Hedging fuel price risk in the Canadian Department of National Defence: An application of risk management in the public sector

Naceur Essaddam* Derek Miller

Abstract

This case is designed for use in a finance course that includes risk management as a topic at the undergraduate or graduate levels. The case is designed to examine the application of a private sector risk management strategy in the public sector to educate the user about the commodity markets and the use of derivative instruments in risk management.

November 15, 2004: Allister Duffield hung up the phone and began to think over the contract the firm had just secured with the Department of National Defence (DND). Duffield is an energy consultant with Energy Solutions Inc, a consulting firm that specializes in assisting firms find solutions to their energy requirements. Duffield joined the firm five years ago after completing the CFA certification. Through his years with Energy Solutions, Duffield had worked on various project teams developing risk mitigation strategies in the fuel markets for a variety of clients. Most recently they had helped a number of aviation companies successfully develop hedging strategies to mitigate the risk of price fluctuation of jet fuel. Increasingly, these types of strategies are necessary for carriers to remain competitive as they face substantial fuel price uncertainty. This can have irreversible impacts on the bottom line, even forcing firms into bankruptcy as restricted cash flow inhibits their ability to meet financial commitments.

Duffield credits this past experience as the main reason Energy Solutions had been awarded this contract with DND. However, this was the first time that he, personally, had been charged with leading a project within the firm. To accommodate his relative inexperience in leading such tasks, his boss, the Director of Risk Management within the firm, had been quite explicit in his instructions for Duffield. Simply put, his task will be to develop and evaluate the various options available for the Air Force to hedge its aviation fuel costs. Facing similar price variation in jet fuel as civilian aviation firms, the Air Force is exposed to considerable price risk. The Director explained that the military leadership would make a decision about adopting such a risk management program based on the information presented. Therefore, Duffield's presentation must include a description of the fuel market and sources of price fluctuation, an explanation of hedging within the aviation industry, a description of hedging instruments used in developing such a strategy, and the application of a hedging strategy within the Air Force. Duffield began to consider the information he must gather to complete this task.

December 1 2004: Over the past two weeks, Duffield had received two files to assist him in preparing his presentation. The Director had given him a package describing the traditional volatility in the fuel market and the hedging strategies used within the aviation industry. A second file had been supplied by the military and included the historical fuel usage and cost of one of the Canadian Air Forces bases. The Wing includes a headquarters element that coordinates the overall efforts of the Wing and five squadrons that conduct flying missions involving transport of freight or personnel, training missions, and search and rescue. Given this high operational tempo, it seemed quite suitable that the military would select it to provide an example for this study. As well, it is typical for new programs within DND to be trialed in one

specific location before full-scale implementation across the rest of the military. For these reasons, the information provided by the Wing would act as the base upon which he would evaluate the benefit of a hedging strategy for the Air Force. Duffield himself put together the third file consisting of general information about derivative instruments that he thought would be useful in educating DND on the topic of hedging.

With this in mind, Duffield began to review each of the files.

File No. 1
Volatility in the Fuel Market
Crude oil, from which jet fuel is derived, is one of the world's most volatile commodities. Prices for crude oil are very erratic, spiking and diving in response to varied stimuli that range from the typical supply and demand considerations to the uncertainties caused by global strife. Companies with a heavy reliance on petroleum, like the airline industry, have a hard time managing cash flows in response to changing prices for one of their principal consumables.

Over the period from 1970-2003 oil prices averaged $22.64 USD per barrel in constant 2000 dollars.[1] Prices exceeded this average during war or international conflict (see Figure 1 for a graph of price fluctuations during this period. The Yom Kippur war and the Arab oil embargo caused oil prices, which had stayed between $2.50 and $3.00 per barrel since 1948, to quadruple to $19 per barrel by the end of 1974. The Iranian revolution and the subsequent Iran-Iraq war caused prices to double between 1978 and 1981, going from $19 per barrel to $53. Following this, a worldwide recession and increasing development of alternative energy sources caused decreasing demand and falling prices for the rest of the eighties, averaging $16 in 1988. The eighties also heralded the beginning of the oil markets and OPEC's attempts to set production quotas in an effort to shore up prices. Adding to price volatility during this time were member nations of OPEC violating quotas on a routine basis and making OPEC's efforts to stabilize prices largely unsuccessful. With the uncertainty created when Iraq invaded Kuwait in 1990, prices again rose sharply to $24. This price rise was short lived as other nations increased production, and the United States led a coalition of countries in a military resolution to the situation. Although the oil price rise was short lived, demand for jet fuel caused by the coalition response to the invasion of Kuwait caused severe shortages and increased prices for this commodity.

Subsequently a United States led recession saw continuing price declines in crude until it reached its lowest level since 1973 in 1994 of $14. Following this a turn around in the United States economy coupled with strong growth in Asian countries strengthened demand and firmed up prices. Iraq's return as a limited oil exporting country in late 1996 did little to slow the price recovery.

In Nov 1997 OPEC raised its production ceiling by 10%, the first increase in four years. This increase in production combined with decreased demand from Asian countries and a mild 1997-98 winter resulted in a major oversupply situation. The subsequent higher crude stock levels resulted in a downturn in prices averaging $11 in 1998. In response to the lower prices OPEC

[1] All crude oil prices taken from *Annual Energy Review 2003*, Energy Information Administration, 13 September 2004, p. 163.

reversed its position and began a round of production target cuts in 1998, which continued through to spring 2000. OECD crude stocks fell back to historic lows by the time these production cuts ended. Increased demand coupled with historic low world reserves and increasing global unrest precipitated increased oil prices up to 2004. These increases stemmed primarily from the American occupation of Iraq, and the accompanying uncertainty in the Middle East region, and a looming terrorist threat.

The historic volatile price fluctuation in the petroleum industry and the resulting price variance is not expected to decrease in the future. It is from this environment that fuel hedging has risen as a potential risk management tool to limit the direct impact of such fluctuations on oil dependant firms, including the aviation industry.

Fuel Hedging in the Airline Industry

Since the Airline Deregulation Act in 1978, the airline industry has become highly competitive. This has made it virtually impossible for airlines to pass along higher fuel prices to passengers through higher ticket prices. Consequently, a key to survival in the industry has been to control costs. One effective way to do this, as well as help dampen the huge swings in operating expenses and profitability associated with volatile fuel prices, is to hedge fuel costs. A well-managed hedging strategy can have a significant impact on firms overall financial performance. Southwest Airlines is one of the few U.S. airlines to consistently post profits over the past decade. This is especially remarkable for the past two years as the industry faced significant price increases for aviation fuel. They associated much of this success to their hedging program. As an example, the airline hedged over 80% of its 2004 fuel expenses. In the first quarter of that year, they posted $63 million in "hedging gains", resulting in a net profit for the quarter. Had the airline not hedged they would have suffered a net loss for the quarter.[2] The airline has hedged 80% of its fuel costs for 2005 as their bottom line continues to benefit from this risk management strategy.

To hedge their fuel cost risk, airlines use derivative instruments based on crude oil, heating oil, or jet fuel. Most airlines rely on plain vanilla instruments available as either exchange traded derivatives or over-the-counter derivatives.[3] Essentially, firms purchase the right or option to buy jet fuel for a predetermined price at some point in the future, thereby protecting them against sudden unexpected increases in the price of fuel because they already have an agreement to purchase the fuel at a lower price. Establishing such hedging positions assists firms in forecasting future cash flows, ensuring the necessary liquidity to meet obligations. Additionally, the firm may be in a position to reduce its overall costs of fuel and improve profitability.

File No. 2

About the Wing

All elements within the Air Force are controlled and directed by Canadian Air Division (Cdn Air Div) in Winnipeg, Manitoba. Consequently, Cdn Air Div plays a very important role in Wing's

[2] *The Southwest Wing*, Vol 2, Iss 5, http://www.swatakeoff.com/swatakeoff/southwest_wing_0407.pdf, p. 2. Accessed 23 January 2004.

[3] Exchange traded and OTC derivative markets, and the specific instruments provided by each, will be examined in greater detail below.

operations as they assign tasks and provide resources for the Wing to complete those tasks. This includes providing funding for the Wing's aviation fuel budget.

Wing itself is commanded by an Air Force Colonel who has a headquarters staff that is divided into different areas of responsibility that include operations, maintenance, administration, and finance. The headquarters staff works together to support the Commander as he gives orders to the various flying squadrons, which are the operational entities of the Wing. The squadrons use various aircraft, including the CC-130 Hercules, CH-149 Cormorant helicopter, and Airbus CC-150 Polaris, in missions ranging from providing logistical support for deployed operations to search and rescue operations within the region.

The Wing purchases aviation fuel through Standing Offer agreements established for them by Public Works and Government Services Canada (PWGSC). These agreements identify various suppliers that are available to provide aviation fuel to a maximum total number of litres over the course of the standing offer (one year). The price per litre is established monthly on dates that are set out in the standing offer. For example, Shell Canada Products Ltd. is listed as an eligible company that fuel can be purchased from in this wing. The standing offer states that total fuel purchases from Shell over the course of the year are not to exceed 38,000,000 litres.[4] As well, the offer stipulates the price that has been established by PWGSC for the applicable month.[5]

While the establishment and management of standing offers are conducted by PWGSC, the Wing has a frontline role to play in the overall process of fuel procurement. The Wing receives a request from Cdn Air Div to provide an estimate of all fuel requirements. An estimate of how much fuel must be purchased for the fuel farm over the coming fiscal year is determined based on the historic number of litres used in the previous year and anticipated increases for the upcoming fiscal year.[6] This information is used by PWGSC in the establishment of standing offers with local fuel companies.

Cost estimates for aviation fuel are determined during the business planning process and are based primarily on the Yearly Flying Rate (YFR). The process begins when Cdn Air Div sends their yearly planning guidance to all wings across Canada, calling for their business plans for the next fiscal years operations. Wings usually prepare the business plan for the upcoming fiscal year during the summer months of the preceding year. For aviation fuel, the planning guidance identifies the projected YFR per aircraft fleet type and provides a reference point for wings to use in estimating the price of fuel. For instance, the guidance for 2005/06 may tell wings to use the price per litre of bulk fuel as of 15 August 2004 as the baseline for the fuel costs. The overall funding requirements of different wings vary based on both the differences in the price of fuel

[4] See Annex A for the standing offer agreement for this firm.

[5] When Duffield first learned of this purchasing arrangement, he pondered whether the government was already employing a form of hedging, as the fuel prices were established in advance for one-month periods. However, he was able to clarify this by discussing the issue with Wing staff. While the process does protect the Wing from the degree of daily price fluctuations experienced by most civilian aviation firms, the process itself is essentially a product of contract management procedures, and not a risk management tool. Further, the standing offers are not, by definition, contracts. Rather, they represent an offer by the government to procure fuel at a predetermined price from a specific fuel dealer. It does not become a contract until the Wing calls against the offer and the fuel dealer accepts that call-up.

[6] The military works on a 01 Apr to 31 Mar fiscal year.

attributed to geographic location and the amount of fuel purchased away from the main operating base. The price of fuel is generally greater at locations away from the home base as a standing offer arrangement cannot be taken advantage of. Wings whose aircraft fleets do the majority of their refueling locally tend to pay less on average for fuel, and can better business plan the costs than wings, where at least thirty percent of fuel is purchased off base at varying prices and locations. Using these figures, the Wing business plan includes an estimate of the number of litres required, based on the YFR, and an estimate average price based on prevailing bulk fuel prices and percent of fuel purchased away from the main operating base. Depending on the amount of funds available for the Air Force in a given year, the wing may or may not be allocated the amount of funds requested in their business plan.

There is an inherent problem with this method of requesting funds because the price per litre is forecasted nine to nineteen months in advance of when the fuel will actually be purchased. The Wing and, by extension, the Air Force assumes significant risk as the price of fuel is historically very volatile, making accurate forecasting of budget requirements exceedingly difficult. If prices prove to be higher than expected, a significant reallocation of resources throughout the budget year is necessary. This may result in certain high priority projects going unfunded, or even placing the Wing in a deficit position, as funds must be redirected to fuel costs to facilitate mandatory flying. A similar problem exists when fuel prices drop unexpectedly. The surplus money could have been used to fund other high-priority projects within DND. As a result of the funds becoming available towards the end of the fiscal year there exists the possibility that the funds would be used to support lower priority requirements, resulting in a less than optimum utilization of very limited resources.

File No. 3

Derivatives

A derivative is a contractual agreement between two parties that derives its value by the price of something else. One of the parties to the agreement is a buyer and the other a seller. There are two types of derivatives, one is option-based and the other is forward-based. With an options-based derivative, a buyer makes a payment, called the premium, to the seller when the contract is established which gives the buyer the right, but not the obligation, to buy or to sell the underlying asset at an agreed to price within a specific time period. A forward-based derivative differs from an options-based derivative in that no up-front payment is required and the buyer has the obligation to purchase and the seller the obligation to sell the underlying asset according to the details specified in the contract. All derivatives facilitate the use of leverage and are a zero-sum game by the fact that every dollar lost by one party to the agreement represents a dollar gained by the other party.

Types of derivative markets

Exchange traded derivatives are traded on exchanges such as the New York Mercantile Exchange, Chicago Board of Trade, and the Chicago Mercantile Exchange. They include futures and options contracts. These contracts are standardized, transparent, easily used, and heavily regulated. There is no risk of default by purchasers of the contract because a clearinghouse acts as a third-party guarantor. For these reasons, exchange traded instruments are highly liquid. The

main disadvantage of exchange-traded contracts is that they are not flexible to the needs of any individual as the delivery date and quantity of commodity quoted on the exchange are fixed.

Over-the-counter (OTC) derivates include forward and swap contracts and are private agreements made between two parties. Trades occur mostly over the computer and phone lines. The greatest advantage of OTC products is that they are tailored to meet the particular needs of the parties involved. Variables such as the delivery date and quantity are selected, not mandated by an exchange. However, because of their non-standard nature, these derivatives are much less liquid than those found on the exchanges. Additionally, they are not guaranteed by a third party and are much less regulated than exchange contracts, making the risk of default an additional consideration.

Types of derivative instruments

The types of derivative instruments eligible for use in a government hedging strategy may also differ from a private firm. Typically, private airlines hedge their fuel risk by purchasing instruments such as swaps, collars, futures and forward contracts on either exchange markets or over-the-counter trades. Each of these has their distinct advantages and disadvantages and varies in their appeal for government use.

Futures

A futures contract is a standardized agreement that is traded on an exchange. The buyer of a future has agreed to take delivery of the specified asset at a future date and is said to have a long position. The seller of a future agrees to make delivery of the asset at the future date and is in a short position. For commodities, only a small fraction of futures contracts traded on an exchange actually result in delivery. Most futures obligations are met by an offsetting transaction that results in an exchange of cash, not the underlying commodity. Prices are marked-to-market daily as the price fluctuates, necessitating a margin deposit by all participants.

Duffiled noted that this might be a problem for the Air Force, as it would necessitate maintaining a margin account with the exchange, which may violate Treasury Board regulations. As well, trading futures requires a specific level of expertise that would have to be developed within the Air Force, with an associated human resource cost.

Forward contracts

A forward contract is the same as a future contract in many facets. The difference is that they are traded on the OTC market and therefore created to suite the needs of the parties to the contract. As well, while futures are marked-to-market daily, forward contracts are settled at maturity.

Options

An option is a contract providing its owner with the right to buy or sell an asset at a fixed price on or before a specified date. Options are a unique type of financial contract because they give buyers the right, but not the obligation, to buy or sell a commodity. There are two types of options, call options and put options. The buyer of a call option essentially purchases the right to buy an asset at a specified exercise price on or before the exercise date. The buyer of a put option essentially purchases the right to sell an asset at a specified exercise price on or before the exercise date. A call (put) option is said to be "in the money" if the asset price exceeds (is less

than) the agreed to exercise price. A call (put) option is said to be "at the money" if the asset price is equal (equal) to the exercise price. A call (put) option is said to be "out of the money" when the asset price is less (greater) than the exercise price. The buyer takes advantage of options that are "in the money", and discards those that are not. If the option expires "out of the money", the buyer loses the premium paid for the option. OTC energy options are usually settled in cash while exchange traded options are exercised into futures contracts.

The use of options within a government organization may be difficult to achieve because of the "value for money" requirement that must be met before any government expenditure. Because options may expire "out of the money", and therefore be worthless, Treasury Board may not agree that purchasing an option meets the value for money requirement. It would have to be proven that the value created is in the form of improved planning capability through more accurate future price predictions and risk management.

Collars

Collar strategies are a unique and effective way to establish a minimum and maximum border around a hedge position that lasts for the duration of the contracts. They are formed by combining a put option with a call option. For someone needing to hedge the future purchase of a commodity a collar can be created by purchasing a call option with an exercise price above the current spot price, and by simultaneously selling a put option with an exercise price below the current spot price. The premium from the put option offsets the cost of the call option, thus lowering the cost of the protection offered by the call option against an upward price movement in the underlying asset. The collar is established by creating a zone in which the party knows it will never pay more than a specific price per litre, but will also never pay less than the strike price of the put.

Swap Contracts

An energy swap is a simple contractual agreement between two parties where one party agrees to accept a fixed price instead of a floating price for a certain specified amount of energy over a certain period of time. It is strictly a financial arrangement and involves no actual transfer of the energy. The contract specifies the type and volume of energy, the duration of the agreement, and the fixed and floating prices. The differences between the fixed and floating prices are settled in cash at specific times covering specific periods as stipulated in the agreement. Swap contracts are available on exchanges and the OTC market.

Swap contracts would be a good option if the Air Force had a counter party within the government with whom to establish a swap arrangement.

Derivatives and basis risk

One similarity common to each of the derivatives discussed above is the exposure to basis risk, an inherent problem of most derivative products. The specific problem for jet fuel is that the jet fuel market does not have adequate liquidity to produce a market for futures or other exchange-traded instruments. Therefore, firms must rely on derivative products of commodities that have a high price correlation to jet fuel, making a perfect hedge impossible to achieve. The variance between the cost of jet fuel and a closely, but imperfectly, correlated commodity produces this basis risk. The fuels that are commonly used to hedge jet fuel price risk are heating oil and crude

oil, which are traded on the New York Mercantile Exchange and the International Petroleum Exchange in London. The specific risk is that the fluctuations in the price of the derivatives underlying asset, say heating oil, may not fluctuate the same as the local market price of jet fuel. This creates a problem where the purchaser is not entirely protected by price increases, as a local price increase may not be accompanied by an offsetting increase in the heating oil spot market. Thus, the increased amount paid on the local jet fuel market will not be offset by gains on the futures market. This is a type of basis risk called product basis and is depicted in Figure 2.

Exchange rate risk

For Canadian firms, a further risk is encountered due to the fact that suitable exchange traded instruments are not available on a Canadian exchange. Firms therefore become exposed to exchange rate risk as they purchase instruments in U.S. dollars, which will fluctuate in value with the posted exchange rate. This risk must be considered when analyzing options available for this Canadian air force base.

5 December 2004: Having reviewed the files in detail, Duffield began to consider the unique aspects of hedging within a public organization.

Hedging and the government

While Duffield was convinced that hedging could be an effective strategy for managing risk in private carriers, he was uncertain that this could be equally applied to a public organization. There were many factors to consider that were beyond the common issues facing private firms interested in hedging.

Firstly, Treasury Board regulations were very stringent and quite complicated to the uninitiated. Funds allocated for a given fiscal year generally have to be spent within that year. As well, contracting regulations are managed by another government agency, Public Works and Government Services Canada (PWGSC), and they would have to be involved in any contract formulation.

Secondly, there would be a significant human resources requirement to actively administer a complex hedging strategy. Duffield knew that it would be extremely difficult to establish the positions required for an undertaking of this sort, plus develop and maintain the necessary financial skill sets required by these personnel. The human resource expense would definitely be a cost that would have to be carefully considered. Duffield also worried that if the positions were filled with military personnel, the frequent moves typical of military personnel would result in a continuous turnover of staff, disturbing continuity in a section and having a negative impact on the day-to-day management of a hedging strategy.

Thirdly, there would likely be substantial resistance to such a program if the responsibility to administer it were assigned to those who currently manage fuel purchasing within the Air Force. Duffield knew that personnel issues would be paramount to the success of any implementation strategy. A further consideration that might limit the importance of this element would be outsourcing the management of a hedging strategy to a third party. This would take advantage of a pre-existing pool of expertise in this area and limit the need to develop this internally. As well, the cost of such an approach may be less depending on the magnitude of the hedging program.

Finally, there is a very real possibility that government officials, politicians, and the Canadian public may be sceptical of a government institution engaging in hedging activities. After all, hedging can generally be used for two purposes: risk management and speculation. Unfortunately, the public are generally familiar only with the speculation aspects of hedging. The many horror-story examples of firms losing millions in hedging deals tend to grab media headlines much more often then stories of firms using hedging as an effective risk management tool. It would be very important for Duffield to present hedging as a risk management tool and allay fears about the speculative and risky nature of hedging.

Developing a hedging strategy

In addition to the factors described above that are specific to considering a hedging strategy for a government institution, there are additional elements common to both the public and private sectors that must be contemplated when developing a hedging strategy. Of course, these factors may have a different effect on the strategy selected for a government organization than they would on a private firm. The goal of the hedging strategy differs as private companies hedge to reduce unexpected increases in operating costs that can severely restrict cash flow and have a negative impact on the liquidity of the airline. Hedging may also reduce long-term fuel expense and improve managerial planning. The Air Force is not concerned with going bankrupt, rather it is interested in being able to reduce the uncertainty of future fuel prices to improve it's forecasting and planning capabilities.

Hedging within the Wing

Duffield began to review the tables of historic data he would use to analyze hedging options for the Wing. He had received details of monthly fuel usage for fiscal years 2002/03 and 2003/04 including quantity used, price per litre, and total cost (see Table 1). As contracts would be purchased on American markets, and therefore in US dollars, exchange rate information would also be important (see Table 2 for exchange rate information). He had also gathered data on the New York No 2 Heating Oil futures and spot prices for the period in question (see Table 3 and 4). Information on the futures contract specifications can be found at Annex B. From his previous experience, he knew that this was highly correlated to the price of jet fuel and commonly used in the aviation industry, although he was uncertain about how these futures correlated to the local market prices experienced at the Wing. Duffield had also selected options pricing data for heating oil at specific intervals leading up to and during the time of actual fuel usage by the Wing (see Table 5). Duffield's next step was to develop a hedging strategy using the available historic Wing`s fuel usage and market data. This would give him all the information he would need to complete his presentation for DND.

Table 1– Fuel Usage for the Wing FY 03/04

Month	Ave $/litre	Total litres	Cost CAD $
Apr-02	0.3563	2,229,690	794,368
May-02	0.3727	2,244,910	836,589
Jun-02	0.3786	2,037,765	771,412
Jul-02	0.3722	3,067,168	1,141,745
Aug-02	0.3779	1,795,953	678,735
Sep-02	0.3976	2,293,319	911,887
Oct-02	0.4320	1,216,542	525,497
Nov-02	0.4341	2,581,552	1,120,669
Dec-02	0.4295	1,695,840	728,378
Jan-03	0.4194	1,843,898	773,334
Feb-03	0.4547	1,670,527	759,621
Mar-03	0.5215	2,143,869	1,118,108
Apr-03	0.5231	1,602,396	838,149
May-03	0.4258	2,682,067	1,142,015
Jun-03	0.3871	1,490,835	577,118
Jul-03	0.3720	2,538,977	944,456
Aug-03	0.3792	2,451,854	929,639
Sep-03	0.4008	2,305,705	924,219
Oct-03	0.3858	1,926,136	743,091
Nov-03	0.3792	2,040,056	773,511
Dec-03	0.3917	1,695,840	664,221
Jan-04	0.4048	1,866,141	755,328
Feb-04	0.4319	1,972,369	851,825
Mar-04	0.4480	3,499,630	1,567,920
Total	0.4108	26,072,006	$10,711,491
Std deviation	0.0425		

Note: As PWGSC sets the price for the next thirty days on the 15th of every month, Ave $/litre reported are the average price paid for the entire month based on the total litres purchased at each price.

Table 2 – Canadian/U.S. dollar exchange rate

Month	Exchange rate CAN$/US$
Dec-01	1.5610
Jan-02	1.5888
Feb-02	1.5895
Mar-02	1.5840
Apr-02	1.5892
May-02	1.5559
Jun-02	1.5500
Jul-02	1.5366
Aug-02	1.5582
Sep-02	1.5857
Oct-02	1.5855
Nov-02	1.5813
Dec-02	1.5602
Jan-03	1.5352
Feb-03	1.5188
Mar-03	1.4822
Apr-03	1.4515
May-03	1.3761
Jun-03	1.3361
Jul-03	1.3929
Aug-03	1.3872
Sep-03	1.3659
Oct-03	1.3242
Nov-03	1.3038
Dec-03	1.3134
Jan-04	1.2979
Feb-04	1.3150
Mar-04	1.3324
Std deviation	0.1111

Note: Exchange rates for the fifteenth day of each month.

Table 3 – Future contract prices for New York, NY No 2 Fuel Oil / Heating Oil[7]

Month	Contract 1		Contract 2		Contract 3		Contract 4	
	C US/g	C US/l	C US/g	C US/l	C US/g	C US/l	C US/g	C US/l
Dec-01	54.25	14.33	55.25	14.60	55.45	14.65	55.3	14.61
Jan-02	52.07	13.76	52.68	13.92	52.93	13.98	53.03	14.01
Feb-02	55.89	14.77	56.1	14.82	56.3	14.87	56.6	14.95
Mar-02	64.76	17.11	64.73	17.10	64.73	17.10	64.88	17.14
Apr-02	63.34	16.73	63.84	16.87	64.34	17.00	65.04	17.18
May-02	67.79	17.91	68.32	18.05	68.82	18.18	69.47	18.35
Jun-02	66.40	17.54	67.11	17.73	67.96	17.96	68.81	18.18
Jul-02	69.55	18.38	70.27	18.57	70.77	18.70	71.27	18.83
Aug-02	72.78	19.23	73.55	19.43	74.15	19.59	74.70	19.74
Sep-02	78.67	20.78	79.69	21.05	80.24	21.20	80.39	21.24
Oct-02	79.98	21.13	80.58	21.29	80.73	21.33	79.28	20.95
Nov-02	68.85	18.19	69.21	18.29	68.76	18.17	67.01	17.70
Dec-02	81.56	21.55	80.55	21.28	77.15	20.38	73.85	19.51
Jan-03	88.38	23.35	86.59	22.88	81.99	21.66	77.19	20.39
Feb-03	106.07	28.02	97.42	25.74	89.97	23.77	84.72	22.38
Mar-03	94.07	24.85	89.00	23.51	84.30	22.27	81.80	21.61
Apr-03	77.26	20.41	72.88	19.25	71.48	18.89	71.23	18.82
May-03	75.04	19.83	74.51	19.69	74.66	19.73	74.86	19.78
Jun-03	74.22	19.61	74.72	19.74	75.27	19.89	75.82	20.03
Jul-03	81.33	21.49	81.87	21.63	82.22	21.72	82.62	21.83
Aug-03	80.51	21.27	81.40	21.51	82.15	21.70	82.65	21.84
Sep-03	74.70	19.74	75.89	20.05	76.84	20.30	77.49	20.47
Oct-03	86.88	22.95	87.78	23.19	88.28	23.32	87.68	23.17
Nov-03	87.97	23.24	88.56	23.40	88.01	23.25	85.51	22.59
Dec-03	92.06	24.32	92.60	24.46	90.30	23.86	86.15	22.76
Jan-04	92.99	24.57	91.65	24.21	86.90	22.96	83.00	21.93
Feb-04	94.27	24.91	90.73	23.97	87.38	23.09	84.98	22.45
Std Deviation	10.7961	2.8523	9.3406	2.4678	7.8130	2.0642	6.6666	1.7613

Note: Prices taken from the fifteenth of each month. Each contract is for one, two, three, or four months in advance.

[7] NYMEX Futures Prices of No. 2 Fuel Oil, *U.S. Department of Energy, Energy Information Administration*, 11 October 2004.

Table 4 – New York, NY No 2 Fuel Oil / Heating Oil Spot Price FOB (C/gal) Apr-02 to Mar-04[8]

Month	Spot price	
	C US/g	C US/l
Apr-02	63.07	16.66
May-02	67.67	17.88
Jun-02	65.80	17.38
Jul-02	69.20	18.28
Aug-02	71.48	18.89
Sep-02	77.75	20.54
Oct-02	78.80	20.82
Nov-02	68.80	18.18
Dec-02	80.85	21.36
Jan-03	90.36	23.87
Feb-03	112.70	29.78
Mar-03	102.30	27.03
Apr-03	86.00	22.72
May-03	75.38	19.92
Jun-03	74.08	19.57
Jul-03	80.90	21.37
Aug-03	80.13	21.17
Sep-03	73.45	19.41
Oct-03	86.31	22.80
Nov-03	87.00	22.99
Dec-03	90.90	24.02
Jan-04	93.27	24.64
Feb-04	94.00	24.83
Mar-04	90.80	23.99

[8] Heating Oil Spot Prices, *U.S. Department of Energy, Energy Information Administration*, 11 October 2004.

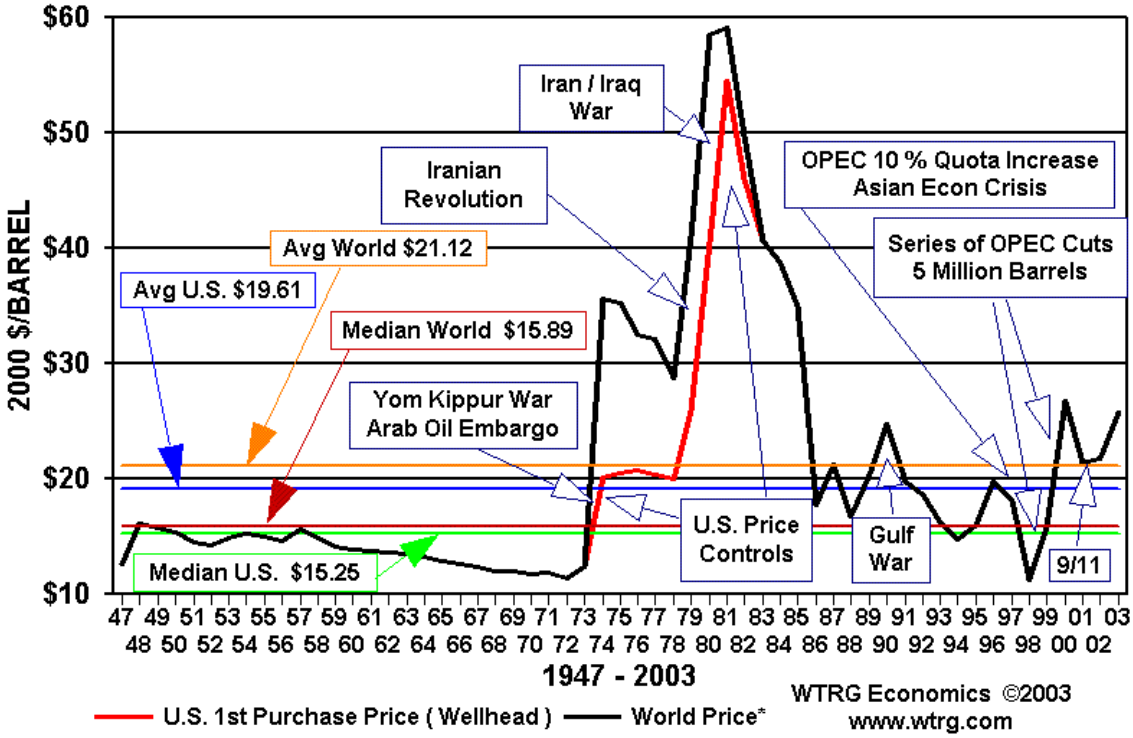
Table 5 – Futures Options pricing data Dec 02 – Feb 04[9]

Month		Contract 1		Contract 2		Contract 3	
	Strike C US/g	C US/g	C US/l	C US/g	C US/l	C US/g	C US/l
Dec-01	52	1.74	0.46	4.40	1.16	5.63	1.49
Jan-02	53	1.52	0.40	3.50	0.92	4.57	1.21
Feb-02	56	1.55	0.41	2.99	0.79	3.90	1.03
Mar-02	66	1.90	0.50	3.31	0.87	4.38	1.16
Apr-02	60	2.02	0.53	3.79	1.00	4.85	1.28
May-02	72	1.87	0.49	3.57	0.94	4.81	1.27
Jun-02	67	1.51	0.40	3.25	0.86	4.71	1.24
Jul-02	71	1.72	0.45	3.53	0.93	4.70	1.24
Aug-02	71	1.53	0.40	3.34	0.88	4.79	1.27
Sep-02	79	1.94	0.51	4.41	1.17	5.79	1.53
Oct-02	81	1.91	0.50	3.78	1.00	5.00	1.32
Nov-02	68	1.86	0.49	4.14	1.09	5.30	1.40
Dec-02	82	2.00	0.53	3.72	0.98	2.95	0.78
Jan-03	90	3.77	1.00	4.70	1.24	3.86	1.02
Feb-03	106	3.86	1.02	3.34	0.88	2.20	0.58
Mar-03	93	6.26	1.65	5.72	1.51	5.18	1.37
Apr-03	78	2.01	0.53	1.70	0.45	2.09	0.55
May-03	76	1.68	0.44	2.92	0.77	4.12	1.09
Jun-03	75	2.86	0.76	4.66	1.23	5.77	1.52
Jul-03	82	1.79	0.47	3.40	0.90	4.63	1.22
Aug-03	81	2.09	0.55	4.23	1.12	5.79	1.53
Sep-03	75	1.67	0.44	4.16	1.10	5.70	1.51
Oct-03	87	2.42	0.64	4.65	1.23	6.26	1.65
Nov-03	88	1.58	0.42	3.90	1.03	5.27	1.39
Dec-03	93	1.95	0.52	4.67	1.23	4.77	1.26
Jan-04	94	2.43	0.64	3.65	0.96	2.89	0.76
Feb-04	95	1.82	0.48	1.98	0.52	1.87	0.49

Note: Prices taken from 15th day of each month. Each contract is for one, two, or three months in advance and are just "out of the money".

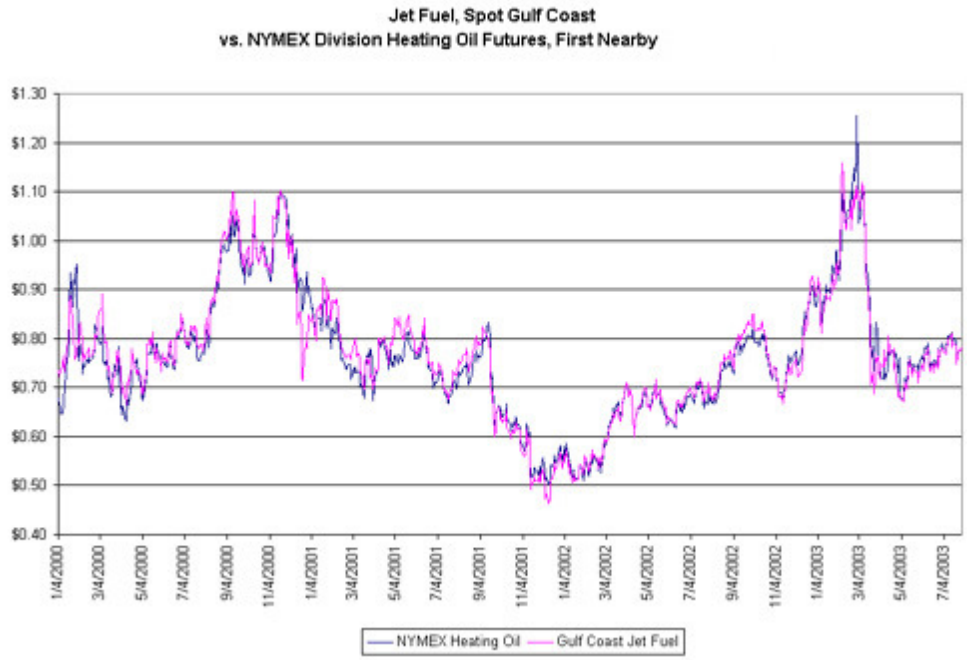
[9] Data taken from the issues of the *Wall Street Journal, Eastern Ed.* The prices reflect market prices on the 15th of each applicable month.

Figure 1 - Crude oil prices 1947-2003, Constant 2000 dollars[10]



[10] Oil Price History and Analysis, www.wtrg/prices.htm. Accessed 27 January 2005.

Figure 2 – Product Basis



Annex A

Example of Standing Offer

Public Works and Government Services Canada Page: 9
Appendix 'A' Notice of Standing Offer
PWGSC File Number: E60HL-3-0052-10-V Price Effective Date: 2003/09/15

Requisitioning Authority Copy

Ordering Office: Requisition Number:

DEPT OF NATIONAL DEFENCE W8486-4-DP04
NDHQ DPMCE 8
101 COLONEL BY DR.
OTTAWA ON J8Y 6R5

Item No.	Zone/ Delivery Address	Invoicing Address/ Call-up Authority	Product	Financial Code/ Delivery Method/ End Use	Estimated Quantity/ Unit Price	Supplier/ Serial No./ Designated Delivery Contact
	ON151 58/TW					
014	DEPT. OF NATIONAL DEFENCE CFB TRENTON (ASTRA) TRENTON ON SEE ATTACHED DND INSPECTION AND SUPPLEMENTARY CONDITIONS OF SUPPLY VOIR ANNEXER L'INSPECTION ET LES CONDITIONS SUPPLEMENTAIRE D'APPROVISIONNEMENT DU MDN	WINDV WINDV	AVIATION TURBINE FUEL KEROSENE TYPE GRADE F-34 CAN/CGSB-3.23-2002	07214 TANK WAGON AVIATION	38,000,000 L $0.3407	SHELL CANADA PRODUCTS LIMITED E60HL-3-0052/03 RMT ATTN: DANIEL LEVERT (450) 658-1795

Refinery: MONTREAL EAST

Annex B

Contract specifications for Heating Oil.[11]

Heating oil, also known as No. 2 fuel oil, accounts for about 25% of the yield of a barrel of crude, the second largest "cut" after gasoline. The heating oil futures contract trades in units of 42,000 gallons (1,000 barrels) and is based on delivery in New York harbor, the principal cash market trading center. Options on futures, calendar spread options contracts, crack spread options contracts, and average price options contracts give market participants even greater flexibility in managing price risk.

The heating oil futures contract is also used to hedge diesel fuel and jet fuel, both of which trade in the cash market at an often stable premium to NYMEX Division New York harbor heating oil futures.

[11] NYMEX website, Heating Oil, http://www.nymex.com/jsp/markets/ho_fut_descri.jsp , Accessed on 23 Jan 2005.

Questions

1. Using the 24 months of data provided, determine the effect on overall cost and the standard deviation of average monthly price per litre if the Wing hedged 50% of its fuel usage. Assume all derivative purchases were made quarterly and positions were established for three-month periods. For example, if average usage per month were 84,000 gallons, hedging 50% of usage for three months would be 126,000 gallons.

a. Three-month No 2 heating oil futures contracts.

b. Three-month No. 2 Heating Oil call options.

2. What is the significance of the results obtained in question 1 given the following possible goals of a hedging strategy and what recommendations would you make for each of the strategies pursued.

a. Minimize overall cost.

b. Minimize standard deviation.

3. If the Air Force decided to pursue a fuel hedging strategy and selected forward contracts as the derivative tool to be used, in what market would they find these types of contracts traded? What factors would have to be considered in formulating the contract? How would the specifications of the contract be determined and what do you think would be important for the Air Force in establishing such a contract?

4. Duffield has selected New York No 2 Heating Oil as a suitable alternative commodity to hedge against fluctuations in the price of aviation fuel used by the Wing. Given the data presented, what is the significance of the basis risk faced during the period of study? What impact does the exchange risk have on the hedging strategies and what options would you recommend to mitigate this risk?

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Annual Energy Review 2003, U.S. Department of Energy, Energy Information Administration, 13 September 2004, p. 163.

Heating Oil Spot Prices, U.S. Department of Energy, Energy Information Administration, 11 October 2004.

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NYMEX website, Heating Oil, http://www.nymex.com/jsp/markets/ho_fut_descri.jsp , Accessed on 23 Jan 2005.

Oil Price History and Analysis, www.wtrg/prices.htm. Accessed 27 January 2005.

Options Pricing Data, Wall Street Journal, (Eastern Ed), various issues.

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http://www.swatakeoff.com/swatakeoff/southwest_wing_0407.pdf, p. 2. Accessed on 23 January 2004.

Authors
Naceur Essaddam*, Royal Military College of Canada, Essaddam@rmc.ca
Derek Miller, Department of National defence, Canada

*Corresponding Author

Note: This case does not reflect the position of the Department of National Defence. All data presented in the case is factual. The scenario and individuals depicted within are fictional. The case is not meant to suggest good or bad management practices; rather the aim is to promote discussion about the issues presented within the case.