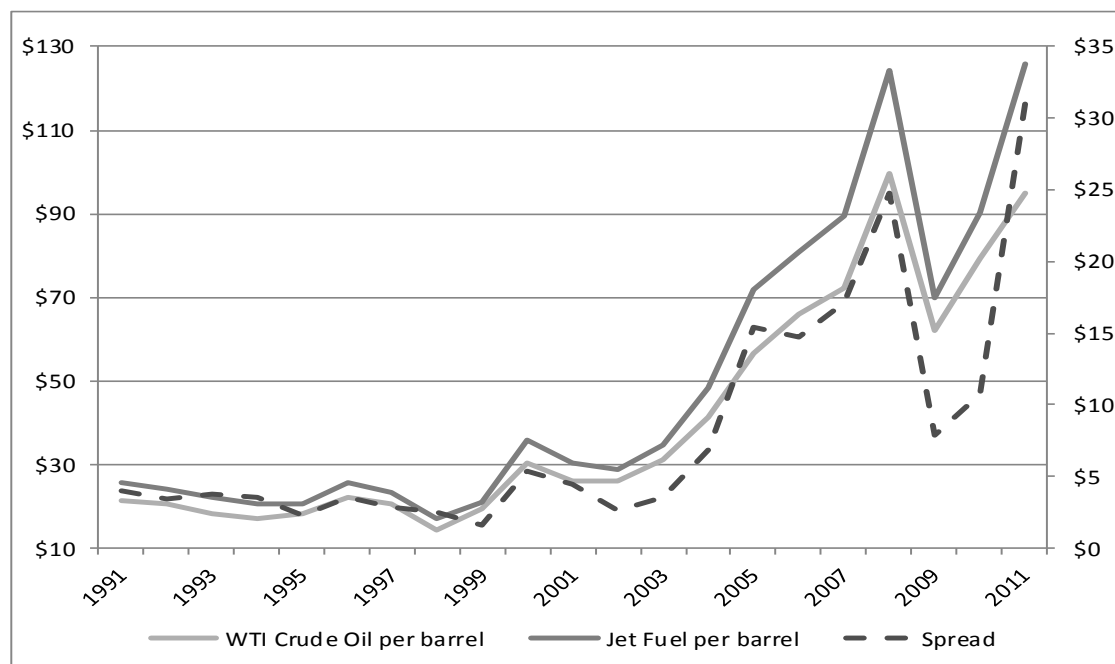
cancelled trips. The price of U.S. Gulf Coast Jet Fuel peaked in September 2008 at a record high US\$4.8 per gallon. A one-cent price increase in a gallon of jet fuel was costing U.S. airlines US\$175 million more per year. However, the supply of jet fuel did not react to the declining demand fast enough. As a result, several million tons of jet fuel had to be held back in tanks on land and onboard tankers at sea. When the economy started to recover again, large volumes of stock kept prices low. In 2009, the price fell back to around US\$1.20 per gallon, but since then it has been rising again.

Difficulties in the jet fuel supply are made worse by big oil companies like Exxon, Chevron or Shell. These companies are less interested in building new refineries but are concentrating their investments on exploration and production, also called upstream sector. Since 2010, Chevron has sold downstream assets such as refineries and retail outlets in over 20 countries worldwide. Many other oil companies are looking to do the same. New and smaller companies are stepping in, but lack the expertise, which is necessary to control supply, and keep prices low. Thus, some airlines fear that they could end up paying for the newcomer's learning curve.

4.2.1 Crack Spread

A crack spread is the price difference between the price of crude oil and refined products. The word “crack” is term commonly used in the oil industry and refers to “cracking” crude oil, the process of breaking long-chain hydrocarbons into different shorter-chain petroleum products. Jet fuel is traded at a premium to crude oil. The spread between those crude oil and jet fuel has become wider since 2005. In 2010, the crack spread was around US\$15, but it has almost doubled at the end of 2011. The spread mainly depends on the relative proportion of each petroleum product that is produced by a refinery. Refineries control their various outputs according to each market's demand. Further adjustments have to be made within markets with seasonal differences, i.e. demand for heating oil is very low during the summer months and very high in the winter months.

Figure 4.2 Spread between WTI Crude Oil and Jet Fuel



Data: (Airlines for America (A4A) 2012)

On important factor that affects the spread is the quality of the crude oil itself. Crude oils from different oil fields will have different characteristics. Heavy crude oil, for example, is more difficult to refine into lighter products, because of its longer carbon chains that have to be cracked. A high-tech refinery can make up for this problem.

The oil supply from the Middle East is often disturbed by political conflicts in that very same region. Supplies for the U.S. are mainly provided by U.S. Gulf Coast, which is virtually a monopoly. On the U.S. west coast however, some oil is usually imported from the Asia-Pacific region. Since Asian demand has grown dramatically in the past decade, prices for the U.S. west coast have gone up and made imports less lucrative. One of the biggest and still growing consumers of oil in Asia is its local airline industry. The increased competition for a decreasing stock of jet fuel will without a doubt lead to even higher prices for the whole world in the future.

Crack Spreads in the Futures Market

In the futures market, the crack spread is often used by oil producers for hedging, especially among refiners. The purchase of crude oil is combined with selling two refined products like heating oil or gasoline. Oil refineries utilize this spread to

hedge against the price risk of their own operations, whereas speculators can utilize the price differential to make more profits in a short time. For oil companies that provide upstream, midstream and downstream products there is a natural hedge against adverse price movements, caused by not only political crises, but also extreme weather conditions and environmental regulations. Independent oil companies, which purchase crude oil from the wholesale market to process and resell refined products, are not protected. Unlike wholesalers, resellers are very much exposed to the risk of increasing crude oil costs and decreasing refined product prices. To overcome the price exposure, refiners utilize the crack spread for hedging purposes. The crack spread of crude oil is combined with two other refined products at a X:Y:Z ratio, where X represents barrels of crude oil, Y represents barrels of a refined product, most commonly gasoline, and Z represents barrels of a distillate fuel oil, which can be heating oil or diesel. The ratio is constrained by $X=Y+Z$ and works as follows; buy X barrels of crude oil and sell Y barrels of gasoline and Z barrels of heating oil in the futures market. Most commonly used ratios are 3:2:1, 5:3:2 and 2:1:1. Due to the popularity, financial institutions have been offering products, known as intercommodity spreads, that are tailored for trading crack spreads. The NYMEX launched crack spread contracts for the first time in 1994. A crack spread contract combines a simultaneous purchase and sale of crude oil and petroleum product futures. This allows refiners to lock in the price differential resulting in either profit from or protection against changes in that value. Refiners can therefore establish a fixed refining margin without the ups and downs of the spot market.

The 3:2:1 ratio is the most popular one, because it reflects the real-world production output ratio the closest. One barrel of heating oil and two barrels of gasoline can be produced from approximately three barrels of crude oil. Since crude oil is quoted in dollars per barrel and petroleum products are quoted in cents per gallon, heating oil and gasoline have to be converted to dollars per barrel. The spread price can be calculated using the following formula.

$$\frac{42 \times (Y \times \text{price of } Y + Z \times \text{price of } Z) - X \times \text{price of } X}{X} = \text{price per bbl}^{18}$$

¹⁸ (CME Group 2012)

Example

- Futures prices (Electronic trade, September 2011 contract)
 - Light Crude Oil US\$98.51 per bbl.
 - Unleaded Gasoline US\$3.13 per gal
 - Heating Oil US\$3.19 per gal
- Spreads
 - 5:3:2
$$\frac{42x(3 \times 3.13 + 2 \times 3.19) - 5 \times 98.51}{5} = \$33.96 \text{ per bbl}$$
 - 3:2:1
$$\frac{42x(2 \times 3.13 + 1 \times 3.19) - 3 \times 98.51}{3} = \$33.79 \text{ per bbl}$$
 - 2:1:1
$$\frac{42x(1 \times 3.13 + 1 \times 3.19) - 2 \times 98.51}{2} = \$34.21 \text{ per bbl}$$

The 3:2:1 spread yields the lowest price per barrel with a saving of US\$64.72.

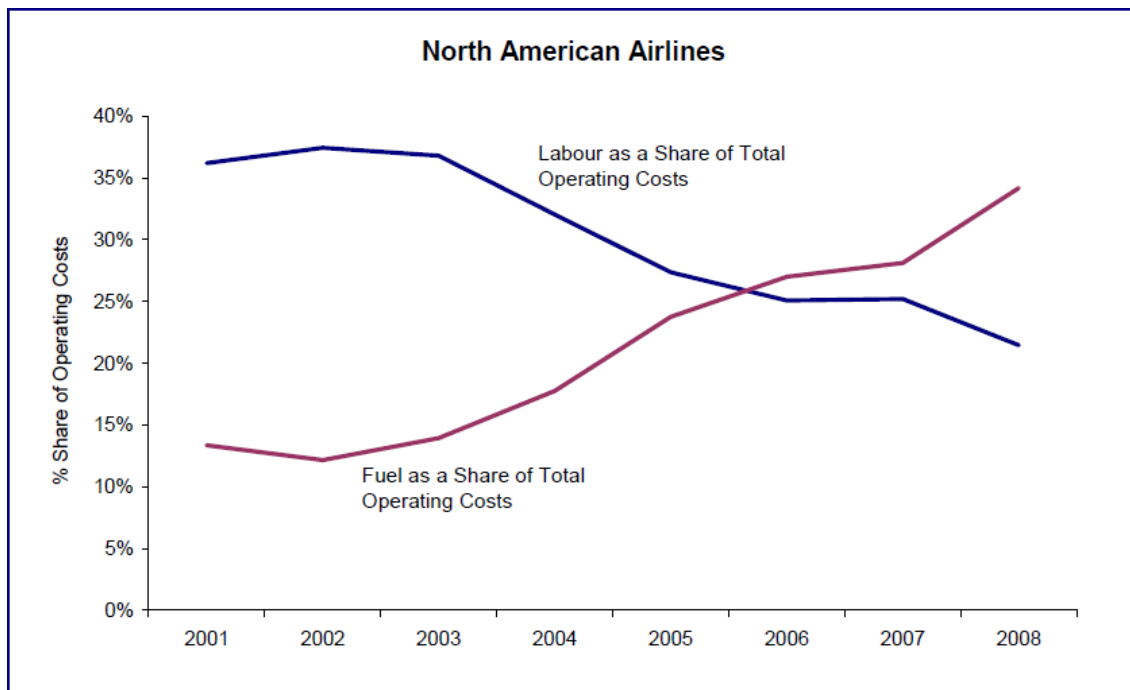
4.3 Airlines and Jet Fuel Cost

According to IATA's Economic Briefing from February 2010, a survey conducted by said organization, fuel represented about 32.3% of total operating cost in 2008, up from 27.4% the year before, whereas labor costs fell from 22.8% in 2007 to 20.1% in 2008. Between 2001 and 2003, the share of fuel costs was only 12-13%. It has more than doubled since, as jet fuel prices rose from US\$34.7 in 2003 to US\$126.7 in 2008. This clearly reflects the strong impact that rising fuel prices have on airlines' cost structures.

Airlines usually enter into short-term contracts with fuel suppliers and purchase fuel according to the monthly price quoted by Platts¹⁹, but these prices are volatile and unpredictable forcing airlines to be price-takers. There are only a few options available to avoid or overcome this problem.

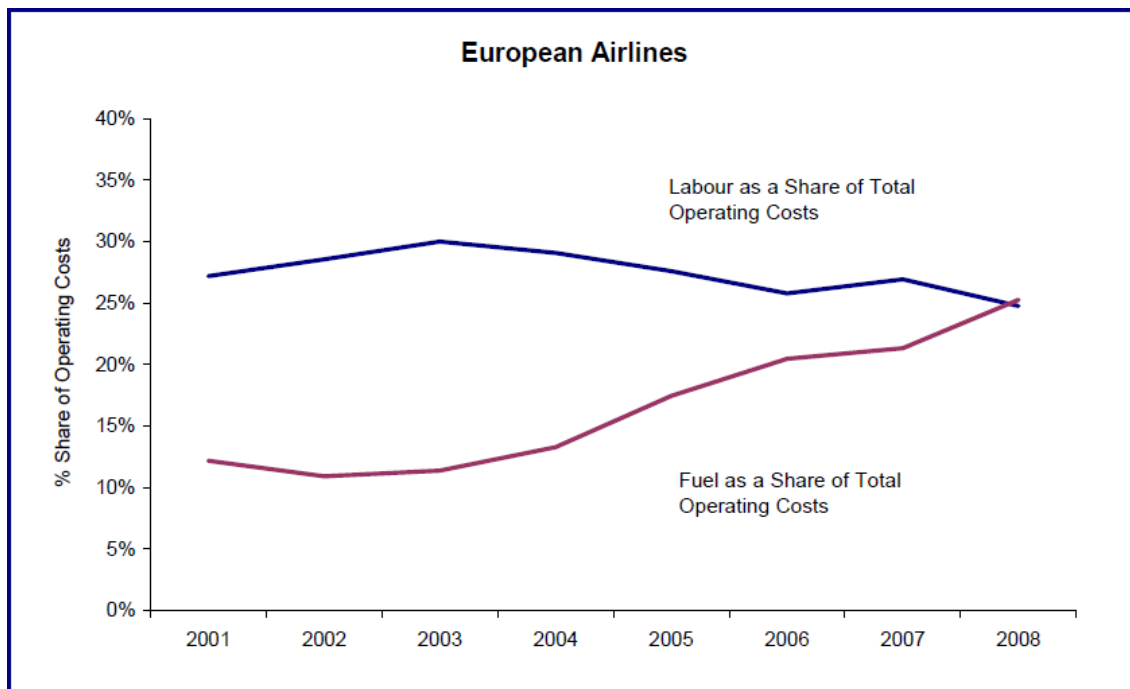
¹⁹ Platts is a provider of energy, petrochemicals and metals information, and a premier source of benchmark price assessments for those commodity markets. (Platts 2012)

Figure 4.3 Share of Operating Costs in North America



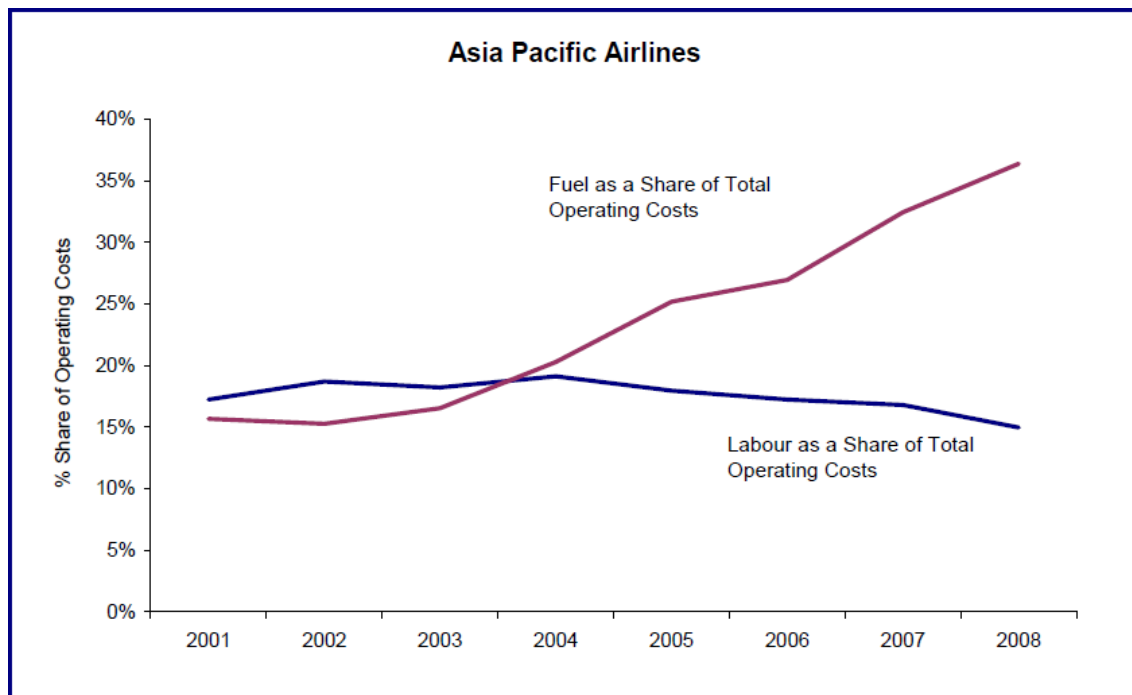
Source: (IATA - International Air Transport Association 2010)

Figure 4.4 Share of Operating Costs in Europe



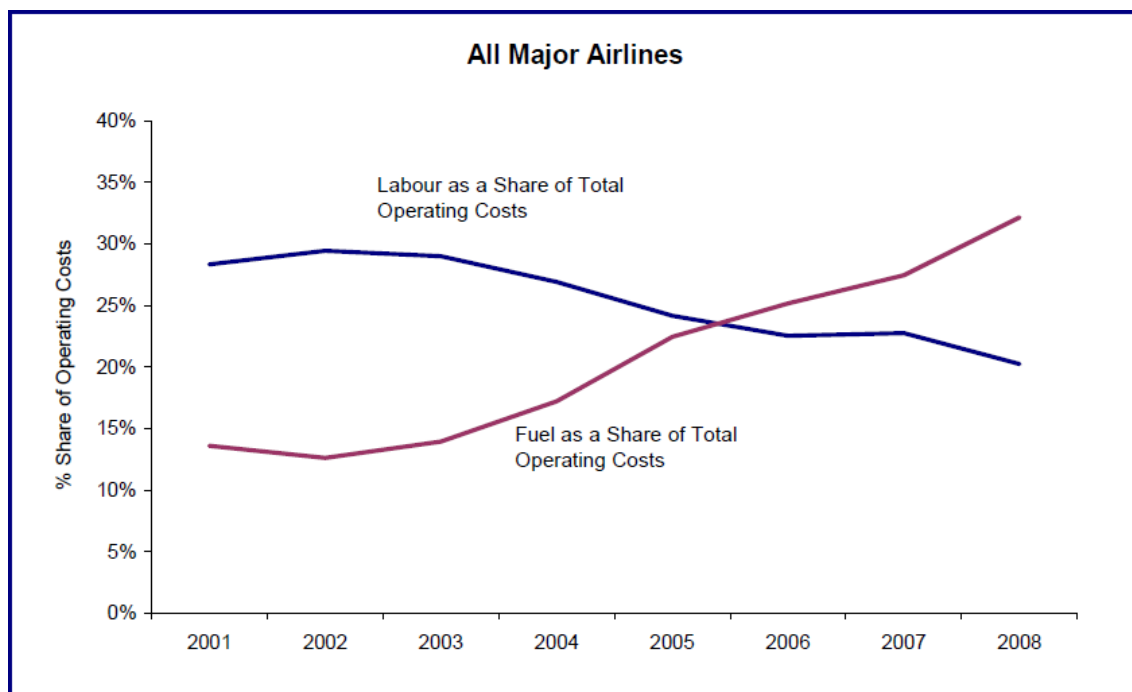
Source: (IATA - International Air Transport Association 2010)

Figure 4.5 Share of Operating Costs in Asia Pacific Region



Source: (IATA - International Air Transport Association 2010)

Figure 4.6 Share of Operating Costs for All Major Airlines



Source: (IATA - International Air Transport Association 2010)

5 Solutions to high Fuel Cost

The majority of airlines reduce their fuel costs by cutting down fuel consumption on existing airplanes. Investing in new equipment that increase fuel efficiency can further reduce the fuel bill. If an aircraft is beyond upgrading, selling it and then investing in newer aircrafts will reduce fuel costs in the long run. Airline are employing all of these measures to maximize savings on fuel cost. However, most of these measures are already exploited to their full potential, thus cannot keep up with the rising price of oil. As a last resort, many airlines have started passing the increased fuel costs to their consumers.

5.1.1 Reduce Fuel Consumption

As mentioned earlier, all airlines are trying to reduce fuel consumption whenever and wherever they can. There are many very straightforward ways to reduce fuel usage that are also practiced by the average car driver, while others require more advanced changes in design and technology. Airlines have developed planning and operational procedures that are aimed at conserving fuel, reducing emissions and optimizing fuel purchases.

Planning procedures

Planning procedures are measures that are employed ahead of flight operations. Precise route planning is of utmost importance for minimum fuel-burn and to avoid unnecessary deviations off course due to bad weather or traffic. Today's aircraft have state-of-the-art navigation, communication, surveillance and weather forecast systems. However, some aviation regulations are still based on previous generation aircrafts and are not up-to present-date standards. En route fuel reserve requirements fall into this category. Airlines are working with regulators to change this. By reducing fuel reserve requirements the flying aircraft has to carry

less fuel and weight around. Investing in winglets, a fin-shaped device that is attached to both wingtips, will reduce aircraft drag and thereby reduce fuel consumption by roughly 3.5% to 6% depending on the type of aircraft. Both Boeing²⁰ and Airbus²¹ have programs to retrofit aircrafts without winglets. All of their next-generation aircraft models already have this technology built in. Airlines have found many ways to reduce weight, even if it just saves a few kilos. By minimizing the airline's paint scheme for example, less paint is applied to the aircraft's body, which in return reduces the overall aircraft weight. Other than changes on the aircraft itself, organizational procedures can also save fuel. A lot of effort is put into network and schedule planning, which is aimed at alleviating traffic congestions. The location where fuel is purchased is also plays an important role and is changed according to prices. Carriers can also pool resources together with other alliance partners to purchase fuel cheaper in bulk.

Operational procedures

Operational procedures, on the other hand, help reduce fuel while operating an aircraft. Starting with ground operations, single-engine taxi procedures and selective engine shutdown during ground delays saves fuel. Reducing speed during take-off can also reduce fuel-burn. During flight, airplanes try to stay longer at higher cruise altitudes and employ more efficient approach procedures. The reason being that if during approach, an aircraft starts its decent too early it has to burn more fuel to keep its approach altitude. And, if it descends too late, it will most probably have to fly holding patterns to reduce its altitude so that it can land safely, which translates to a higher fuel consumption. These are all measures to reduce fuel consumption, but the bad news is that fuel savings during flight operation are already at its limits and are constrained by strict safety requirements.

Another possible operational method of saving money on jet fuel is called tankering. The aircraft is filled up with fuel exceeding the required amount plus reserves required flying from A to B. This is of course only beneficial if the fuel price at the airport where the aircraft was refueled is cheaper than at the next

²⁰ Blended winglets are available for the Boeing 737, 757 and 767 Series.

²¹ Airbus' "sharklets" are available for the Airbus A320.

airport. The problem with this is, with the added fuel weight, the aircraft has to burn more fuel²². This is also referred to as “fuel carriage penalty”. Moreover, the longer the flight goes on, the longer the airplane has to carry the additional weight around and the benefits from tankering decrease. Therefore, tankering is almost only feasible on short-haul flights. The fuel costs to transport the extra fuel must be less than the savings created from the price difference. However, with rising fuel prices the differences in prices are not big enough anymore to make tanking a long-term solution. Calculating the required fuel for a given route should be an easy task for any pilot, but deciding whether to tanker or not is a much more complex calculation. It is an equation, which requires the price at departure, the price at destination, length of trip and the length of the onward trip, that the average airline pilot cannot effectively solve using a simple calculator. Only the latest state of the art flight planning software available today can do this quickly and easily, and give pilots the appropriate tankering fuel amount and the generated cost savings.

5.1.2 Passenger has to pay

Airfares are generally offered at a fixed price. However, discounts can be given to those who buy well in advance to increase the chance of a fully booked flight. The price of a ticket at any given time reflects the price of fuel at the time of booking. In case that the price of fuel changes after being booked, consequently profit margins will change. If the fuel price increases, airlines can raise ticket prices to compensate. In times of high demand, this would not be a problem.

In recent years, airlines have increasingly tried passing fuel price increases on to their customers in form of surcharges. These practices were actually not that common on the passenger side of the business, but were very common on the cargo side. Some airlines like FedEx²³ do not hedge their fuel at all and only rely on passing the current fuel prices on to their customers.

European and Asian airlines have had more success with fuel surcharges than their American counterparts have. There simply is too much competition in the

²² Approximately 3-5% more fuel costs varying on each type of aircraft

²³ Cargo airlines publish fuel price indexes which include trigger points and the resulting fuel surcharges.

U.S. domestic airline industry, which make it almost impossible to introduce fuel surcharges. Low demand induced by the weak economy makes this option even more difficult.

5.1.3 Fuel Hedging

A fuel purchase contract often involves clauses that allow the oil companies to adapt the price in accordance to the world market. Charges for storage, tankering and airport concession fees are all part of the contract. As mentioned before the oil production industry is an oligopoly. And as such, airlines have pretty much little to say in terms of fuel pricing. They have to take the oil companies' demanded price. If prices rise there is little time to react. However, airline managers can hedge this kind of risk using forward contracts, future contracts or derivatives such as options, collars and swaps. Hedging protects airlines from sudden losses caused by rising fuel prices. The goal of hedging is to lock in the price of future fuel purchases and stabilize long-term fuel costs. Another advantage of hedging is that it can steady highly volatile oil prices. Fuel expenses account for 15% to 30% of an airlines' total cost, and because of the large percentage, any small price changes will have a big effect on overall expenses.

5.1.4 Bio Jet Fuel

Fossil fuels are non-renewable and as such will be depleted sooner than later. Nobody knows exactly when the last drop of oil, last lump of coal or last bit of natural gas will be collected, but estimates put an end to fossil fuel reserves within 50 years. Global economy remains to be heavily dependent on fossil fuels. Many people say that renewable energy sources like solar or wind will solve this problem. However, development and distribution of alternative or renewable fuel technologies are still not mature enough to substitute fossil fuels economically. Currently, only about 7% of the world's energy supply²⁴ come from renewable

²⁴ (U.S. Energy Information Administration (EIA) n.d.)

resources. This number is going to increase, but only little by little. The bottom line is that we are going to run out of fossil energy resources. The challenge of alternative energy resources is not only to replace current fossil fuel demand, but will also be to keep up with the increasing population growth. Aviation plays an important role in the economic growth, especially in developing and emerging markets. It is therefore inevitable for the aviation industry to switch to an alternative fuel resource as fast as possible. Designing more efficient aircrafts and improving operational procedures can only reduce fossil jet fuel consumption by a little. While new technologies on solar, electric and hydrogen powered aircrafts are being researched, it is not expected that these technologies are able to replace current jet-engine aircrafts in the near future or even before we run out of oil. A non-fossil jet fuel has to be renewable. In addition, it has to be environmentally, socially and economically sustainable. The first generation of biofuels, that was produced from plants, were not sustainable as they used up land, water and other resources that could have otherwise been used for food production. Energy efficiency and reduction in carbon emissions were low and production costs were high.

To address the environmental impact of fossil fuels a group of airlines and aircraft manufacturers have formed the Sustainable Aviation Fuel Users Group (SAFUG) in 2008 and have committed themselves to the development of a suitable and more sustainable alternative fuel for commercial aviation. The new generation of biofuels is produced from plant material like jatropha, algae, tallow, babassu, camelina, and other waste oils. Biofuel produced from these materials are specified as “Bio-SPK²⁵”. Producing biofuel from algae seems very promising, but is still an emerging technology. A second solution turns biomass into a synthetic fuel, which is then processed into “FT-SPK²⁶” jet biofuel. These biofuels do not compete with food crops for land and water, and have a potential of reducing carbon emissions by up to 80%. Airlines have already began testing these biofuels since 2008 and numerous test flights have already been conducted including commercial flights with passengers. However, most tests were conducted using a blend of regular jet fuel and biofuel and powered only one engine. The first test flight was operated by Virgin Atlantic on a Boeing 747 from London to Amsterdam

²⁵ Bio derived Synthetic Paraffinic Kerosene

²⁶ Fischer-Tropsch Synthetic Paraffinic Kerosene

in February 2008. The aircraft used a blend of 20% biofuel based on coconut and babassu in one engine of its four engines. Following test flights increased the ratio of biofuel used. The first commercial flight using biofuel was performed on a KLM Boeing 737-800 on a flight from Amsterdam to Paris carrying 171 passengers in June 2011. The biofuel used was processed from recycled cooking oil.

So far, all test flights have been completed successfully proving that biofuels do work. The fact that these biofuels are “drop in”, meaning that no technical modifications need to be made to the aircraft fuel system, is a huge benefit for the aviation industry. The challenge now is commercialization. Currently, airlines are not able to deploy biofuel throughout their entire fleet, because it is still only available in limited quantities. A lot of funding is needed to grow the feedstock and to build bio refineries that can produce enough supplies. Further research must be made in order to bring down production costs.

Even though most of the major oil companies are involved in the research of alternative fuels, they have no incentive to turn off their crude oil production in order to switch to biofuel production. For many industries, especially aviation, there currently is no equal alternative to fossil fuel. For that matter, oil companies will continue to pump up as much oil as possible to the surface until they reach the very last drop or until an equal alternative has been found. The remaining oil beneath the surface has still a lot of potential to be turned into cash. At least for the short term, oil companies can rest assured that the aviation industry and many others would continue the demand for fossil fuels.

6 Hedging Instruments

Derivatives are financial instruments that derive their value from an underlying commodity or other asset, including other financial instruments, and as such do not represent ownership rights. The main function of a derivative contract is to transfer risk, in the case of fuel hedging it is price risk, to those who are able to profit by bearing it. However, derivatives are not the ultimate answers in eliminating price risks and have resulted in substantial losses in the past. The German Metallgesellschaft, for example, lost about US\$1.3 billion in energy trading in 1993. Using derivatives to offset certain risks have long been around, but it was only about 20 years ago when the energy sector became deregulated and the financial market started utilizing energy commodities. Prices were no longer set by regulators, but followed supply and demand rules of a free market. The only problem was that prices became extremely volatile. Globalization, flexible exchange rates, price deregulations and the growth of cash markets have certainly increased the risk involved in trading with derivatives. Market participants have to be aware of main risks.

- market risk (unexpected changes in interest rates, exchange rates, stock prices, or commodity prices)
- credit default risk (counterparty fails at paying his/her obligations)
- operational risk (execution failure within a company, equipment failure, fraud)
- liquidity risk (inability to pay bills or the inability to purchase or sell commodities at a quoted price)
- political risk (new regulations)

In trading, only those risks that both parties are willing and able to bear will be accepted.

Options, futures and forward contracts are all derivative instruments that are traded on either exchanges or over-the-counter markets. Derivatives from both markets offer hedging opportunities. The major difference between these two markets is that the exchange has a standardized structure, which makes trading more transparent and liquid. Over-the-counter contracts are generally less liquid, but offer much more customization possibilities. Traders on regulated exchanges can sell contracts before due date without any problems. If an airline wants to hedge for longer periods, then exchange-traded crude oil contracts can guarantee a certain liquidity. Conversely, jet fuel contracts are only traded over-the-counter and these contracts are only liquid for shorter periods. The premium paid for jet fuel typically varies from around 5 cents to 15 cents. The spread tends to be wider at times of instability and war. During wars more diesel and gasoline is used by the military, thus production of these products are increased and others like kerosene are reduced. Even though hedging with jet fuel contracts would reflect the actual movement of the jet fuel price more precisely, most trading is exercised using crude oil or other refined products as the underlying commodity.

6.1 Options

Option contracts are simpler in structure and as a result are becoming more popular among hedgers. An option gives the buyer or seller the right, but not the obligation, to buy or sell a given amount of the underlying commodity at a specified expiration date and fixed price, also called a strike or exercise price. A one-time premium payment is made to purchase an option. The price of the option is dependent upon the value of the underlying asset, which can also be a futures contract. An option to purchase a commodity is called a call option and an option to sell is called a put option.

6.1.1 Call Options

A call option gives its buyer the right to buy a commodity at a pre-specified strike price. Commodity buyers often use call options as price caps, when they fear that the price of the commodity is going up. In comparison to forward and futures contracts, the holder of a typical call option can go two ways giving the buyer a choice. If the price of the underlying asset goes up and exceeds the strike price, then the holder will exercise the option and will buy the commodity at the lower strike price. Otherwise, when the market price goes down, the option is simply allowed to expire worthless at the expiration date. The only loss recorded is the premium and the holder can simply purchase the commodity at the lower market price. This way, airlines can limit their exposure to increasing jet fuel prices. The reward for the option buyer is basically unlimited minus the premium. If the price of the underlying commodity increases to infinity, then the profit from a call option would be unlimited. The risk of the buyer is clearly defined before entering the contract and is confined to the premium paid. The seller of the call option on the other hand has a maximum profit of only the premium and an unlimited possibility of loss if the price of the asset drops indefinitely.

Example

The following scenario illustrates the value of a call option. Suppose an airline buys ten call option contracts that expire in three months. The stock price of the underlying asset is currently at \$30 per share. The strike price was determined to be \$30 as well for each contract and each contract is trading for 100 shares. The premium for each share is quoted at \$5 per share, so \$500 for each contract. The airline buys ten contracts and has to spend a total of $10 \times \$500 = \$5,000$. When the expiration date arrives after three months, the airline will decide upon exercising the option or not based on the option value and profit per share at that time. A profit can be made when the asset price rises above the exercise price. Assuming that the market price has gone up to \$40, the call option buyer will exercise his/her right to purchase the shares at \$30, resulting in a profit of \$5 per share. On the other hand, if the price were to fall to e.g. \$20, then the option will not be exercised. The option buyer will lose the premium of \$5 per share, but can

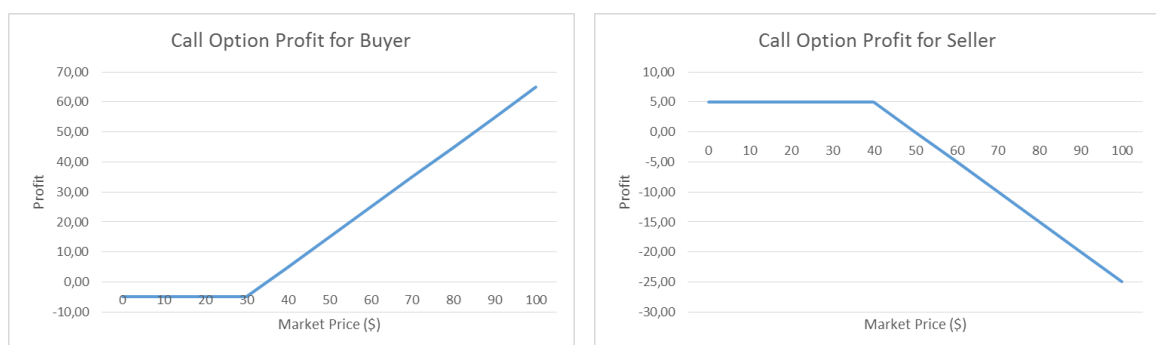
purchase the shares on the market at the lower price. The table below shows the option value and profits per share at each stock price.

Table 6.1 Call Option Values and Profits per Share

Stock price	Option value	Premium	Profit
\$0	\$0	-\$5	-\$5
\$10	\$0	-\$5	-\$5
\$20	\$0	-\$5	-\$5
\$30	\$0	-\$5	-\$5
\$40	\$10	-\$5	\$5
\$50	\$20	-\$5	\$15
\$60	\$30	-\$5	\$25
\$70	\$40	-\$5	\$35
\$80	\$50	-\$5	\$45
\$90	\$60	-\$5	\$55
\$100	\$70	-\$5	\$65

The profit rises in proportion to the asset price as it passes the exercise price. If the asset price is lower than the exercise price, the call option would expire worthless and the loss of the buyer is limited to just the premium paid.

Figure 6.1 Call Option Profit for Option Buyer and Seller



6.1.2 Put Options

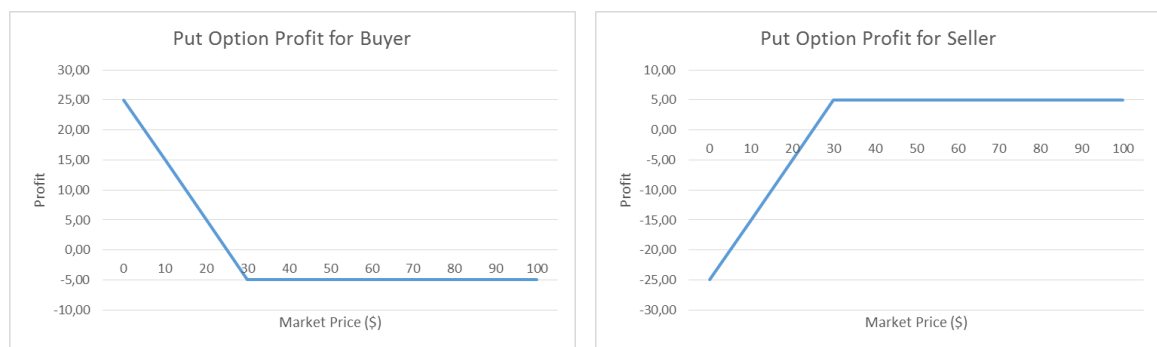
Put options are the opposite of call options. They give the option buyer the right to sell a commodity at a pre-specified strike price. Commodity sellers who fear that prices are going to decrease can purchase put options to counteract this risk. The predetermined strike price of the option acts as a price floor. Therefore, the option will only be exercised if the market price falls below the strike price. The ultimate reward for the put option buyer is a limited loss in the amount of the premium and the possibility to sell the asset at a higher market price. On the other side of the transaction, the maximum reward for a put option seller is only the premium received for that option. The option seller's maximum loss is limited by the exercise price minus the premium.

The following table shows the option value and profit per share using the same numbers from the call option example above. Each contract is again for 100 shares at a \$5 premium each. The put option buyer agrees to sell those shares at a predefined strike price of \$30 per share at expiration. If the market price falls to e.g. \$20, the commodity seller will exercise his right and can sell at \$30. After deducting the premium, the put option will give the buyer a profit of \$5. Conversely, if the market price rises to e.g. \$40 after expiration, the option will not be exercised and the loss for the option buyer is only the premium.

Table 6.2 Put Option Values and Profits per Share

Stock price	Option value	Premium	Profit
\$0	\$30	-\$5	\$25
\$10	\$20	-\$5	\$15
\$20	\$10	-\$5	\$5
\$30	\$0	-\$5	-\$5
\$40	\$0	-\$5	-\$5
\$50	\$0	-\$5	-\$5
\$60	\$0	-\$5	-\$5
\$70	\$0	-\$5	-\$5
\$80	\$0	-\$5	-\$5
\$90	\$0	-\$5	-\$5
\$100	\$0	-\$5	-\$5

Figure 6.2 Put Option Profit for Option Buyer and Seller



The advantage of purchasing call or put options is that the investor cannot lose more money than the premium.

6.2 Forward Contracts

A forward contract is a non-standardized agreement between two parties to buy or sell a specific amount of an asset at a fixed price (forward price) at a specified time in the future (maturity). For an airline, this means agreeing to purchase a fixed amount of fuel from an oil company at the price and at a future time stated in the forward contract. The profit for both parties involved is determined by the difference between the forward price and the spot price, the market price of the commodity at maturity. The loss incurred by one party is the profit of the other party. Therefore, if the forward price of jet fuel stated in the contract is \$3 per gallon and the spot price at maturity is \$3.2, the jet fuel supplier will have to sell the amount specified in the contract at \$3 per gallon thereby incurring a loss of \$0.2 per gallon. The airline on the other hand will pay for the delivery and save \$0.2 per gallon. Either way, the forward contract binds both parties to payment and delivery. There are no costs involved when entering a forward contract. Forward contracts are not traded on the stock market, because of their non-standardized nature, but are traded only over-the-counter (OTC). Both trading parties are dependent upon each other. An advantage to this is that oil companies and airlines are able to fully customize their terms of deal. However, this makes reversing a position for one party difficult, as both must agree to cancel the contract. This increases the

possibility that either party could default, thus increasing credit risk. The obligatory delivery at maturity causes another logistical problem. If the jet fuel supplier were to honor his part of the agreement, he would have to deliver the amount of jet fuel stated in the contract on a single day, which is often not possible. Therefore, forward contracts are not always the most suitable instrument to use in a hedging strategy.

In regards to third party speculators, a forward contract is also not an optimal instrument, because the non-standardized nature of forward contracts makes them very difficult to compare. In addition to this, the speculator is also susceptible to full counter party risk.

6.3 Futures Contracts

Futures contracts, in contrast to forward contracts, are traded on the stock market making them more suitable for hedging. Futures contracts are similar to forward contracts. Both are agreements to buy or sell a commodity at a future date. However, futures are highly standardized contracts where the underlying asset, type of settlement, amount of underlying asset, currency, quality, delivery location and time, and last trading date is predefined. Only one element is not standardized and that is the price. The price of the hedge is not set by a premium like with options, but is rather determined directly by the opportunity costs of the hedge itself. These are settled daily at exchanges based on their current market value. Just like with stocks, the futures market provides real-time price listings on futures contracts with various durations.

To enter a futures contract one party has to agree to supply a fixed amount of a commodity at a predefined strike price on a predefined future date. The buyer of the contract and the underlying commodity is defined as entering a “long” position, and the seller as entering a “short” position. The buyer hopes that the price of the asset will increase, while the seller hopes that it is going to decrease. A futures contract requires no initial payment of any kind. At the end of the contract, each party is legally obliged to fulfill his forward commitment. However, in reality the underlying commodity is rarely actually physically delivered. Actual delivery

accounts for only about one percent. Financial or cash settlements are often arranged in place of delivery to facilitate speculating.

6.3.1 Futures Marketplace

In the United States, the futures and options market is regulated at three different levels. The federal government is the primary regulatory agency that authorizes industry organizations and individual exchanges to be able to provide financial instruments to the general public. At the second level, the Commodity Futures Trading Commission (CFTC) oversees the all futures markets and exchanges in the United States as an independent federal agency. In 1982, the CFTC authorized the National Futures Association (NFA) to handle registrations and licensing of all industry participants who are exchange members and are offering financial instruments to the public.

The Chicago Mercantile Exchange (CME) is the largest futures marketplace in the United States. What started out as a traditional regional commodities market is now a global marketplace. The location of the city of Chicago, situated at the Great Lakes, thereby close to farmlands and cattle country of the Midwest, makes it perfect as the center for distribution, transportation and trading of agricultural produce. In 1992, the CME introduced the first electronic trading platform in the world for futures contracts named “Globex”. The New York Mercantile Exchange (NYMEX)²⁷ is a commodity futures exchange in New York City also operated by CME Group. Since 2006, trading on the exchange has mostly become electronic leaving only a small part to the traditional open outcry system. WTI light sweet crude oil futures and options are the main crude oil products offered in the United States. CME offers WTI contracts only electronically and NYMEX trading is only performed on the trading floor. Apart from WTI, CME also offers contracts based on Brent and Oman crude.

In Europe, the London based International Petroleum Exchange (IPE) had been the leading open-outcry energy futures exchange for 20 years. Brent crude oil

²⁷ In 2008, CME Group Inc. acquired NYMEX Holdings Inc., which is the parent company of the New York Mercantile Exchange and Commodity Exchange.

contracts were one of its flagship offerings. In 2001, it was acquired by U.S. based InternationalExchange (ICE) and has since been renamed to ICE Futures. The exchange has become fully electronic since 2005. While most exchanges have clearing houses to handle settlement, both CME and ICE do not have them as they clear trades themselves through their in-house clearing houses.

Other major exchanges that offer crude oil contracts include the Tokyo Financial Exchange (TFX) and European-based Euronext.liffe²⁸.

6.3.2 Trading with Futures

The electronic platform CME Globex offers WTI light sweet crude oil futures contracts 24 hours a day, 7 days a week. NYMEX on the other hand also offers the same contracts, but because of the limited trading times²⁹ on the floor there is a differences between the last electronic trade and the last regular settlement.

All contracts are settled on the third business day prior to the 25th of each month that precedes the delivery month. The light sweet crude oil futures contract specifies the whole settlement procedure, which includes grade and quality, delivery location and delivery time, etc., in great detail.

The WTI futures price is listed on a per barrel basis with one contract trading 1,000 barrels (42,000 gallons). Therefore, a single December 2012 futures contract bought in August 2012 would cost \$96.950. Because of the high volume involved in a single trading unit, oil futures are mainly aimed at the institutional investor or corporations and not the individual trader. Contracts are usually arranged on a monthly basis for a period of up to two years. Anything that goes beyond that, three years is the longest, can only be entered every six months.

²⁸ London International Financial Futures and Options Exchange (LIFFE) prior to 2002

²⁹ Monday – Friday 9:00 a.m. – 2:30 p.m.

Table 6.3 Globex WTI Light Sweet Crude Oil Futures Contracts

	High	Low	Recent Settle	Volume
September 2012	95.75	93.93	95.60	200,371
October 2012	96.04	94.21	95.89	93,627
November 2012	96.30	94.58	96.17	29,637
December 2012	96.64	94.93	96.51	54,289
January 2013	97.08	95.40	96.95	14,547

Data: Globex Futures data on August 1, 2012³⁰

An extended duration of the contract makes liquidity a major issue. Liquidity has to be ensured to minimize credit risk to both parties. This is guaranteed with the help of margin requirements set by a clearing house. Traders have to maintain a certain minimum amount of funds for each position, which serves as an insurance policy against possible losses. The clearing house is responsible for collecting the margin from their clients. It also automatically acts as an intermediary, so that buyer and seller are anonymous to each other throughout the duration of the futures contract. Traders are therefore protected against counter-party risk.

As a hedging instrument, futures are much more effective compared to options, but as previously mentioned no futures market for jet fuel contracts exists. For the airline industry, this creates a problem. As a solution, another widely traded commodity must be used as an underlying asset instead. Because jet fuel is a refined product derived from crude oil, any other refined products should have similar pricing characteristics. In order to determine which commodity is suitable for hedging, we have to look at the historical prices of jet fuel and the other commodity, and calculate their correlation coefficient. A positive correlation indicates a close relationship meaning that the prices move in the same direction. The five-year correlation coefficient for U.S. Gulf Coast Jet Fuel and New York Harbor Heating Oil between 2007 and 2011 is 0.9869³¹. This translates to approximately 98.69% of price fluctuations in U.S. Gulf Coast Jet Fuel also being experienced in New York Heating Oil. The difference between the correlation coefficient and one, in the above case 0.0131, is basis risk. Basis risk describes

³⁰ (CME Group 2012)

³¹ Correlation coefficient calculated using historical data provided on www.eia.gov (U.S. Energy Information Administration (EIA) n.d.); June 23, 2012.

the risk that the value of the commodity does not move according to the value of the derivative contract. It defines the proportion of fluctuations in the jet fuel price that does not translate to e.g. the price of heating oil. Basis risk can be further split into three components that are product basis risk, time basis risk and location basis risk. Product basis risk describes the potential of discrepancy in the quality or weight of the underlying commodity. Even though crude oil, heating oil and jet fuel are similar products, they have very different product and market characteristics, which could lead to distortions in pricing. Time basis risk occurs when the time frame of the hedger is different from the period specified in the futures contract. Finally, location basis risk describes the mismatch in the price of a commodity based on its location. The spot price of jet fuel for example can vary significantly not only within a country, but also globally.

There are no limitations to the choice of commodity for hedging jet fuel as long as its correlation coefficient is positive and close to one. Since the goal of hedging is to reduce risk, keeping basis risk as low as possible increases the efficiency of the hedge. Based on these criteria, New York Heating Oil and WTI Light Sweet Crude Oil³² are good candidates for hedging purposes.

³² Correlation coefficient is 0.9436.

7 Airlines and Hedging Strategies

The majority of airlines can be roughly categorized as being risk-averse and do not hedge their entire fuel needs for extended periods. Only partial amounts are being hedged for the following 12 to a maximum of 24 months on average.

Consequently, call options, swaps and collars are considered the preferred choice for hedging fuel for being less speculative. However, some airlines do hedge fuel with futures. A hedging strategy is not limited at all to call options, swaps, collars and futures. There are numerous variations possible and these four instruments only form the basis for most hedging strategies. Regardless of the type of instrument, the most used underlying commodities are crude oil and heating oil for the reason that they are both traded on exchanges, which jet fuel currently is not.

7.1 Hedging with Swaps

A commodity swap is a derivative in which counterparties exchange a floating price for a fixed price over a specified period of time.

A large proportion of commodity swaps traded on the market involve crude oil. In the airline industry, swaps are normally arranged between the airline and fuel suppliers. While the airline assumes the fixed price portion of the swap as its main goal is to reduce the fluctuations in the price of jet fuel, the fuel supplier usually assumes the portion of the variable price. There is no physical delivery of the commodity involved in a swap and there can only be one winning party (zero-sum game). The contractual obligations are settled through cash transfer from the losing to the winning party.

Swap contracts are available on organized exchanges as well as over-the-counter markets. Swap banks are often used to facilitate a transaction. These financial institutions act as an intermediary for finding suitable counterparties in return for a

premium. Custom agreements can be created only in the over-the-counter market. These contracts allow both counterparties to specify quantity, settlement and time period. If a swap bank is not involved, then these basic swaps, also called plain vanilla swaps, do not cost any money. Besides being able to create jet fuel contracts over-the-counter, exchanges also offer swap agreements, e.g. Gulf Coast Jet Fuel Calendar Swap listed on the NYMEX.

Example

An airline enters into a one-year swap agreement involving 100,000 barrels of monthly jet fuel for a fixed price of \$120/barrel. The floating price of jet fuel is based on the monthly average of the New York Harbor Jet Fuel price. Each month the airline would purchase jet fuel on the spot market at the current price regardless of the swap agreement. However, at the end of each month the airline and the other party compare the fixed price of \$120/barrel with the average spot price of the month. If the average spot price is higher than the fixed price, then the airline will receive the difference from the other party. However, if the average spot price is lower, then the airline will have to pay the difference to the other party. For the airline the calculation goes as follows

$$\text{Settlement Cost} = (\text{Monthly Average Spot Price} - \text{Fixed Price}) \times \text{Quantity}^{33}.$$

So, if in the first month the average price results in a \$3 increase, the airline would receive \$300,000 to offset its spot market purchase of \$12.3 million. If the average spot price decreases to \$116/barrel in the second month, then the airline will be forced to pay the other party \$400,000. Either way, the airline continues to buy jet fuel on the spot market regardless of the price. The settlement payments from the swap contract may fluctuate from month to month, but the effective cost for the 1.2 million gallons of jet fuel purchased throughout the one-year time remains the same at \$130/barrel. The annual average price determines the winning party. If it exceeds the fixed price, the airline would benefit from the swap.

³³ (Vasigh, Fleming and Mackay 2010, 322)

Conversely, if the annual average price falls below the fixed price, then the airline would record a hedging loss.

7.2 Hedging with Call Options

Airlines need fuel to be delivered, so it is almost logical that they want to buy call options when they believe that the price of jet fuel is going up in the future. Call options like futures have no organized market for jet fuel contracts. To overcome this limitation, traders turn use options for heating oil, diesel fuel or crude oil instead because of their highly correlated prices. The advantage of a call options is that it can act as a price cap ahead of impending jet fuel price increases. Even if the price falls below the strike price, the airline can still choose not to exercise the option. The only loss recorded is the initial premium. Unlike swaps, where a spot price below the strike price would mean a heading loss, call options allow airlines to benefit from unexpected lower prices.

Call options can be purchased either on exchanges or over-the-counter. However, because of the nature of over-the-counter contracts, both parties have to take into account counter-party risk. Financially weaker airlines are therefore already hindered at the very beginning in trading with over-the-counter options, because nobody wishes to deal with companies that are prone to default. To overcome this problem, most airlines purchase call options on exchanges. Theses have clearing houses that eliminate counter-party risk. Exchange-traded options are usually available for the next three months, but longer period oil options are also available. On the NYMEX or CME, oil options are specified very much like futures contracts. One standard oil option contract contains 1,000 barrels of oil. Maturity dates are listed on a per month basis, but the actual expiration date various from month to month. Usually it is around the middle of the preceding month. One maturity month includes several strike prices. A low strike price equals to a high premium and is limited in the number of contracts available.

Table 7.1 WTI Light Sweet Crude Oil Call Options, January 2013

Maturity Month	Strike Price \$ / barrel	Premium ¢ / barrel
January 2013	4500	53.00
January 2013	7700	22.19
January 2013	10450	4.03
January 2013	15500	0.18

Data: Globex Options data on August 1, 2012³⁴

Airlines can use the following formula to calculate whether to exercise an option or not, and how much profit or loss they will make.

$$\text{Hedging Gain/Loss} = (\text{Spot Price} - \text{Strike Price, or 0 if Spot Price} < \text{Strike Price}) \\ \times \text{Quantity} - (\text{Premium} \times \text{Quantity})^{35}$$

If the spot price is below the strike price, the option is not exercised and the end result should be a negative number equaling the premium paid. If the spot price is slightly above the strike price and the result should be near zero and the option had little to no hedging effect. A positive end result equals to a gain from the hedging activity.

7.3 Hedging with Collars

A collar is a combination of purchasing call and selling a put option. The sale of the put option is required to offset the premium from the call option.

As the name suggests, collars can decrease the speculative risk that one might have with conventional options. The call and the put are usually purchased at the same time with the same expiration date. The strategy here is to purchase both options out-of-the-money. For the call option, this means that the option's strike price is higher the spot price of the underlying asset. Conversely, for the put, the strike price is lower than the spot price. These options would be worthless when

³⁴ (CME Group 2012)

³⁵ (Vasigh, Fleming and Mackay 2010, 325)

bought separately. The put option protects against decreasing prices of the underlying asset, thus creating a price floor. At the same time, the call option protects against any price increases beyond the call option's strike price, thus creating a price ceiling. The premium received from the put option can be used to pay for the call option. The actual cost of the collar is dependent on the two premiums and the strike price of the two options, thus called "premium collar". If both options have the same premium then no fees apply, making it a "zero-cost-collar".

Table 7.2 WTI Light Sweet Crude Oil Put Options, January 2013

Maturity Month	Strike Price \$ / barrel	Premium ¢ / barrel
January 2013	4500	0.01
January 2013	8600	2.70
January 2013	9100	4.03
January 2013	15500	57.17

Data: Globex Options data on August 1, 2012³⁶

7.3.1 Zero-Cost-Collar

An airline owns crude oil futures with a value of believes that the price of crude oil futures will become unstable, thus increasing the risk of losing money. Using the January 2013 quotes, an airline first sells a put option at a strike price of \$91. The buyer of the put pays a premium of \$4.03. The airline then uses the received premium to buy a call option with a strike price of \$104.50 for the same premium. As a result, the airline has created at price ceiling at \$103.50 and a price floor of \$91. Compared to purchasing a call option alone, this construction eliminates the cost for the premium. However, the downside to this construction is that if the spot price falls below \$91, the airline would record a hedging loss. The hedging gain/loss can be calculated as

³⁶ (CME Group 2012)

$$\text{Hedging Gain/Loss} = (\text{Put Option Premium} - \text{Call Option Premium}) + (\text{G/L Call Option} + \text{G/L Put Option})^{37}.$$

Zero-cost-collars are only one of many other combination possibilities. Moreover, each combination of put and call option can be created to suit each individuals' needs and will have a different gain/loss outcome.

7.4 Hedging with Futures

Futures are popular among airlines due their relatively easy and cheap application to insure against price risks. As previously mentioned, one of the issues with futures is that there are no jet fuel contracts available. A perfect alternative would be Kerosene. It is highly correlated with jet fuel being the primary component. However, the Tokyo Commodities Exchange (TOCOM) is one of the very few that has kerosene futures contracts. The problem with these futures is that they are traded in Japanese Yen, thus introduce foreign exchange risk. That being, they are not suitable for traders from other regions of the world. Nonetheless, futures contracts with refined oil products as an underlying commodity are widely available on most major exchanges. These futures contracts can be traded for up to eight years making them very suitable for long-term hedging strategies, although most airlines only hedge with shorter six-month forward time frame. While the long-term hedges usually allow for larger hedging gains, shorter periods reduce the amount of risk and speculation that is involved. The strike price for long-term hedges also tends to be lower, but airlines have to bear the risk that the oil price might suddenly move into the opposite direction for a much longer time.

One the major advantages of futures contracts is that airlines do not need to pay a premium up front. The most important decision airlines have to make is to determine the right amount to hedge. On the one hand, cautious airlines that have successfully hedged only partial amounts of their fuel needs "in-the-money" would have wanted to hedge the entire amount. On the other hand, airlines that were unsuccessful with their hedges would have wanted to not hedge at all. There is no

³⁷ (Vasigh, Fleming and Mackay 2010, 328)

simple way to determine the right ratio. An approach to an optimum hedge would be a ratio where the gains/loss of hedging are offset by a substantial increase/decrease in the commodity's spot price.

Even though futures are standardized instruments, and as such are protected against counter-party risk by the exchange, they do not eliminate basis risk. Basis risk is introduced because crude and heating oil are not perfectly correlated with jet fuel, and thus create inequalities between spot price and futures price. Basis risk plays an important role in determining the optimal hedge ratio, which in return can help build a suitable hedging strategy.

$$\text{Basis} = \text{Spot Price of Hedged Commodity} - \text{Futures Price}^{38}$$

The change in price caused by the differences in volatility can be expressed by

$$\Delta \text{ Jet Fuel Spot Price} - H * \Delta \text{ Futures Contract}$$

where H symbolizes the hedge ratio.

$$H = \rho * \sigma [\text{spot}] / \sigma [\text{futures}]$$

ρ : correlation between jet fuel spot price and futures contract

σ : standard deviation

The value for the hedge ratio H varies depending on the data being used. Hedging managers must therefore cautiously monitor these contracts at all times to ensure that the involved basis risk maintains at its relative value throughout the contract's time.

³⁸ (Cobbs and Wolf 2004)

7.5 Airlines and Foreign Currency Risk

International airlines transport their passengers from one country to another. In order to do so they have to sell tickets in many foreign countries and accept foreign currency. Not only do ticket sales involve foreign currencies, but also various expenses like fuel or aircraft purchases and many other are paid in the local currency of the supplier. Thus, airline treasuries have to deal with revenues, expenditures, assets and liabilities in both local and foreign currencies. Airlines can be seriously affected by foreign exchange rate movements. As long as income and expenditures in a foreign currency balance each other out, and thus not involving transferring money in or out of the country, there is no exchange risk. However, this is far from reality, as periods of surpluses or losses will occur. Surpluses have to be converted to home currency and losses have to be compensated by transferring home currency money abroad. Thus, exchange risk is involved. One way to avoid conversion is to borrow or lend money in foreign currencies. Europe has limited its exchange rate problem by introducing the Euro in 2000. Since then, European airlines were able to reduce their currency risks and transaction costs.

Fluctuations in the foreign exchange rate can have a very negative effect on profits. Airlines are faced with the problem that profits earned in a foreign currency could be worth less after a conversion. The more foreign currencies are involved, the more risk exposure to price movements. Scandinavian airline SAS for example has three “domestic” currencies, the Swedish Krona, the Norwegian Krona and the Danish Krona covering roughly 60% of total revenues and costs. Apart from those three, SAS also trades in Euro, US Dollar, Pound Sterling, and currencies from other smaller markets. Turkish Airlines on the other hand is trading with more foreign currencies than with their Turkish New Lira. Almost half of total revenues come in Euros due to its strong presence in the European Union. However, Turkish Airlines has expenditures of about 50 % in their home currency and about 13 % in Euros.

Airlines have a very conventional way dealing with these imbalances. They simply try to match revenues and expenses, assets and liabilities, in each currency, also called a “natural hedge”. United Airlines, for instance, reduced their Euro surplus

by spending it on food and wine in France for its in-flight catering. When natural hedges are not possible, surpluses can be sold immediately on the spot market. The forward market would be another alternative. Prices for the forward market are quoted for the following three, six, nine and twelve months. A forward contract will commit an airline to buy a predetermined amount of a given currency at a future date at a given exchange rate.

While most of the airline industry hedges fuel costs, currency hedging is also practiced extensively. Currencies are much more liquid compared to jet fuel, which allows airlines to participate in the futures market directly.

7.6 Hedging Strategies

There are many strategies to hedge one's fuel needs, but none are perfect. Each solution has its advantages and disadvantages. Southwest Airlines and few other airlines have proven that hedging fuel can be successful on a long-term scale, but at the same time, numerous airlines going bankrupt over the past several years have shown that it can also go wrong.

7.6.1 Over-the-Counter vs. Exchange-Traded Instruments

Over-the-counter instruments are traded directly between two parties, e.g. airline and investment bank. These instruments are highly customizable and can be arranged for the individual need. Therefore, airlines are more flexible in adapting their hedging strategy to any market situation.

The cost involved in a transaction is also lower than at an exchange. Negative side effects of not being a standardized product are counterparty risk and illiquidity. As a result, airlines tend to trade with more than just one financial institution in order to diversify counterparty risk and to get the lowest possible price. When trading with over-the-counter derivatives, airlines prefer options, collars and swaps. Oil prices move up and down in cycles creating recurring low and high points. The

basic goal of a basic hedging strategy is to lock in low prices at the low points and cap rising prices at the higher end.

Airlines use different instruments during different phases of the oil price cycle. A low point presents the best opportunity to lock in the low price using swaps. At this point, the oil price is not likely to drop even further. During the phases in between low and high point, collars are used to lock in a certain range of prices. There is however a trade-off with collars. If the oil price drops, there is no way of exiting the collar to take advantage of the lower price. If prices are at the higher end of the cycle, capping can prevent losses from further increases.

Unfortunately, there is no simple rule that defines the best strategy. The key to hedging successfully is to have a dynamic hedging program utilizing a mixture of instruments over the price cycle.

7.6.2 Hedging vs. No Hedging

“A lot is said about hedging strategy, most of it well wide of the mark. I don’t think any sensible airline believes that by hedging it saves on its fuel bills. You just flatten out the bumps and remove the spikes.”³⁹

Sir Roderick Ian Eddington, British Airways CEO (2000-2005)

There are airline managers who believe that hedging is not a solution to the risk of rising fuel prices and therefore do not hedge. Many airline executives say that hedging is not a core competency in their respective airline and that as long as the competition does not hedge; there is no reason to do so either. The problem with these kinds of statements are, that when fuel prices do start to rise badly, these airlines have no other choice then to pass the additional expenses to their customers which is not a viable solution for the long term. Especially in the United States, airlines are struggling to pass on fuel surcharges to the passenger because of fierce competition and weak demand.

³⁹ (AFX News 2004)

Former British Airways CEO Roderick Ian Eddington, being against hedging, once said: “when you hedge all you do is bet against the experts of the oil market and pay the middle man, so you can’t save yourself any money long term. You can run from high fuel prices briefly through hedging but you can’t run for very long.”⁴⁰ The majority of airlines does not share this idea and believes that remaining exposed to market prices as the standard strategy is all but arguable. So, why are there still airlines in the world that do not hedge at all and even are opposed the idea that fuel hedging can be a money saving tool? A possible answer to that question is that there seems to be a peer-pressure mentality among legacy carriers that prevents them from hedging. Some airline executives even see fuel hedging as a sign of financial weakness, while others do not hedge, because they like to take risks. Low-cost carriers among many others do not share their traditional counterpart’s thinking.

On the other side, many positive aspects point in favor of hedging. Some non-hedging airlines with older aircrafts have even stated in their Form 10-K⁴¹ report that their decision not to hedge has led them to a disadvantage compared to other airlines with newer aircrafts. Any increase in the price of jet fuel due to sudden disruptions in supply, like the invasion of Kuwait by Iraq in 1990, would have introduced a disproportional higher increase in the airline’s total fuel expenses. Apart from protecting against price volatile prices and saving money on fuel cost, empirical evidence has shown that hedged airlines can achieve a hedging premium for their stocks, thereby increasing firm value. Investors value more consistent and stable cash flows, and the ability to better predict future earnings. The overall confidence of the financial market is also strengthened by hedging airlines. The connection between hedging purchases of jet fuel and the firm value of an airline has been extensively researched by Carter, Rogers and Simkins (2003)⁴². They state that the cost of jet fuel costs is positively correlated to airline investment opportunities, meaning that industry cash flows are usually low when jet fuel costs are high. Jet fuel form a large portion of an airline’s total operating

⁴⁰ (AFX News 2004)

⁴¹ Annual report required by the U.S. Securities and Exchange Commission (SEC). It contains a comprehensive overview of a public company’s business and financial condition and includes audited financial statements.

⁴² (Carter, Rogers and Simkins, Does Fuel Hedging Make Economic Sense? The Case of the US Airline Industry 2003)

costs, and this portion is strongly linked to highly volatile prices. Airlines that have the necessary funds hedge this risk. Lower jet fuel costs means more capital that can be utilized elsewhere. During periods of high fuel prices, bankruptcy rates are higher than normal. Airlines going bankrupt are forced to sell their most valuable and most important main assets, namely their airplanes, at unreasonably low bargain prices. On the other hand, airlines that are hedged will have more resources available and have the opportunity to purchase the underpriced assets from those distressed airlines. Furthermore, hedging allows airlines to maintain the ability to meet contractual obligations that were previously made, engage in new investments, in particular aircraft purchases, leading to a major strategic advantage over competing airlines. Moreover, shareholders benefit from higher stock values. The research from Carter, Rogers and Simkins concluded that a hedged airline could approximately aggregate a 12-16% increase in firm value, thereby increasing its overall market value and strengthen its position against the competition.

Even though the majority of airline executives agree on the advantages and the financial necessity of fuel hedging, their strategies differ. The following table shows eleven major domestic U.S. airlines and their take on fuel hedging in 2003.

Table 7.3 Airline Fuel Expense and Hedging Summary 2003

	FY2003								
		Per ASM		Fuel as a			Max		
	ASM		Fuel	% of Op	Current	Years Fuel	Maturity	Avg % of Fuel Hedges	
Airline	(millions)	Revenue	Expense	Exp	Ratio	Hedged	of Fuel Hedged	FY2004	FY2005
Airtrans H.	10.046	\$0,091	\$0,018	21,5%	2,61x	1999-2005	2,0	35,0%	12,0%
American	165.209	\$0,106	\$0,017	15,2%	0,71x	1993-2005	2,0	12,0%	4,0%
ATA	21.126	\$0,072	\$0,013	19,2%	0,29x	2001-2002	1,0	0,0%	0,0%
Continental	78.385	\$0,113	\$0,016	14,5%	0,90x	1996-2003	1,0	0,0%	0,0%
Delta	134.000	\$0,099	\$0,014	13,8%	0,75x	1996-2004	3,0	32,0%	0,0%
Frontier	2.841	\$0,208	\$0,036	17,9%	1,65x	2003-2004	0,5	7,0%	0,0%
JetBlue	13.639	\$0,073	\$0,011	17,8%	1,75x	2002-2004	1,0	40,0%	0,0%
Northwest	88.593	\$0,107	\$0,018	15,9%	0,93x	1997-2004	1,5	0,0%	0,0%
Southwest	71.790	\$0,083	\$0,012	15,2%	1,34x	1997-2007	4,0	82,0%	60,0%
United	136.630	\$0,100	\$0,015	13,7%	0,66x	1995-2003	2,0	0,0%	0,0%
USAirways	58.106	\$0,118	\$0,014	11,7%	0,80x	2000-2005	2,0	30,0%	5,0%

Data: (Cobbs und Wolf 2004)

ASM = Available Seat Mile⁴³

⁴³ "Available Seat Mile" is a measure of an airline's passenger carrying capacity and is calculated as number of available seats multiplied by number of miles flown. It is used as a unit of production for passenger-carrying airlines.

All airlines included in the table were hedging their fuel needs. Furthermore, jet fuel represented one of the largest operating expenses. In 2003, fuel expenses, on average were 16% of total expenses; Airtrans Holdings and Air Transport Association were among the highest with almost 21.5% and 19.2% respectively. Therefore, everyone tried to acquire jet fuel at the lowest possible price and at the same time reduce volatility through hedging programs. The amount of fuel that was hedged varied greatly. Southwest Airlines is well known for its extensive hedging strategies. Southwest hedged 82% of its 2004 and 60% of its 2005 fuel needs. Compared to the other airlines these numbers were well above average. Still, there are situations where hedging is simply not possible. Especially small regional airlines that want to hedge against fuel price risks are sometimes unable to do so, simply because they do not have enough funding. Even large airlines sometimes struggle with the cost of hedging due to bad creditworthiness. Unfortunately, without the necessary funds, an airline is presented with only a limited choice of hedging contracts. These contracts, which are mostly designed by their counterparties who generally seek different goals, are cheaper, but are also less advantageous for the airline. Thus, the ability and effect of fully protecting against potential future price surges is greatly reduced.

With all the benefits of reducing the volatility of profits or increasing firm value presented, there are certain situations where it does not result in the desired effect. Generally, hedges are aimed at protecting fuel prices from unforeseen increases due to wars or economic events that lead to a low oil supply. When oil supply is low, consumers and businesses lose confidence. Air travel demand and revenues are negatively affected. In this situation, profits from hedged fuel are used to compensate the losses. In times of economic growth oil demand increases, which causes prices to move upward again. Hedging contracts then become demand-driven and can lead to increased profit instabilities. During times of conflict in the Middle East for example, hedging fuel can reduce volatility. However, when the world is at peace, hedging has the potential to increase volatility.

8 Southwest Airlines

“If we don’t hedge jet fuel price risk, we are speculating. It is our fiduciary duty to try and hedge this risk.”⁴⁴

Scott Topping, former Vice President Treasurer at Southwest Airlines

Southwest Airlines originally was founded as Air Southwest Co. in Texas in 1961 as an intrastate service. In 1971, the airline changed its name to Southwest Airlines Co. and began offering service between Houston, Dallas and San Antonio using three Boeing 737 aircrafts. Southwest Airlines has a business model based on being a low-cost carrier and has been very successful at offering the lowest airfares in the United States.

When airline deregulation came in 1978, Southwest started expanding its service to other states. However, it was not until 2006, after years of hindrance by federal laws and legal actions by competitors, when Southwest was finally able to grow and expand its services nationwide effectively resulting in consistent market share growth. It has since become the largest low-cost airline in the United States based upon domestic passenger numbers. Southwest has also received numerous awards for its on-time service, good baggage handling and fewest customer complaints. Over the years, it has introduced innovative products such as a frequent flyer program that was based on the number of trips taken rather than number of miles flown, senior discounts, same-day airfreight service, paperless tickets, and many others.

Southwest is a sole Boeing 737⁴⁵ operator. By only using one type of aircraft, it can save additional management and maintenance costs. When purchasing new aircrafts at Boeing Southwest can obtain higher bulk discounts. This strategy is

⁴⁴ (Blanco, Lehman and Shimoda 2005)

⁴⁵ Southwest Airlines also operates a fleet of 88 smaller Boeing 717 aircrafts. These aircraft were added to the current fleet in 2011 after acquiring AirTran Airways.

mainly suitable for domestic flying low-cost carriers. Legacy carriers usually utilize different sized aircrafts for different destinations based on capacity.

As of September 30, 2011 Southwest Airlines is the largest operator of the Boeing 737 worldwide with over 559 aircrafts in its fleet and has open orders of over 300 new aircrafts including 150 firm orders and 150 options for the newest Boeing 737 MAX scheduled for delivery in 2017. It is currently the largest “major”⁴⁶ domestic airline in the United States based on domestic passengers carried.

8.1 Corporate Risk Management

Jet fuel is a very important commodity for Southwest Airlines, because without it their airplanes would not fly. As with every airline, fuel cost has become a dominant cost factor for Southwest besides labor expense. Fuel costs per gallon had risen from \$0.46 in 1998 to \$1.70 in 2007 when overall fuel expense made up 28% of total operating expenses. Intense competition among U.S. domestic airlines has made passing on the increased cost to the passenger very difficult. A solution would be to increase ticket prices, but this is not an option for Southwest. Air travel has already transformed into a commodity business and being as such, high-cost producers are not able to survive. As a low-cost carrier, Southwest Airlines needs to continue offering cheap prices to stay competitive, as this is their key to survival and success. Therefore, the solution to address fuel price increases is to either cut down other operating expenses and hedge fuel prices by locking in advantageous prices in advance.

Southwest Airlines has gained a reputation for its proactive risk management, which in return has led to a lot of positive press. Even during the oil crisis in 2008, when most of the other airlines were struggling to minimize the losses, Southwest was able to maintain its competitive advantage and even announced that it was able to sustain growth.

⁴⁶ The Department of Transportation defines a “major” carrier to having operating revenues of at least \$1 billion a year.

8.1.1 Counter-party Risk

Southwest preferred using OTC hedging instruments and with such credit risk was a major problem. As of 2007, the airline has diversified its credit risk across nine different counterparties. These counter-parties were required to pay a cash collateral if predefined credit rating or market risk exposure thresholds were crossed. This measure ensured that the counter-parties' financial health was secure.

8.1.2 Derivatives

Throughout the years, Southwest Airlines has always had one of the highest hedge ratios in the world. In 2005, Southwest hedged over 70% of its 2006, over 60% of its 2007 and approximately 30% of its 2008 projected fuel requirement. While the average crude oil prices for the aforementioned years were \$66.05, \$72.34 and \$99.67 per barrel⁴⁷, Southwest was able to achieve average crude oil equivalent prices of \$36, \$38 and \$39 per barrel respectively through its hedging program.

Southwest strategy incorporates a mixture of purchased call options, collar structures and fixed price swap agreements. Generally, the type of contracts does not vary much across airlines. While some airlines rely on exotic structured option combinations, Southwest has mostly committed itself to plain vanilla contracts. OTC contracts are the preferred choice as they provide the needed flexibility for Southwest Airlines' dynamic strategy. Depending on the various phases of the oil price cycle different contracts or combinations of contracts are used. At the bottom of the oil price cycle when further price declines are unlikely to occur swaps are suitable to lock-in good prices. Then, during the mid-range of the cycle collars are a cheap measure to protect from increasing prices. The only caveat is giving up eventual gains from decreasing prices. At the peak of the cycle straight calls allow capping prices and protect from further increases with the benefit of prospected decreasing prices.

⁴⁷ (U.S. Energy Information Administration (EIA) n.d.)

8.1.3 Commodities

Southwest Airlines mainly uses three kinds of commodities to hedge fuel, they are crude oil, heating oil and unleaded gasoline. The reason behind these choices is based on both basis risk and liquidity. Crude oil in general is the main commodity used to hedge fuel required far out in the future. That being said, the oil future market is, although being very liquid, in the short term vulnerable to speculative manipulations. Another problem is basis risk, which is introduced simply by using crude oil as the underlying commodity. Besides crude oil, heating oil provides hedgeable contracts for up to two years into the future and its price moves are more correlated with jet fuel prices, thus greatly reducing basis risk. Jet fuel contracts are mostly used only to cover short-term hedges for up to six months, due to the lack of available traded contracts and consequently limited liquidity. Southwest goal is to achieve the best possible price, reducing both costs and basis risk. The type of commodity used mainly relies on timing and the level of the basis risk that is involved.

8.1.4 Hedge Ratio

Southwest Airlines' flexible hedging strategy does not differ that much from other airlines. What sets everyone apart is the percentage of fuel hedged, also known as the hedge ratio. It is difficult to fully understand the motivation behind Southwest's hedge ratios, but it is at least possible to identify all the necessary steps that were made to achieve Southwest's perpetual hedging success.

Prior to 1999, Southwest approached fuel hedging very cautiously and hedged only small portions of its fuel needs. This changed in the year 2000 when Southwest started to become more aggressive and hedged most of its fuel requirements. Comparing to all the other U.S. airlines Southwest immediately stands out with its high percentage of around 80% while competitors average only at about 55%. These airlines tend to align their hedged percentage to the rest of the industry and follow a more traditional rule of capping their hedged fuel at around 50%.

8.2 Southwest Airlines' Hedging Program

Every airline in the United States is obliged to disclose its financial situation to the United States Securities and Exchange Commission on an annual basis. These so-called Form 10-K filings are then made available to the public. According to the data published from 2008 to 2011, Southwest's hedging program is based on a five to six year schedule. During this time Southwest implements long-term hedges and then adjusts yearly depending on short-term fuel needs by rolling over positions, increasing hedge ratios or switching to different contracts. Long-term contracts help the airline to avoid temporary distortions of the market induced by speculative activities. Short-term contracts help counterbalance previously made mistakes and grasp unexpected advantageous investment opportunities.

The following table illustrates Southwest Airline's hedging ratio for the years 2004 to 2011. Comparing the resulting crude oil prices that were achieved through Southwest hedging program with the actual WTI Crude Oil prices of the respective years clearly shows how successful Southwest's dynamic strategy turned out to be.

Table 8.1 Percentage Hedged and Equivalent Crude Price

	2004	2005	2006	2007	2008	2009	2010	2011
WTI Crude Oil Price (per barrel)	\$41,51	\$56,64	\$66,05	\$72,34	\$99,67	\$61,95	\$79,48	\$94,88
% hedged of total requirements FY2003	82%							
equivalent Crude price (per barrel)	\$24							
% hedged of total requirements FY2004	80-85%	85%	65%	45%	30%	25%		
equivalent Crude price (per barrel)	\$24	\$26	\$32	\$31	\$33	\$35		
% hedged of total requirements FY2005		85%	70%	60%	35%	30%		
equivalent Crude price (per barrel)		\$26	\$36	\$39	\$38	\$39		
% hedged of total requirements FY2006			70%	95%	65%	50%	25%	15%
equivalent Crude price (per barrel)			\$36	\$50	\$49	\$51	\$63	\$64
% hedged of total requirements FY2007				100%	70%	55%	30%	15%
equivalent Crude price (per barrel)				\$50	\$51	\$51	\$63	\$64
% hedged of total requirements FY2008				90%	78%	10%	10%	10%
equivalent Crude price (per barrel)				\$50	\$51			

Data: (Southwest Airlines Co. 2004, 2005, 2006, 2007, 2008)
(U.S. Energy Information Administration (EIA) n.d.)

Southwest Airlines' strategy has always been one of the more aggressive compared to the rest of the industry. Other airlines have a tendency to be more passive when it comes to hedging. Especially traditional carriers often depend on

the point of view of their consulting banks. However, banks and airlines have conflicting interest as banks also play a major role as speculators in the oil market. At the end of 1999, Southwest employed a mixture of crude oil call options and swap agreements. The latter instrument was implemented to protect against rising fuel prices, but they also exposed Southwest to the strategic risk of falling prices. Call options provided additional flexibility. However, because Southwest entered into crude oil contracts product and location basis risk were introduced. Options were used on short-term (within a quarter) hedges and swaps on longer-term hedges (three to five quarters). During the first two months in 2000, the company increased its hedge ratio immensely and added crude oil collars into their hedging program. By the end of the year, Southwest had begun using heating oil contracts as their primary hedging commodity. During the next four years, heating oil options were mainly used for short-term hedges and crude oil contracts for longer-term hedges. Southwest had hedged its fuel requirements for a maximum of two years in advance. At the end of 2003, the hedge ratio was 82% for 2004 and 60% for 2005. This changed by the end of 2004 when Southwest had also employed hedging contracts for significant proportions of its 2007 to 2009 fuel needs. This was quite unique when compared to other airlines. From Southwest standpoint, the risk of an increase of jet fuel prices far outweighed the possibility of a decrease. However, the risk of falling prices was still there, because of Southwest significant amount of fuel hedging contracts a price decline triggered by a weakening economy could really cause tremendous losses.

In 2005, Southwest employed hedges to reduce product basis risk that resulted from fluctuating refinery margins. Since then, the airline has also stopped disclosing every detail about its hedging program for competitive reasons.

The general trend of jet fuel prices has been positive most of the time and this has helped Southwest gain considerably amounts of money.

Financial Year 2004

- cost of fuel becomes second highest category after labor
- fuel hedged 80%-85%
- \$455 million total savings from hedging

Financial Year 2005

- Jet fuel accounts for 19.8% of total operating expenses
- Industry total losses \$40 billion over previous five years
- Southwest reports 33rd year of consecutive profitability

Financial Year 2006

- \$675 million total savings from hedging
- since 2000 \$2 billion total savings from hedging
- 95% jet fuel requirement for 2007 hedged
- significant hedge ratio increase for the next three years (+25% for 2007, 2008 and +30% for 2009)
- retains investment grade rating
- \$1.8 billion cash, debt ratio under 35% (including aircraft leases)⁴⁸

Financial Year 2007

- the 95% fuel hedge from FY2006 generates \$727 million in savings
- year-over-year increase in jet fuel price is effectively limited to 11.3%
- 65% jet fuel requirement for 2008 hedged at \$51 per barrel
- \$52 million spent on hedging premiums

Financial Year 2008

- since 1999 Southwest had saved \$3.5 billion
- during the same period while Southwest paid \$1.98 per gallon for jet fuel, American Airlines and United Airlines paid \$2.73 and \$2.83 respectively
- hedging profit of \$291 million dwarfs Southwest's overall profit of \$34 million
- fuel price tumbles after record high of \$145 per barrel in July to \$32 within months

⁴⁸ As comparison the debt ratio for Continental Airlines excluding aircraft leases was 97% in 2009.

- profit streak comes to an end resulting in three quarterly losses due in part of its fuel hedging contracts
- most swap contracts are sold at a loss
- 4%-5% reduction of capacity
- fuel requirement hedged for 2009, 2010, 2011 and 2012 were 70%, 40%, 20% and 20% respectively

The following table illustrates Southwest's quarterly fuel prices vs. market prices.

Table 8.2 Quarterly Fuel Price, Hedge Ratio and Savings

prices in US dollars per gallon	2004 Q1	2004 Q2	2004 Q3	2004 Q4	2005 Q1	2005 Q2	2005 Q3	2005 Q4	2006 Q1
WTI	0.84	0.91	1.04	1.15	1.18	1.26	1.50	1.43	1.51
Heating Oil	0.90	0.95	1.15	1.32	1.36	1.49	1.82	1.81	1.72
Jet Fuel	1.02	1.11	1.28	1.42	1.45	1.62	1.93	1.89	1.85
Hedge Ratio	82%	82%	82%	82%	85%	85%	85%	85%	70%
Hedged Fuel Price	0.80	0.82	0.80	0.80	0.90	1.02	1.01	1.01	1.51
Savings per gallon	0.22	0.29	0.48	0.61	0.55	0.60	0.92	0.88	0.34

Data: (Mancini 2009, 29)

In addition to fuel expense savings, the company's hedging program also protects against underinvestment risks and allows it to consistently expand operations. In the case that Southwest has to turn back its capacities, it will be able to reduce less than its competition. According to Southwest Airlines' 2008 Form 10-K, the company expected net available seat mile (ASM) capacity for Q1 in 2009 was four to five percent less than the previous year. However, competing airlines with services on the same routes had to reduce their capacities by up to 15%. At the same time, Southwest announced that it would start three new routes and that it already received initial approval to seize 14 take-off and landing slots from a bankrupt airline at New York's LaGuardia airport. These slots would allow up to seven daily roundtrips to LaGuardia. New York was only one of several expansion plans for 2009.

Southwest's fuel hedging strategy allows the airline to continue directing resources toward future investment opportunities when competitors are struggling for cash. Since 2008, Southwest has sold all of its unprofitable fuel hedging contracts and entered into new lower priced contracts. In contrast to the more aggressive

hedging strategy in the past, Southwest has only covered 10% of its fuel needs for 2009-2013 with hedges in 2009.

9 Conclusion - Does It Make Sense To Hedge?

The oil price is a major concern for any business that relies on it. Airlines are in particular vulnerable to volatile oil prices, because their entire business heavily relies on jet fuel for their aircrafts. They have no alternative fuel source at their disposal, not at the moment at least. The constant upward trend of the oil price in the last two decades has led to a major change to the airlines' entire cost structure. While labor cost was once the largest cost factor, fuel cost has now taken over as the number one cost of an airline. Today's airlines are faced with jet fuel cost that represent approximately 20%-40% of total operating costs. This is a major problem, because even a small change in the price of oil could have a major effect on total cost. Hedging, when execute right, can greatly reduce the exposure to volatile prices.

Table 9.1 Percentage of 2004/2005 fuel needs hedged in 2003/2004

Column1	Percentage hedged	Average fuel price in cents/gallon	Market value of fuel hedge in \$	Commodity	Instrument
British Airways	41%	68,1	53	n/a	Collars, Swaps
KLM	80%	n/a	n/a	n/a	n/a
Air France	78%	n/a	n/a	n/a	n/a
Iberia	54%	55-62	n/a	Jet NWE	Swaps, Options
Lufthansa	72%	72,6	72	crude/heating oil	n/a
Air New Zealand	47%	n/a	84	WTI crude/jet	Options, Collars
Cathay Pacific	25%	n/a	n/a	n/a	Various
Singapore Airlines	n/a	n/a	59	n/a	Options, Swaps
Thai Airways	12%	n/a	n/a	n/a	Various
Emirates	19%	n/a	n/a	n/a	Options, Futures

Data: (Morrell and Swan 2006, 30)

Most of the airlines in the world hedge their future fuel needs. Usually, they hedge a fraction of their entire future fuel consumption. It seems that no airline has a hedge ratio of 100%. However, hedging has not always been as straight forward as it is today. Some state owned airlines were not allowed to use hedging

instruments until only the recent decade. Soaring fuel prices have made it necessary for governments and their central banks to change their minds and grant airlines permission to use hedging instruments. Air India for example was allowed to hedge only since 2003. Among US carriers, Southwest Airlines has the highest amounts of fuel hedged. In 2003, the airline has hedged 82% of its fuel needs for 2004 valued at 251 million US dollars. In the same year, Delta and US Airways both only hedged approximately 30%, and United Airlines, Continental and Northwest did not hedge at all. Even on a global scale, Southwest Airlines is one of the top hedgers.

“We view our program as insurance. Our goal is to minimize the volatility of fuel expenses. To do that, you’ve got to be in the market actively without an opinion as to what energy prices will do.”⁴⁹

Paul Jacobson, treasurer of Delta Airlines Inc.

Hedging is not about making money. Of course, you could argue that without a profit, airlines would not achieve a hedging success. However, for airlines, hedging is all about making an unpredictable future more controllable. An airline is a long lead-time business. It has to put out business schedules months if not years in advance. This is no easy task, if you do not know what is going to happen in the future. The best example for this are new aircraft orders. The time between the placement of an order and delivery can take many years. Emirates first placed an order for the Airbus A380 in April 2000 and has since increased its firm orders to 90 aircrafts. The first A380 was delivered to Emirates in 2008 and as of August 2012, a total of 23 A380s are operating in its fleet. It will take Airbus five more years, assuming that no more delays occur, to deliver the entire order of 90 aircrafts. Hedging is the insurance policy that let airlines know their future costs. Despite all its advantages, hedging is not always accessible to every airline. Cost and timing can often be a problem. Airlines with low capital will not be able to afford hedging contracts that include an upfront premium and airlines with low creditworthiness will find it difficult to find a suitable counterparty. Timing can also be major problem for hedging fuel. In times of high oil prices hedging fuel is rather

⁴⁹ (Associated Press 2008)

difficult. However, these are the time, when airlines might depend on it the most in order to survive. In addition, even if an airline has enough funds to enter hedging contracts, hedging is not always a “win-win” solution. Many major airlines have made the headlines with their hedging losses. The oil price movement in 2008, when prices rose up to US\$146 per barrel and then suddenly declined to below US\$40 within a few months, caught many airlines off guard. The following year, many airlines, including Singapore Airlines and British Airways, reported high losses. Cathay Pacific posted a record loss of US\$1 billion⁵⁰ and Emirates had a fuel-hedging loss of US\$428⁵¹. These airlines all thought that the oil price would continue to rise and signed large fuel contracts before the economic crisis that sent oil prices plummeting.

Even though not being a guarantee to success, hedging is still considered the best solution against high and volatile fuel prices. By utilizing the right strategies, airlines can greatly reduce risk and stabilize their financial profits and cash flows. Furthermore, hedging also contributes to an airline’s firm value. These are major advantages over non-hedging airlines. However, airlines will only be able to hedge their fuel needs as long as oil is being supplied. It is only a matter of time, when we run out of fossil fuels. The entire aviation industry in the world consumes over 5 million barrels of jet fuel in a single day. The increasing population and easier access to air travel will most likely make this number go up rather than go down. Scientists have predicted that the earth’s oil deposits will already be depleted around the year 2050.

So, the only long-term solution to this problem, it seems, lie in the hands of the engineers to come up with more innovative designs and technologies and create new airplanes that do not run on fossil fuels. Future aircrafts could run on 100% sustainable biofuel or even a fuel source that has not yet been invented. The bottom line, with the increasing travel demand and the continuous pressure to keep operating costs low, airlines will still have to rely on hedging instruments for quite some time to remain profitable in the future.

⁵⁰ (Vasigh, Fleming and Mackay 2010)

⁵¹ (Gale 2009)

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Appendix A – Curriculum Vitae

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Appendix B – Abstract (English)

The worldwide aviation industry depends on a single fossil fuel. Kerosene powers modern jet aircrafts that carry people and cargo to their destinations. An equally efficient alternative fuel that is also economical and sustainable is still not available. The oil price is highly volatile and unpredictable, thus forcing buyers to take any market price. This leads to immense cost that airlines can hardly bear. It has also become almost impossible to evaluate the future development of the oil price. Jet fuel hedging can counteract this problem by setting prices that are now considered favorable for the future. A successful hedging strategy can reduce price risk and stabilize profits.

The goal of this thesis is to acquire knowledge about financial hedging that is specific to the airline industry. The topics “historic development of the aviation industry”, “oil market” and “hedging instruments” serve as a basis for a practical work approach. Why is the oil price so unstable, and how do airlines cope with this development? Which hedging instruments are available to airlines and how do airlines make use of them? All of these questions are covered within the scope of this thesis by utilizing secondary literature and case studies. Finally, Southwest Airlines is used as an example to illustrate a successful hedging program.

Appendix C – Abstract (German)

Das Kerngeschäft der weltweiten Luftfahrtindustrie ist von einem fossilen Brennstoff abhängig. Kerosin ist jener Treibstoff, der den Transport von Mensch und Fracht mit modernen Flugzeugen möglich macht. Eine gleichwertig effiziente und darüber hinaus noch wirtschaftliche und nachhaltige Alternative gibt es noch nicht. Der Preis für dieses Erdölprodukt ist durch heftige unvorhersehbare Preisschwankungen gekennzeichnet, und ungeachtet deren Höhe müssen Treibstoffeinkäufer jegliche Preise auf dem Erdölmarkt hinnehmen. Dies führt zu enormen Kosten, die sich Airlines heutzutage kaum leisten können. Für Fluggesellschaften bedeutet Preisvolatilität aber auch, dass ein genaues Einschätzen des zukünftigen Verlaufes und Niveaus der Treibstoffpreise fast unmöglich ist. Jet Fuel Hedging kann diesem Problem entgegenwirken, indem Preise, die gegenwärtig als günstig empfunden werden, für die Zukunft festgelegt werden. Eine erfolgreiche Hedging-Strategie kann das Preisrisiko minimieren und Gewinne stabilisieren.

Das Ziel dieser Arbeit ist es, die Luftfahrtspezifischen Faktoren von Hedgegeschäften zu erarbeiten. Als Grundlage für eine praxisnahe Erarbeitung dienen die Themen „historische Entwicklung der Luftfahrtbranche“, „Erdölmarkt“ und „Hedging-Instrumente“. Warum ist der Ölpreis so instabil und wie stellen sich Fluggesellschaften auf diese Entwicklung ein? Welche Instrumente kommen für Jet Fuel Hedgegeschäfte in Frage? Wie und warum setzen Fluggesellschaften Hedging-Instrumente ein? Alle diese Fragen werden im Rahmen dieser Diplomarbeit anhand von Sekundärliteratur und Fallbeispielen behandelt. Zum Abschluss wird anhand der amerikanischen Fluggesellschaft Southwest Airlines ein erfolgreiches Hedging-Programm vorgestellt.