DOES HEDGING REDUCE RISK? ANALYSIS OF LARGE DOMESTIC AIRLINES

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ABSTRACT

In this paper two approaches are applied to understand the hedging behavior of companies which compete in the American airline industry (2007-2014) as they seek to cope with the uncertain, future costs of jet fuel. The first measures the risk that jet fuel prices will fall, a matter of concern to airlines that hedge against rising jet fuel prices, for when jet fuel prices fall, those airlines that have hedged lose money on their hedges. The second describes the risk of hedging or not by using some of the tools of game theory. Two different cases are investigated. In the first case airlines compete against one another in a market structure where it is assumed that whether one airline hedges is of no immediate concern to its rivals. In this first case hedging decisions of one airline produce no effects upon other airlines. In the second case airlines compete against one another in the context of an oligopoly. Hedging decisions of one airline are connected to the hedging decisions of other airlines. If some airlines hedge jet fuel costs while at the same time others do not, winners and losers are created among the competing airlines. The problem here is that while hedging can fix the price of jet fuel, it cannot guarantee that this fixed price will be lower than the price paid by a rival that did not hedge. The last part of this paper is an empirical data analysis of the differences in jet fuel costs, net of hedging results, is conducted. The null hypothesis that all airlines have equal jet fuel costs after hedge results are accounted for could not be rejected at any reasonable level of confidence.

INTRODUCTION

The only purpose of a hedge is to reduce risk. There are different hedge strategies available. Some fix the price of an input. Other strategies locate the input price below an upper bound or within a range defined by upper and lower bounds. Consider the case of an airline wishing to mitigate the effects of an increase in jet fuel prices. This airline may agree to purchase some portion of its future jet fuel usage at a fixed price known today by way of either a forward pricing contract or a swap contract, thus shifting the risk that jet fuel prices might increase to the speculator who takes the other side of the forward contract or the swap contract. (Futures contracts are often used as substitutes for forward contracts.) Or an airline may construct a collar around current jet fuel prices. A collar could be constructed by purchasing call options on jet fuel with the exercise price of these calls somewhat above the current level jet fuel prices and by selling put options on jet fuel with the exercise price of these puts somewhat below current jet fuel prices. The effect of this collar would be to fix jet fuel costs within a known range of jet fuel prices. There are other hedging strategies. Perhaps the simplest is to buy calls with exercise prices well above the current level of jet fuel prices to insure against a large price increase in jet fuel. Readers interested in the nuts and bolts of creating hedges using call options, put options, forward contracts, futures contracts, and swap contracts may consult Hull (2009).

There are real-world problems with every hedge. There are often problems of basis risk: in some markets jet fuel derivatives are not available, not available in sufficient quantity, or too expensive relative to contracts that are highly correlated with jet fuel price movements. A solution to these difficulties might be to use derivative contracts on heating oil instead of contracts on jet fuel. But heating oil is not the same thing as jet fuel, so the price movements of heating oil and those of jet fuel may be highly correlated, but these changes are not identical. A perfect hedge is impossible in these instances. There are also financial problems that must be addressed. Creating hedges requires collateral (margin) to secure performance and/ or cash to make hedge investments. Some airlines may be unable to hedge because they had insufficient collateral or not enough cash. Of the six airlines studied in this paper four have sought bankruptcy protection in the last 15 years. And financial health remains a problem among large, domestic airlines. In this regard, Table 1 contains bond ratings for these companies. Of the largest domestic airlines, only Southwest Airlines is rated as an investment grade risk. The others are rated as below investment grade risks.

Table 1
Bond Ratings as of February 2014

	UNITED CONTINENTAL	AMERICAN	DELTA	SOUTHWEST	JETBLUE
Moody's	B1	B1	Ba3	Baa2	B2
Standard & Poor's	B	B+	BB	BBB	B
Fitch	B	B+	BB	BBB	B+
Source: Bloomberg					

Rampini, Sufi, and Viswanathan (2014) find that airlines which are financially vulnerable hedge less than those airlines with stronger balance sheets.

In addition to problems of raising money to buy hedge investments or finding assets that can serve as collateral for hedge investments, there is the issue of counterparty risk for those airlines who choose and who are able to afford hedging. Every hedge investment is defined by a contract or a collection of contracts. If the other side of the hedge contract (or contracts) does not keep their end of the bargain, then the hedge fails.

Finally, and of special interest in this paper, there is a problem with hedging that result from competing against rivals within the context of an oligopoly. To see this problem, consider competing airlines within an oligopoly Suppose, contrary to the present set of facts which describe the large carriers of the domestic airline industry, all but one of these rival airlines hedge away 100 percent of the jet fuel price risk associated their future jet fuel usage for the next ten years. In doing so each airline that has hedged has done so perfectly without encountering any of the hedging difficulties discussed above, fixing the price of jet fuel for the next ten years. One airline does not hedge any of the jet fuel price risk. And suppose also that after all hedge commitments have been made that will be made by those choosing to hedge, jet fuel prices drop by one-half over the space of six months. Should those airlines that have hedged against an increase in jet fuel prices be concerned that jet fuel prices have declined? The answer to this question is yes. Why? Airlines have some control over the prices that they charge their passengers. If jet fuel prices decline, the airline that chose not to hedge can better afford to reduce the prices that it charges to its passengers because its cost structure is now less than that of its rivals. The main point is this: although hedge contracts can fix input prices so that they are constant, these same hedge contracts cannot guarantee low input prices, low relative to the rival that chose not to hedge.

It makes a difference whether all firms in a given oligopoly choose to hedge. If in this oligopoly, competitors all hedge alike, then no airline that fixes the price of its jet fuel will be at a disadvantage if in the future jet fuel prices fall, even though all have locked in fuel costs at an older, higher price. The effort to gain an understanding of the risk that all rivals will not hedge alike motivates this paper.

This paper is organized in the following manner. First, brief comments are made about the net present value (NPV) concept of capital budgeting and whether or not this tool has been or can be found to be useful in the problem of deciding whether to hedge. As a calculation, NPV seems to be of little help in the problem of hedging. This could be because NPV works on expected future cash flows or the certainty equivalent of future cash flows, while hedging works to eliminate the risks of realizing future cash flows that had not been expected. Second, a method for measuring the risk that jet fuel prices will decline is studied. Hedges are most often designed to deal with the problem of higher jet fuel prices. What is the risk that jet fuel prices will fall instead? That is the problem of this section. To address this problem, a first passage time model operating under an assumption that changes in jet fuel prices follow geometric Brownian motion is proposed. The assumption of geometric Brownian motion is controversial. Pros and cons concerning this assumption are discussed. Third, a game theory approach to the problem of hedging is attempted. Using ordinal preferences which rank possible outcomes in different future states of the world for each of two competitors, the consequences of the actions of rival airlines are compared. Fourth, the last part of this paper is an empirical data analysis of the differences in jet fuel costs, net of hedging results, is conducted. Results are inconclusive.

NET PRESENT VALUE AS A TOOL TO EVALUATE HEDGING DECISIONS

The decision of whether or not to hedge can be thought of as a choice to alter the future cash flows of a capital investment. Why not calculate the Net Present Value of a hedge in order to determine whether a hedge should be undertaken? NPV tools are often used to evaluate capital investment decisions. Irving Fisher (1930) developed the concept Net Present Value, the quantity of shareholder wealth created by a management's investment decision. Robichek and Myers (1965) extended Fisher's work so that the risk of expected future cash flows could be taken into account in the calculation of NPV. Some have studied the connection of NPV to hedging decisions. In perfect markets it may well be the case that decisions to hedge are all zero NPV decisions. Aretz and Bartram (2010) note that shareholders and bondholders themselves can choose to hedge risk without any assistance from corporate management. To apply this reasoning to the case of the airline industry: if Southwest Airlines should choose to stop hedging the risk that jet fuel prices might increase, there remains nothing to stop their shareholders and bondholders from choosing to hedge this risk in their own accounts. So, it is argued, hedging decisions on the part of managers cannot create or destroy value for owners. And if this is true, then hedging is a zero NPV decision in perfect markets.

However, capital markets may not be perfect. Some argue that corporate managers can generate positive NPV from hedging decisions in the presence of capital market imperfections produced by tax law and bankruptcy costs, but empirical evidence in this regard is slight. Those interested in these issues may see two articles: one written by Mackay and Moeller (2007), and the other by Campello, Lin, Ma, and Zou (2010), for more information about the connection of market imperfections and the ability of corporate managers to create wealth by way of hedge decision making. The works cited above consider whether or not hedging decisions can create a positive NPV and if so under what conditions.

There are problems in applying NPV to a specific hedging problem. NPV analysis is understood in terms of expected cash flows or in terms of certainty equivalents of expected cash flows, but hedging is understood in terms of realized cash flows. Nevertheless, it may, in some cases, be practical to translate ex ante data about all possible cash flows that may be realized into expected cash flows so that a NPV analysis of hedge decision making could be undertaken. One could then consider all possible realized cash flows with and without hedging. And too, it ought to be the case that if one takes an investment proposal and hedges away all of the risk associated with forecasting future cash flows that one has, though this hedging, defined what the certainty equivalent cash flows must be. But no one has pursued this line of reasoning, and this present paper does not study the connection of NPV to hedging decisions.

WHEN JET FUEL HEDGES LOSE MONEY

Through hedging, an airline can choose to eliminate the risk of large increases in jet fuel prices, but the problem remains that jet fuel prices may decline after the airline puts into place these hedge contracts. If this occurs, hedge contracts lose money. Plus, in periods of falling jet fuel prices, the airlines that do not hedge pay less for their jet fuel than their rivals that do hedge. This is the risk that remains after management decides to put hedges in place. Recently – during the fourth quarter of 2014, jet fuel prices declined.

Table 2
Jet Fuel Cost Per Gallon After the Results of Hedging:
Fourth Quarter Results 2014 vs Fourth Quarter 2013

	2014	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**
	United Continental		American		Delta		Southwest		JetBlue	
Per Gallon Fuel Cost (Economic)	$2.83	$3.08	$2.52	$3.06	$2.62	$2.83	$3.08	$2.52	$3.06	$2.62
Source: various company press releases										

The cost reduction in American Airlines is largest because American Airlines has chosen not to hedge jet fuel prices. Martin (2015) and Levine-Weinberg (2014) comment on American Airlines' decision not to hedge jet fuel prices, noting that it is a risky decision, but one that is responsible for increased profits in 2014.

What is the probability that jet fuel prices will fall? To answer this question, an assumption must be made as to the stochastic nature of the changes in jet fuel price changes through time. Carter, Rogers, and Simkins (2004) assume that changes in jet fuel prices can be described as geometric Brownian motion. Not everyone agrees. Tan (2002) asserts that there is instead mean reversion in jet fuel prices. Perhaps Tan is right in identifying ex-post data sets of jet fuel prices in time-series as better described with mean reversion than with other stochastic assumptions of price behavior. If Tan (2002) is correct in an ex ante sense, then the first passage time model application of this paper is misguided.

In an ex ante sense, a mean reversion model would necessarily produce expectations on future jet fuel prices such that when jet fuel prices move above some price, then they are more likely to decline, and when jet fuel prices move below that same price then they are more likely to increase. Any economic story explaining this price behavior would unfold in two parts. First, it would divide the quantity demanded and the quantity supplied of jet fuel into two categories: normal and abnormal. Second, it would also fix both supply and demand curves. Put these assumptions together and one can then justify mean reversion. When market conditions are normal, jet fuel prices are likely observed in the neighborhood of some mean value. When market conditions are abnormal, jet fuel prices are more likely to be observed farther away from their mean value price. For short-run problems where the OPEC cartel dominates the market for petroleum products, where supply and demand are fixed, the choice of a mean reversion model seems reasonable.

An economic story justifying geometric Brownian motion is simpler than that of mean reversion. There is no need to locate reflecting barriers above and below a mean value price and no need to measure the speed at which jet fuel prices return to their mean. And economic thinking consistent with geometric Brownian motion permits both the quantity demanded and the quantity supplied to change over time along with both the supply and demand curves of jet fuel. Given recent large increases in oil production in Texas and North Dakota oil fields, it may be argued that the OPEC cartel has lost the ability to control the price of oil. If this is so, then one could argue that price changes of petroleum products will no longer be mean reverting.

If a geometric Brownian motion assumption is employed to describe the stochastic nature of jet fuel prices, parameter estimates are required to produce forecasts: a drift term μ which describes the constant, instantaneous rate of change of jet fuel prices, absent any random shocks; and a volatility term σ which describes the sensitivity of jet fuel prices to these random economic shocks. This expected drift rate may or may not be realized, for it is a random variable, which in every future time period is normally distributed with expectation equal to a constant μ and standard deviation about this expectation equal to a constant σ. If one can estimate both drift and volatility, then a first passage time model, working in the context of geometric Brownian motion, can answer the question: what is probability that jet fuel prices will drop far enough to penetrate some fixed lower boundary price at least once over the next T years?

$$p = N\left[\frac{\ln\left(\frac{C}{S}\right) - \mu T}{\frac{\sigma}{\sqrt{T}}}\right] + \left(\frac{C}{S}\right)^{\frac{2\mu}{\sigma^2}} N\left[\frac{\ln\left(\frac{C}{S}\right) + \mu T}{\frac{\sigma}{\sqrt{T}}}\right]$$

where: C is the lower boundary jet fuel price, S is the current jet fuel price, μ is the expected continuous rate of drift in jet fuel prices, σ is the volatility of jet fuel prices, and T is the number of years of the planning horizon. If future changes in jet fuel prices are normally distributed in cross-section, and if changes in jet fuel prices are described as a geometric Brownian motion, then the probability solution given in this model above is exact. An example below is provided only to illustrate an application of this first passage model. Suppose that management wanted to know the probability that jet fuel prices would fall by fifty percent at least once over the next four years. Given parameter estimates for drift and volatility this question can be addressed.

Table 3
An Illustration of Solutions in A First Passage Time Problem

Planning Horizon	Decline in Jet Fuel Prices as a Percentage	Expected Drift Rate	Volatility	Probability of a Specified Decline in Jet Fuel Prices Occurs at Least Once
4 years	50 %	0 %	25 %	16.6 %
4 years	50 %	0 %	40 %	38.6 %
4 years	50 %	0 %	55 %	52.9 %

Holding drift and planning horizon constant, the probability of jet fuel prices penetrating a lower boundary price for jet fuel increases as volatility increases and vice versa.

THE HEDGING DECISION VIEWED AS A GAME

In this section the problem airlines have of choosing whether to hedge jet fuel prices is studied from the viewpoint of a game-theoretic framework. The airline industry is an example of an oligopoly. As such it may be the case that an airlines' choice to hedge jet fuel prices is not only connected to the future price that an airline will pay for jet fuel but also connected to their rival's profitability. Two cases are considered. In the first case considered below, illustrated in Table 4, two rival airlines both make hedging decisions, but these decisions cannot affect the other's profitability. In the second case, illustrated in Table 5, two rivals both make hedging decisions as before, but these decisions can affect the other's profitability.

In Table 4 the decision of whether to hedge jet fuel prices is illustrated. Two rival airlines make their hedge choices simultaneously and without collusion. After these hedge decisions are made, jet fuel prices change. The change in jet fuel prices is a random variable, beyond the control of either airline. A hedge will be beneficial to an airline if jet fuel prices rise. Otherwise, hedging will reduce the airline's profits. Both the potential benefits and the potential losses depend upon the size of the hedge relative to the airline's jet fuel usage, and how large the movement is in jet fuel prices.

In Table 4 the outcomes shown are ordinal preferences. These ordinal preferences rank outcomes over all possible future states of the world. Game theorists show that knowledge of ordinal preferences, rather than knowledge of the cardinal outcomes associated with these preferences, is sufficient to reach a rational decision. For an explanation see McCain (2004) pages 68-69.

How are these ordinal preferences assigned? Four ranks are employed. Rank 4 is the most preferred. In this state jet fuel prices have declined and the airline has not hedged, so there is no cost of hedging to be subtracted from the benefits associated with the decline in jet fuel. Rank 3 is assigned to a state where jet fuel prices have declined, but the airline has hedged against the possibility of an increase in jet fuel prices. The cost of this insurance will increase jet fuel costs. Rank 2 is assigned to a state where jet fuel prices have increased, but the airline has hedged against higher jet fuel prices. Airlines seldom or never hedge all of their jet fuel needs, and at the time that this paper was being written (February 2015), the airlines under study (American, Delta, JetBlue, Southwest, and United Continental) each hedged significantly less than half of their jet fuel requirements. So, even though in this state, where jet fuel prices have increased and the airline has hedged against these price increases, the airline would have preferred states where jet fuel prices drop. Rank 1, the worst possible outcome, is a state where jet fuel prices increase, but the airline did not hedge against any price increase.

Table 4
Hypothetical Preferences (You, Rival) Over Future States of the World for Two Airlines
Where Rank 1 is Least Preferred: A Case Where No One is Penalized for Being Outguessed by a Rival or Rewarded for Outguessing a Rival

	Rival Hedges	**Rival Does Not Hedge**
You Hedge	→ 2,2 Costs Rise → 3,3 Costs Fall	→ 2,1 Costs Rise → 3,4 Costs Fall
You Do Not Hedge	→ 1,2 Costs Rise → 4,3 Costs Fall	→ 1,1 Costs Rise → 4,4 Costs Fall

If airlines can make hedging decisions independently of one another, without any concern that their rival's hedging choices will affect their profitability or that their hedging choices will affect their rival's profitability, then preferences over all possible future states for one airline must not depend on the hedging decisions of any other airline, and vice versa. Such independence is plausible if and only if one airline does not gain any economic advantage by outguessing its rival in regard to future jet fuel price movements and it is not subject to any penalty when it is outguessed by its rival. The preferences of Table 4 above describe these circumstances.

There is no dominant strategy for either airline, no Nash equilibrium. But there is a Minimax strategy available to both, if they are financially able. von Neumann and Morgenstern (1947), using methods of theorem and proof, justify Minimax strategies for decision makers as a reasonable choice for rational decision makers on the grounds of risk aversion. Adopting this strategy, both should consider hedging. Doing so avoids the worst possible outcome, a state where jet fuel prices drop and this drop is unmitigated by any hedge.

Unlike the preceding analysis, the ordinal preferences of Table 5 below assume an oligopolistic market structure where the hedging decisions of rivals are relevant to the hedging decisions that an airline must make. Consistent with these ordinal preferences found below is the notion that outguessing a rival in regard to the direction of future jet fuel price movements generates economic benefits for the airline, and, to the contrary, being outguessed by rivals results in economic penalties. In periods of falling jet fuel prices, airlines that do not hedge (or that do not hedge as much as their competitors) are able to translate reduced jet fuel prices into reduced ticket prices if they want. Competitors who choose to hedge jet fuel prices bear this risk unless all hedge alike. If jet fuel prices go up, then those who hedge will benefit from gains associated with their hedge investments which offset to some degree the increases in jet fuel prices. But their unhedged (less hedged) competitors suffer (or suffer more) from higher jet fuel prices. Airlines who have hedged before an increase in jet fuel prices takes place are able to translate gains from hedging into lower ticket prices. Airlines choosing not to hedge jet fuel prices bear this risk unless all choose not to hedge.

An analysis of ordinal preferences in the case where one airline's hedging choices can affect both its own profitability and the profitability of its rivals requires eight ranks rather than the four of the previous case. Why? There is an added dimension to this new problem. As before jet fuel prices may go up or down, and as before an airline may either hedge or not hedge, but now it matters whether an airline pays the same price for jet fuel as its rival. A possible state of the world where both pay the same high price for jet fuel because jet fuel prices went up and neither airline hedged is ranked differently than a possible state of the world where your airline pays a high price for jet fuel because jet fuel prices went up and your airline did not hedge, but your unhedged rival pays less.

Rank 8 is preferred above all others. In this state jet fuel prices have declined and your airline has not hedged (so for your airline there is no cost of hedging to be subtracted from the benefits associated with the decline in jet fuel), but your rival has hedged and thus pays more for jet fuel than your airline does. Rank 7, in this state jet fuel prices have declined, your airline has not hedged, and your rival also has not hedged, so both benefit fully from lower jet fuel prices – both your airline and your rival pay the same price for jet fuel. Rank 6, in this state jet fuel prices have fallen, your airline and your rival have both hedged, so both do not benefit fully in the decline of jet fuel prices, but neither your airline or your rival are put at a competitive disadvantage by hedging, because both your airline and your rival pay the same price for jet fuel. Rank 5, in this state jet fuel prices have fallen, but your airline has hedged against jet fuel price increases while your rival has not hedged, so you must pay more for jet fuel than your rival.

Rank 4, in this state jet fuel prices have risen, but your airline has hedged against jet fuel price increases while your rival has not, so you pay less than your rival for jet fuel. Rank 3, in this state jet fuel prices have increased, but both your airline and your rival have hedged against jet fuel price increases, thus both your airline and your rival pay the same price for jet fuel. Rank 2, in this state jet fuel prices have increased, but neither your airline nor your rival has hedged, so your airline and your rival pay the same price for jet fuel. Rank 1, in this state jet fuel prices have risen and your airline has not hedged, but your rival has hedged, so your airline pays more for jet fuel than your rival does.

Table 5
Hypothetical Preferences (You, Rival) Over Future States of the World for Two Airlines Where Rank 1 is Least Preferred: A Case Where One is Penalized for Being Outguessed by a Rival and Rewarded for Outguessing a Rival

	Rival Hedges	**Rival Does Not Hedge**
You Hedge	3,3 Costs Rise 6,6 Costs Fall	4,1 Costs Rise 5,8 Costs Fall
You Do Not Hedge	1,4 Costs Rise 8,5 Costs Fall	2,2 Costs Rise 7,7 Costs Fall

As in the first case above that is illustrated in Table 4, a Minimax solution is again available, suggesting that if both you and your rival are rational and risk averse, then both should consider hedging to avoid the worst possible outcome. If all hedge alike, then two good things happen: the risk of paying a high price for jet fuel is mitigated, and, ceteris paribus, all competitors pay the same price for jet fuel.

But, what if there is a risk that your rival cannot or will not hedge? If you persist in hedging, then your hedging strategy is made more risky. In this scenario, when jet fuel prices fall your rival will pay less for jet fuel than your airline. If there is a risk that your rival will not hedge, then your airline may consider not hedging as well. If no one hedges against possible changes in jet fuel prices, then, ceteris paribus, all airlines pay the same price for jet fuel in every possible future state. Depending on an airline's ability to pass higher jet fuel costs on in the form of higher ticket prices, decision makers may look with favor upon a strategy that attempts to attain the same price for jet fuel at the expense of hedging against the possibility that jet fuel prices rise.

In fact not all airlines do hedge. In Table 6 below, one can see that American is unhedged. The other airlines studied: United Continental, Delta, Southwest, and JetBlue are hedged in varying degrees against a possible increase in the price of jet fuel. American Airline's decision to not hedge jet fuel prices is consistent with that of US AIR, which completed a merger with American Airlines on December 9, 2013. Levine-Weinberg (2014) writes that management of this airline decided in 2008 to no longer hedge their jet fuel costs. By the third quarter of 2009 all of their hedging contracts were gone. American shows no hedge losses in the fourth quarter of 2014 because they are not hedged. Their rivals all show losses in the fourth quarter of 2014 because they have hedged against the possibility of higher prices for jet fuel, but jet fuel prices fell instead.

But, in times past hedging has paid well. Gwynne (2012) reports that Southwest is the only domestic airline that has avoided bankruptcy. American, United, Delta, Northwest, and US Airways have sought bankruptcy protection since September 11, 2011, or, like Continental, have lost their separate existence. When the price of oil began to increase dramatically in 2000, Southwest was protected in large degree by jet fuel hedges, which saved the company four billion American dollars from 2000-2011.

Table 6
A Comparison of Fuel Expense per Income Statement and Economic Cost of Jet Fuel as it is Reported in Schedules Associated With Financial Statements: Fourth Quarter Results 2014 vs Fourth Quarter 2013

	2014	**2013**	**2014**	**2013**	**2014**
	United Continental	United Continental	American	American	Delta
Fuel Purchase Cost	$2,445	$2,987	$2,659	$3,214	$2,394
Add: Realized Hedge Losses (Gains)	85	(22)			2,146
Add: Refinery Segment Impact Loss (Gain)					(105)
Add: Hedge Loss (gain) or Mark to Market Effects	151	(4)			(1,966)
Equals: Total Economic (or Adjusted) Fuel Cost	$2,681	$2,961	$2,659	$3,214	$2,469
Total Fuel Expense (GAAP)	$2,530	$2,965	$2,659	$3,214	$4,435

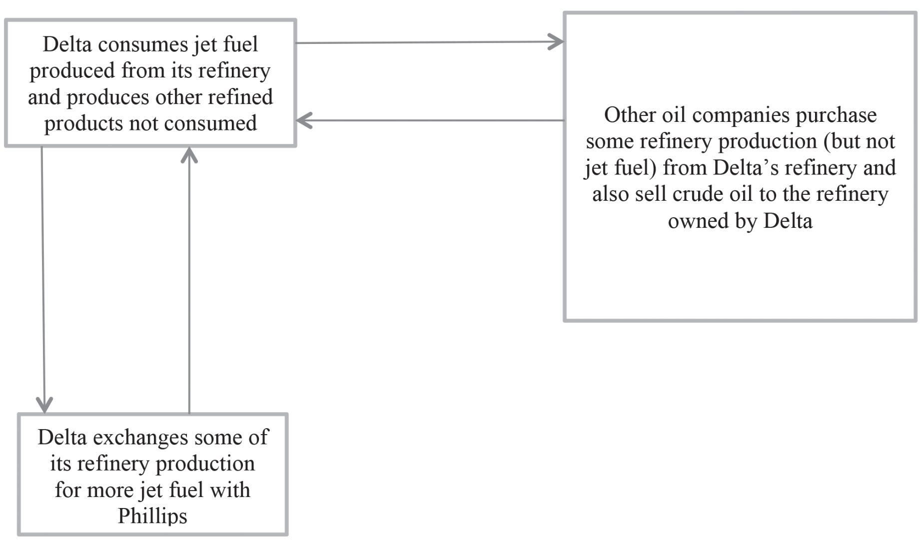
	2013	**2014**	**2013**	**2014**	**2013**
	Delta	Southwest	Southwest	JetBlue	JetBlue
Fuel Purchase Cost	$2,823	$1,150	$1,364	$410	$463
Add: Realized Hedge Losses (Gains)	(150)	17	3	26	3
Add: Refinery Segment Impact Loss (Gain)	46				
Add: Hedge Loss (gain) or Mark to Market Effects	92	(1)	(13)		
Equals: Total Economic (or Adjusted) Fuel Cost	$2,811	$1,166	$1,354		
Total Fuel Expense (GAAP)	$2,719	$1,167	$1,367	$436	$466

Source: various company press releases and, where information was not available from company sources, calculations by the author.

Calculations above are consistent with accounting standards: Statement of Financial Accounting Standards No. 133 defines jet fuel hedges to be cash flow hedges such that the market value of all derivative contracts are found on the balance sheet and, for hedges that are effective, the changes in the market value of derivative contracts are booked to other comprehensive income until the jet fuel purchase that is being hedged is used. When the jet fuel is used, the hedging results become a part of the jet fuel expense. On the other hand, ineffective hedging results in immediate income statement recognition. Statement of Financial Accounting Standards No. 161, an amendment to FASB Statement No. 133, requires that firms disclose how and why they hedge, and how the gains and losses associated with derivatives affect both balance sheet and income statement accounts, and cash flows.

One major airline has taken the extraordinary step of making its own jet fuel. Delta Air Lines in 2012 purchased an oil refinery with the intention that this investment will alleviate a shortage of jet fuel supply. Hargreaves (2012) reports that Delta purchased the shut-down Phillips 66 Trainer Refinery for $150 million, and that Delta planned to invest another $100 million to modify the refinery so that it can produce more jet fuel. Delta management (2012 form 10-K) explains that the Trainer refinery, located near Philadelphia, Pennsylvania, was acquired in response to Delta's inability to control jet fuel costs through hedging, and that this investment is in response to both higher refining margins for jet fuel and the declining supply of jet fuel in the North-Eastern United States. The Trainer refinery has a capacity of 185,000 barrels per day. This refinery restarted in September 2012. Figure 1 below describes the work of this refinery. Delta consumes the jet fuel produced by Trainer refinery and sells or swaps the by-products of refinery products to oil companies.

Figure 1



Delta, in their 2013 10-K filing, reports that their refinery operations lost money in 2013 because of U. S. Environmental Agency requirements. The EPA requires refiners like Delta that do not blend renewable fuels (ethanol) to obtain a waiver from this requirement, or to purchase renewable energy credits in a secondary market from refiners that produce more renewable fuels at their refineries than regulations require. Delta chooses to purchase these credits and their cost in 2013 is high enough to cause Delta's refinery business to show a loss. Delta is studying the matter and hoping for better results in the future. Nevertheless, Delta contends that their refinery has succeeded in increasing jet fuel supplies.

ANALYSIS OF VARIANCE OF JET FUEL COSTS PER GALLON

Consider the following data set contained in Table 7 below. Every year in annual reports airlines report their average jet fuel cost per gallon after hedge results are taken into consideration. Similar data, in some instances differing by a penny or so on the gallon, is provided by the Bureau of Transportation Statistics. It could be the case that for the airlines under study, different hedging practices result in different jet fuel costs per gallon after hedging effects are accounted for. Proving this by way of hypothesis testing fails.

Table 7

Per Gallon Jet fuel Cost After Hedging Results are Considered

	United Continental	American	Delta	Southwest	US AIR	JetBlue
2014	$2.97	$2.91	$2.87	$2.92	N.A	$2.99
2013	$3.13	$3.08	$3.07	$3.12	N.A.	$3.14
2012	$3.27	$3.20	$3.26	$3.30	$3.17	$3.21
2011	$3.06	$3.00	$3.05	$3.19	$3.11	$3.17
2010	$2.39	$3.20	$2.33	$2.51	$2.24	$2.29
2009	$1.80	$2.00	$2.15	$2.12	$1.74	$2.08
2008	$3.52	$3.03	$3.13	$2.44	$3.17	$3.08
2007	$2.18	$2.13	$2.24	$1.80	$2.20	$2.18

Source: Company 10-K filings and Bureau of Transportation Statistics

Consider the null hypothesis – mean per gallon fuel costs after hedging are equal for all airlines appearing in the sample for the time period indicated. Take the data set contained in Table 7 which is the jet fuel costs after hedging effects, airline by airline for the years 2008 through 2012. Let the treatment variable be identified as the choice of airline, with six levels of that treatment variable, one for each of the six airlines studied. And let the blocking variable be the time periods in which annual per gallon jet fuel costs were measured, with six levels of that blocking variable, one for each of the six years annual per gallon jet fuel costs were recorded. Table 8 below is an ANOVA table that results:

Table 8
Analysis of Variance of Per Gallon Jet Fuel Cost After Hedging Effects For the Years 2007-2012

Source of Variation		Sum of Squares		Degrees of Freedom		Mean Squares		F Ratio
Airline		0.155600		5		0.031120		0.55
Year		8.761233		5		1.752247		30.85
Error		1.419870		25		0.056795		
Total		10.33670		35				

The F Ratio calculation of 0.55 is much too low to show at any reasonable level of confidence that fuel costs, net of hedging results, are different from airline to airline. One cannot reject the null hypothesis that mean differences in jet fuel costs after hedging is accounted for are equal for all airlines studied. As expected, the inclusion of blocking variable – time period – is highly effective in making the analysis of variance more powerful than it otherwise could be. The blocking variable is statistically significant at the 99 percent level of confidence. This test is arguably powerful in a statistical sense, and yet the null hypothesis cannot be rejected.

The work summarized in Table 9 is similar to that of Table 8. Again an analysis of variance of jet fuel costs, net of results is undertaken. But, in the data set associated with Table 9, an airline that has lost its separate identity in 2013 is omitted from the study. However, dropping US Air, which now no longer exists as a separate entity, and including the years 2007-2014 do not change the results. Again, the null hypothesis that all airlines have equal jet fuel costs after hedge results are accounted for, cannot be rejected at any reasonable level of confidence.

Table 9
Analysis of Variance of Per Gallon Jet Fuel Cost After Hedging Effects
For the Years 2007-2014

Source of Variation		Sum of Squares		Degrees of Freedom		Mean Squares		F Ratio
Airline		0.092810		4		0.0232025		0.49
Year		7.929997		7		1.13285679		23.99
Error		1.321990		28		0.04721393		
Total		9.344797		39				

CONCLUSION

In the airline industry, hedging may be used by management to fix the price of jet fuel, or to locate it within some predetermined range, but hedging cannot guarantee that an airline will pay a price for jet fuel as low as the price that its competitors pay, unless all competitors hedge alike or all refuse to hedge. Hedging cannot guarantee an airline which hedges that its unhedged rivals will not benefit from a decline in jet fuel prices.

All in airline industry may wish to hedge alike. There are benefits to the risk averse for doing so. If all do hedge alike, then all are protected against a sudden surge in jet fuel prices and, when ceteris paribus conditions are met, all will pay the same price for jet fuel. But it may be the case that not every airline can afford to hedge jet fuel costs, or hedge as much as they would like. Hedge commitments may require collateral and cash beyond the means of some airlines. If this is so, then those airlines which do not hedge are put at further risk should jet fuel prices increase. However, these airlines by not hedging, put their rivals who do hedge at risk should jet fuel prices decline. Those who hedge in these instances find themselves paying more for jet fuel than their unhedged rivals.

Therefore, knowledge that your rival may not or cannot hedge may change your own hedging strategy. You may choose not to hedge as well. If no one hedges against possible changes in jet fuel prices, then, ceteris paribus, all airlines pay the same price for jet fuel in every possible future state. Depending on an airline's ability to pass higher jet fuel costs on in the form of higher ticket prices, decision makers may look with favor upon a strategy that attempts to attain the same price for jet fuel at the expense of hedging against the possibility that jet fuel prices rise.

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