How to Utilize Hedging and a Fuel Surcharge Program to Stabilize the Cost of Fuel

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ABSTRACT

This paper looks at some of these travails as well as the common tools used to approach a volatile priced commodity, diesel fuel. It focuses on the impacts of hedging for companies that are directly impacted through the consumption of diesel fuel in addition to companies that are indirectly impacted because they outsource their transportation. It examines the impact of a fuel surcharge and how it distributes risk throughout the supply chain. To complement the research, analysis was conducted in the form of a survey to benchmark the industry with respect to current practices of hedging and fuel surcharges, a sensitivity test of a fuel surcharge matrix to find its appropriate usage, and a simulation to provide guidance as to the appropriate strategy for hedging. Lessons learned from the survey flowed into the sensitivity testing and simulation. These three segments of analysis highlighted the problem of volatility, increasing cost, and inability to pass on the cost, proving the true pain of fuel in the market. Ultimately, the paper answers: How to utilize hedging and a fuel surcharge program to stabilize the cost of fuel? The survey showed the wide adoption of fuel surcharges, confirming the academic research. The sensitivity test proved the need to keep the escalator variable in line with a carrier's actual fuel efficiency and standardize for all carriers. The simulation recommended longer term derivatives. Putting this together, the fuel surcharge establishes stability for the carrier, at the risk of the shipper. The shipper must maintain that stability through its maintenance of the escalator in the fuel surcharge matrix. Additionally, the shipper should hedge fuel via long term derivatives to establish personal fuel cost stability, creating a competitive advantage and enabling the shipper to compete more effectively.

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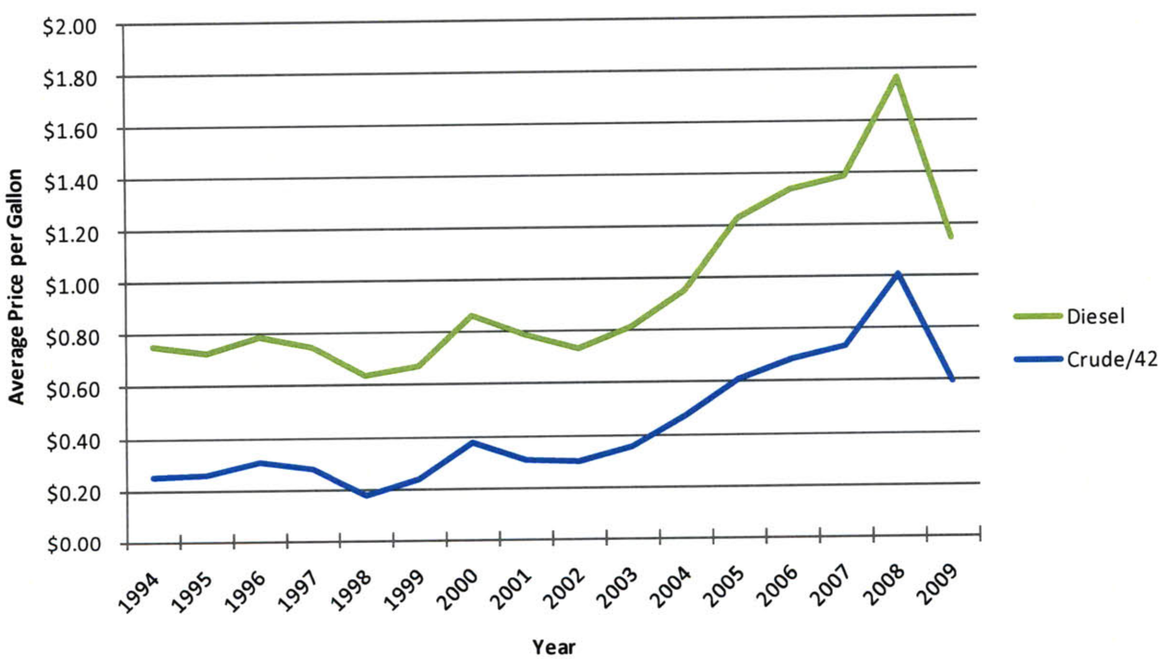
1 INTRODUCTION

Fuel prices have become a growing concern for companies across the United States, as well as the rest of the world. With the expansion of supply chains beyond traditional borders, the dependence upon fuel has become a larger part of a good's cost. Figure 1.1 shows how crude oil, as recorded by the U. S. Department of Energy, has outpaced inflation, when adjusted using the U.S. Department of Labor's Consumer Price Index (CPI), to become a growing cost component.



(Department of Energy, STEO, 2010 & US Department of Labor, CPI-U, 2010)

Figure 1.1 – Rising Cost of Fuel, Inflation Adjusted

Figure 1.1 shows that both crude oil and diesel have outpaced inflation, eroding profitability for companies through transportation costs increasing at a faster pace than consumer goods. This growing cost component is only the initial pain point as the economic impacts will carry downstream to employee wages via cost of living increases. Such a reinforcing spiral, as wage increases cause cost of living increases and cost of living increases cause wage increases, is a concern for companies trying to control costs.

In addition to fuel prices outpacing inflation, fuel price volatility is another concern. The unpredictability of fuel prices undermines a company's ability to accurately forecast their transportation costs, which translates into poor product pricing or contribution margin issues. Both translate into profit concerns. Figure 1.2 shows the year over year change in crude oil prices, highlighting the unpredictability of this commodity.

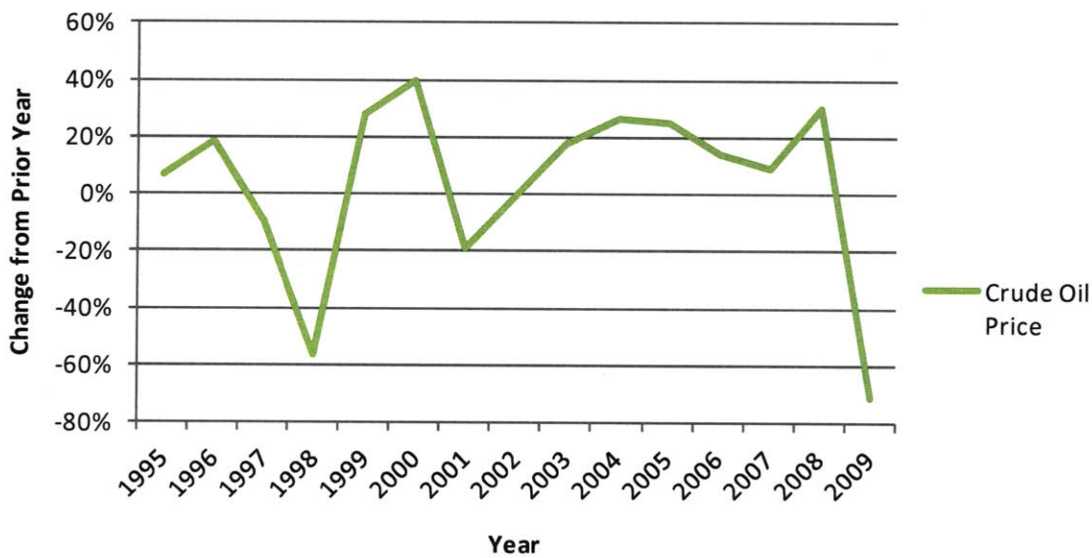


Figure 1.2 – Yearly Change in Crude Oil Prices

The following sections provide more background into the oil market and its evolution, followed by an explanation of how crude oil becomes diesel fuel at the pump. A brief history of the United States trucking industry is reviewed, with the intent of explaining the carrier's role in the transportation industry, and how it relates to their customers. This provides an understanding of the players and markets involved.

1.1 History of the Oil Market

The energy market has experienced significant price volatility over the past 40 years, especially in the petroleum industry. The 1970s were volatile with the Organization of Petroleum Exporting Countries, or OPEC, embargo of 1973-74 as well as the supply shortage of 1979. Both were a result of the political situation in the Middle East. The market did not fully recover until the mid 1980s when additional supply was brought online, eventually creating a surplus. Without OPEC being able to unify its members, oil prices remained low and relatively stable. Short spikes occurred, such as the period around the Persian Gulf War in the early 1990s, but prices quickly stabilized, returning to years of constant and cheap oil. However, the rise of new industrial powers, such as China and India, fed a growing demand spike into the late 2000s. In addition to real demand growth, market speculation contributed to the situation, artificially inflating demand. Adding to the problem, OPEC's strength and unity grew, diminished supply and further aggravated the supply-demand equilibrium. The result was the rise of crude oil to a record high, over $140 per barrel, in July of 2008. Quickly following this spike, the price plummeted over 75%, finishing the year around $79, highlighting the volatility of this commodity. As this history shows, the unpredictability and subsequent volatility is a function of many components, ranging from political to economical inputs. While these components cannot all be managed, tools exist to mitigate the volatility, such as hedging and fuel surcharges, which are discussed in more depth in sections three and four of this paper, respectively.

1.2 Crude to Diesel

Crude oil comes in varying levels of quality. These levels of oil quality impact the output of refining the crude oil, a process known as cracking, into its many byproducts. Table 1.1 shows an example breakdown of a barrel of crude once it has been cracked. These ratios vary with quality of the crude, and are traded as separate commodities on an exchange. Once delivery is taken, the diesel fuel, which itself is a byproduct of heating oil, is then transported to a gas station and available for use at the pump. The numerous byproducts of crude are important to note, since the process is not reversible. Thus, future needs must be forecasted to insure the proper refining volume of each final product, otherwise supply will not match demand and prices of those byproducts will have to compensate, potentially adding more volatility to the price of diesel fuel.

Table 1.1 – What's in a Barrel of Crude Oil

What's in a Barrel of Crude Oil?

Output varies with crude selection, but the average break-down is as follows:

Product	***Gallons per barrel***
Gasoline	19.5
Distillate fuel oil (includes home heating and diesel fuel)	9.2
Kerosene-type jet fuel	4.1
Residual Fuel Oil	2.3

(Heavy oils used in industry, marine transportation, and power utilities)

Liquefied refinery gases	1.9
Still Gas	1.9
Coke	1.8
Asphalt & road oil	1.3
Petrochemical feedstocks	1.2
Lubricants	0.5
Kerosene	0.2
Other	0.2

In the oil business, a "barrel" is a unit of measure that is equal to 42 gallons, as opposed to the 55 gallon steel drums with which most of us are familiar.

(If you've added up the numbers, you found that the sum came to 44.2 gallons, of which the 2.2 *extra* gallons represent "processing gains.")

(Marcus, 1999)

1.3 American Truckload Transportation

The transportation industry is segmented by mode: sea, air, rail, intermodal and over-the-road. The sea, air and intermodal segments consist of larger companies due to the high capital investments in freighters, cargo planes or railroad tracks, creating a significant barrier of entry for new participants. The over-the-road mode is segmented even further by shipment size, into parcel, less-than-truckload (LTL) and truckload (TL). The United States Postal Service is an example of a parcel carrier. The LTL segment targets palletized shipments or larger, with the TL segment targeting shipment sizes that favor the economy of a full truck. This paper focuses on the truckload portion of the transportation industry.

The TL market is still highly fragmented, largely a result of the deregulation resulting from the Motor Carrier Regulatory Reform and Modernization Act, also referred to as the Motor Carrier Act of 1980 (MCA). Previously, carriers had to be certified on a state level in order to conduct business in that state. This turned into a significant barrier of entry, limiting carriers to state or regional levels. The MCA removed this barrier of entry, permitting several carriers to grow to the national level. Yet, rather than the market consolidating, the lack of a significant barrier to entry made it much easier for new market entrants. The result was many small carriers. Of the 228,000 for-hire and 282,000 private domestic carriers, approximately 96% have a fleet of less than 20 trucks, as reported by the American Trucking Association (ATA, 2010). This immense number of carriers, over 500,000, has fostered a highly competitive market. While these companies are able to manage labor and equipment costs, they cannot afford to shoulder the burden of volatile fuel price fluctuations.

Now that the oil and transportation markets are understood, as well as the refining of crude to diesel fuel, an example of a typical supply chain manager's fuel cost dilemma should demonstrate the heart of the fuel price volatility problem. Table 1.2 shows the average diesel price for 2007 through 2009, as well as a fuel spend for fifty million gallons of diesel fuel for each year. This represents a typical fuel spend for a company.

Table 1.2 – Average Diesel Prices Circa 2007 - 2009

Year	Average Diesel Price	Shipper Fuel Cost
2007	$2.88	$144,000,000
2008	$3.81	$190,500,000
2009	$2.46	$123,000,000

Remembering that fuel costs have outpaced inflation, as shown in Figure 1.1, raising prices is not an easy decision, depending upon the price elasticity of the product market. Alternatively, a stabilization solution would provide longer term cost management. Yet price instability, increasing by 24% in 2008 and then falling by 55% in 2009, make such an idea difficult to conceive.

From a trucking industry perspective, a small increase can create immense costs. It is estimated that $146.2 billion was spent on diesel fuel by the US trucking industry in 2008 (ATA, 2010). This cost represented 22% of the $660.3 billion in revenues in 2008 (ATA, 2010). Holding other costs constant, for every 5% increase in fuel costs, profits decrease by over 1%.

An estimated 55 billion gallons of diesel fuel was consumed by trucking companies in 2007 (ATA, 2010). With the average retail price of diesel in 2007 being $2.88, that total spend comes to $158.4 billion. A nickel increase would create an additional $2.75 billion in diesel fuel costs for the same number of miles traveled.

This paper recommends a solution to the increasing cost of fuel, shown in Figure 1.1, and volatility, illustrated in Figure 1.2. History has shown that crude oil has a wide range in inputs, and its complex refining process can influence the market price. Yet, carriers cannot shoulder this volatility alone.

The remainder of this thesis is organized to encompass a literature review highlighting past research and an explanation of the core tools needed to combat market volatility and carrier fuel risk sharing. It continues through the use of a market benchmarking survey, fuel surcharge sensitivity testing, and hedging simulation, and proposes an answer to the following question: How can a company utilize hedging and a fuel surcharge to stabilize the cost of fuel?

2 LITERATURE REVIEW

This section provides an overview of the literature related to this topic. First, it presents examples of previous studies and methodologies on hedging. Second, a review of specific industry studies relevant to our research. Third, a review of relevant studies on fuel surcharges, citing the history and the motivation behind the implementation. Finally, awareness is brought to the motivation behind our research explaining the contribution it brings to the academic community.

2.1 Hedging

Most commodity markets are highly volatile. Spot prices change continuously, often, without warning. To counter changes in prices, companies hedge their exposure in an attempt to stabilize prices. Hedging is any technique designed to reduce or eliminate financial risk. Hedging allows market participants to lock in prices, and costs, in advance, while reducing the potential impact of volatile prices and creating cost stability. Yet hedging doesn't eliminate risk, it merely stabilizes a portion thereof, as poor hedging decisions can result in higher than market costs, much like Coca-Cola Bottling Co.'s $11 million mark-to-market loss due to ineffective hedging decisions in 2008 (Mufson, 2008).

Several studies have shown that hedging is conducted by firms to raise firm value (revenues). Stulz (1984) presents a study in which value-maximizing firms pursue active hedging policies in the foreign exchange rates market. He derives optimal hedging policies for risk-averse agents and solely focuses the analysis on hedging foreign exchange exposure through forward contracts on foreign currencies. Building on this, Smith and Stulz (1985) treat hedging simply as part of the firm's financing decisions. They develop a hedging theory that is part of the overall corporate financing policy. Mello and Parson (2000) evaluate alternative hedging strategies for financially constrained firms. They determined hedging creates value by increasing the return earned on the liquidity available to the firm focusing only on short-term futures contracts. Brown and Toft (2002) derive optimal hedging strategies for a value-maximizing firm. However, they focus solely on a single-product, price-taking company with linear production costs making a one-period hedging decision. However, firms can also use hedging to stabilize prices for their customers rather than create value.

Studies have found that firms primarily use derivatives to reduce the risks associated with short-term contracts. Stutlz (1996) followed by Hentschel and Kothair (20010 investigate whether firms systematically reduce or increase their riskiness with derivatives. They also look at whether corporations' use of derivatives is significantly related to overall stock return risk. Both found that derivatives were positively related to better stock returns. However, in commodities short-term contracts might not always meet the needs of the corporation.

Nance, et al.(1993), utilizing a survey and COMPUTSTAT data, found firms hedge to reduce expected tax liabilities, to lower expected transaction costs, and to control agency problems. Mian (1996) obtained data on hedging directly from annual reports and found that larger firms are more likely to hedge. This leads to a hypothesis that economies of scale exist in hedging.

Guay and Kothari (2002) show the magnitude of risk exposure hedged by financial derivatives in large non-financial corporations. They state that corporative derivative use appears only to be a small piece of their overall risk profile. The use of derivatives is economically small in relation to overall risk exposures. They observed increased derivative use for firms for which a CEO's bonus is highly correlated the company's stock price. They state the main types of derivatives used to hedge risk are foreign exchange rates (the rate at which one currency can be converted to another) and interest rate swaps (an exchange of interest payments on a specific principal amount), reinforced by McCarthy (2003) when he compares a number of strategies for managing foreign exchange exposures.

While numerous studies have been conducted on various firms across various industries, Tufano (1996) specifically studied the gold mining industry while Morrell and Swan (2006) focus solely on the airline industry to study why corporations hedge. Both noticed that companies that do hedge are rewarded with higher stock prices on the marketplace. However, no true correlation is found as to whether this is due to better management decisions or if investors believe that if a company hedges it must have solid financials run by better leaders.

2.2 Fuel Surcharge

Fuel surcharges (FSC) first appeared after the first Arab oil embargo of 1973, then disappeared over the next two decades before returning as a permanent price structure for transportation costs in the mid-1990s, when diesel spiked to $1.15/gallon (extremely high for this time period). Schulz (2006) Grant and Kent (2007) state a significant cost in the transportation industry is to budget fuel. Gross (2006) reported when companies are faced with unacceptable exposure to fuel prices they have three choices: (1) raise their prices; (2) sacrifice profits to keep prices steady; and/or (3) utilize fuel surcharges. While Leak (2009) reports shippers have two possible strategies when faced with unacceptable exposure to fuel prices: hedge or partner with their freight provider to "lock in" fuel surcharge since fuel surcharges represent a significant, volatile component of transportation costs. Building on Leak, Kilcar (2004) states there are a variety of fuel management strategies to offset high fuel prices. The most prevalent is a fuel surcharge, which enables carriers to pass a portion of the higher fuel costs onto customers. Kilcar continues stating that fuel surcharges are the most effective method for handling escalating diesel prices and have become staples in contracts between carriers, shippers, and receivers since about 1994-1995. Conversely, Manning (2003) states companies levy surcharges to either associate themselves with or dissociate themselves from additional costs of doing business, both actual and planned. He argues that firms can generate additional revenue, reduce costs, or both. With this, Bohman (2005) states fuel surcharges are designed to enable a carrier to react quickly to increases/decreases in fuel volatility.

Bohman states just about every for-hire trucking company has established a scale of FSC that is tied to DOE weekly average for national, regional, or sub regional diesel fuel prices. He states that for LTL trucking fuel surcharge is structured using a scale that triggers an increase or reduction in the fuel surcharge of 0.1% when average diesel fuel prices rise or fall by one cent per gallon. For TL shipments, a one-cent increment in diesel causes a surcharge to rise or fall by 0.2%. However, Bohman states, and our survey confirms, that not all LTL and LT carrier's FSC scales are alike. Bovet (2008) reports FSC are well established in all transportation modes: truckload, less-than-truckload, intermodal rail and container ocean carriers. This is usually presented as a step increase tied to the weekly DOE retail diesel price. For some LTL freight, Bovet report, the FSC can often be a percentage of the base rate per hundredweight.

The review of literature outlined above is helpful to gain understanding of fuel hedging policies and fuel surcharges leading to the following key points:

(1) Hedging doesn't eliminate risk, but does stabilize a portion, and is mainly used to create revenues for a firm, not to stabilize prices

(2) Fuel surcharges are the most effective method for handling escalating diesel prices, and have become staples in contracts between carriers, shippers, and receivers since about 1994-1995

(3) Fuel surcharges are designed to enable a carrier to react quickly to increases/decreases in fuel volatility

(4) Fuel surcharges are well established in all transportation modes

In summary, firms create value (revenues) using short-term hedging contracts via exchange rates and currency swaps. However, in commodities, short-term contracts do not always meet a firm's needs. There are a variety of fuel management strategies to offset high fuel prices. The most prevalent is a fuel surcharge, which is the most effective method for handling escalating diesel prices and has become a staple in contracts between carriers, shippers, and receivers with just about every for-hire trucking company establishing a scale of FSC that is tied to a DOE average. However, not all carriers' FSC scales are alike.

3 HEDGING

Hedging is the activity of utilizing a technique to reduce or eliminate a risk by using one asset to offset that risk associated with another asset. People engage in such activities throughout their lives. The simple act of filling up one's gas tank before a summer weekend, doing so because prices are expected to rise, is a hedging activity. Expanding upon this activity to provide a better understanding, while providing real life examples, each of the five core types of hedging is explained, as well as common models for deriving the value of a hedging opportunity.

3.1 Derivatives

Derivatives are financial instruments whose value comes from another asset. There are five main types of derivatives: options, futures, swaps, forwards and exotic. The utilization of a derivative is referenced as 'hedging,' with the underlying intention of protecting oneself against risk. This could be considered "market insurance." Hedging, at its basic level, speculates price movements in the marketplace. We will now explain the five types of derivatives.

3.1.1 Options

An option contract, along with futures contracts, are the most common derivatives in use. Options give the owner an option without commitment to buy the underlying asset. Thus, the owner has purchased the first right of refusal. To illustrate, consider K-mart's Lay-A-Way in Table 3.1:

Table 3.1 – K-mart's Lay-A-Way Program

Term	Detail	Term Type
Contract length	8 weeks	Policy
Service Fee	$5	Initiation fee
Cancellation fee	$10	Termination fee
Payments	Bi-weekly, 25% of balance	Payment schedule
Down Payment	10% of value	Initiation fee
Return to stock	7 days post missed payment, eligible for refund minus fees	Policy

The Lay-A-Way Program costs an upfront fee of $5, regardless of the cost of the underlying good(s). Customers are permitted to have the good(s) in the program for as long as eight weeks, with payments being made every two weeks. These elements resemble an options contract, whereby there is an upfront price to purchase the contract, the service fee in Table 3.1. The length of the contract is clearly specified, like the eight weeks in K-mart's program. The delivery location is implied, as the goods do not leave the K-mart store. An example would consist a woman placing a pair of shoes on law-a-way at K-mart. She expresses interest at the customer service desk and is shown the terms, much like one would review a derivative contract. She approves of the terms and puts the shoes on law-a-way, paying the $5 and entering into the contract, just like one would do when purchasing an option contract. While she will make bi-weekly payments, the equivalent of multiple expiry dates, she maintains the right to back out of the contract at any time. She continues making the bi-weekly payments and takes delivery on her asset on week eight, picks up her shoes, exercising her option contract.

More generally, an option contract, commonly shortened to just option, offers the right to buy or sell an asset with no future obligation to do so. A call option gives one the right to buy an asset, whereas a put option gives one the right to sell an asset. An option contract specifies the strike price, the price at which you can buy or sell the asset on the open market, as well as the contract price and the expiry date, among other terms. The option contract will end on what is called the expiry date. The expiry date is the last date when the option contract is valid.

Options can exist in many forms, with the most common being European, American, and Asian options. The key difference between European and American options is the expiry date. A European option can only be exercised on the expiry date. However, an American option can be exercised on any day up to and including the expiry date. Asian options, or average priced options, are valued by the average underlying price of the asset over a pre-set time period, as opposed to at the time of maturity as is the case for European and American options.

If any of the above options are acted upon, the buyer will be responsible for taking delivery, also referred to as delivery exposure. This presents a serious problem for anyone who buys an option contract without the intention of consuming the underlying asset, such as market speculators. Usually the contract will specify the delivery location, which can vary for a set asset, much like other terms in the contract. Some examples of these variants include currency, asset grade and quality.

The next section demonstrates a few basic option situations: a call with rising prices, a put with rising prices, a call with falling prices and a put with falling prices.

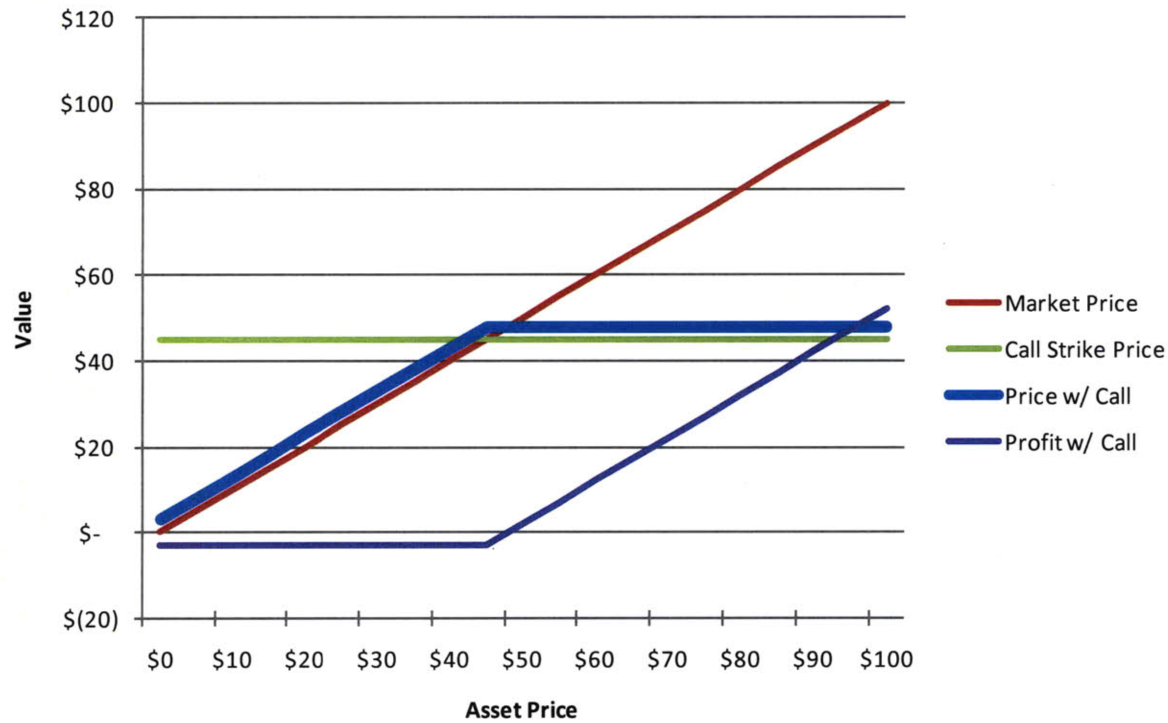


Figure 3.1 – Call Option with Rising Prices

In Figure 3.1, the market price increases to $100. An American call option contract was purchased for $3,000 with a strike price of $45 for 1,000 units. Since the market price is steadily rising, the contract is profitable when (if) the option is executed while the market price is greater than $48 (strike price of $45 plus option purchase price of $3,000 / 1,000 units, or $3 per unit, $45 + $3 = $48). Conversely, the option contract is unprofitable while the market price is below $48. On such a contract, the upside is limitless, as prices can theoretically rise infinitely. Yet, the downside risk is fixed and irrelevant to the price of the underlying asset, as the cost of the option contract will be the only expense should it not be executed.

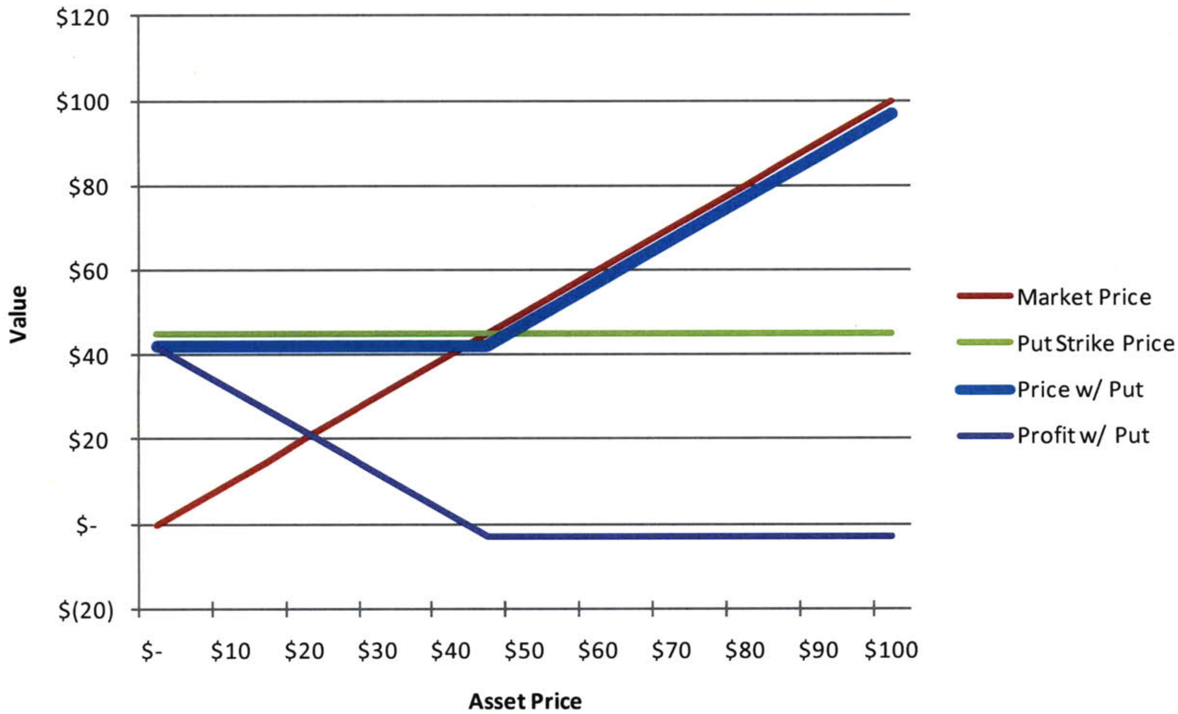


Figure 3.2 – Put Option with Rising Prices

In Figure 3.2, the market price again increases to $100. An American put option contract was purchased for $3,000 with a strike price of $45 for 1,000 units. A put option is commonly utilized when the underlying asset is believed to be overpriced. The same principle holds as before, since the market price is steadily rising, the contract is profitable when (if) the option is executed while the market price is less than $48 (strike price of $45 plus option purchase price of $3,000 / 1,000 units, or $3 per unit, $45 + $3 = $48). Conversely, the option contract is unprofitable while the market price is above $48. The risk situation is identical to that of the prior example, where the downside risk is still fixed and irrelevant to the price of the underlying asset, as the cost of the option contract will be the only expense should it not be executed. However, in this case with the put option contract, the upside is also limited, as its maximum value was at the point of contract purchase.

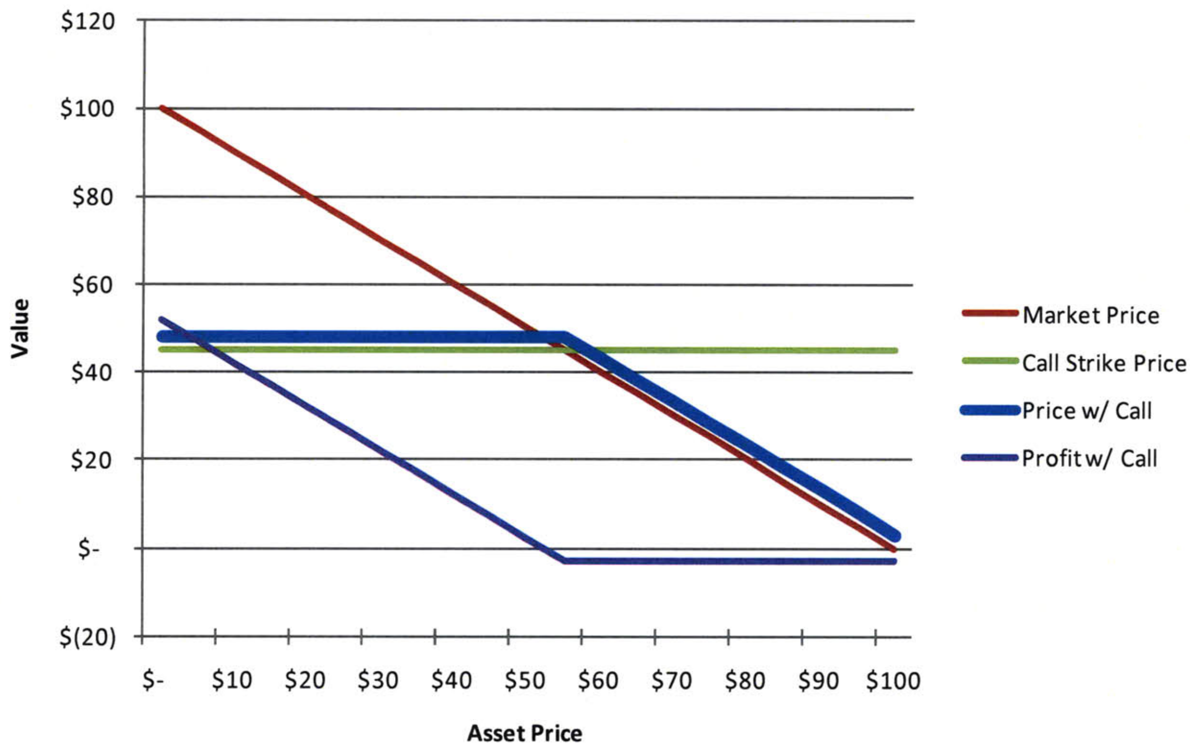


Figure 3.3 – Call Option with Falling Prices

In Figure 3.3, the market price now decreases from $100. An American call option contract was purchased for $3,000 with a strike price of $45 for 1,000 units. Since the market price is steadily falling, the contract is profitable when (if) the option is executed while the market price is greater than $48 (strike price of $45 plus option purchase price of $3,000 / 1,000 units, or $3 per unit, $45 + $3 = $48). Conversely, the option contract is unprofitable while the market price is below $48. The contract upside is limitless, as prices can theoretically rise infinitely. The downside risk remains fixed and irrelevant to the price of the underlying asset, as the cost of the option contract will be the only expense should it not be executed. With such a market situation, timing is of the essence in order to make a profit on the contract.

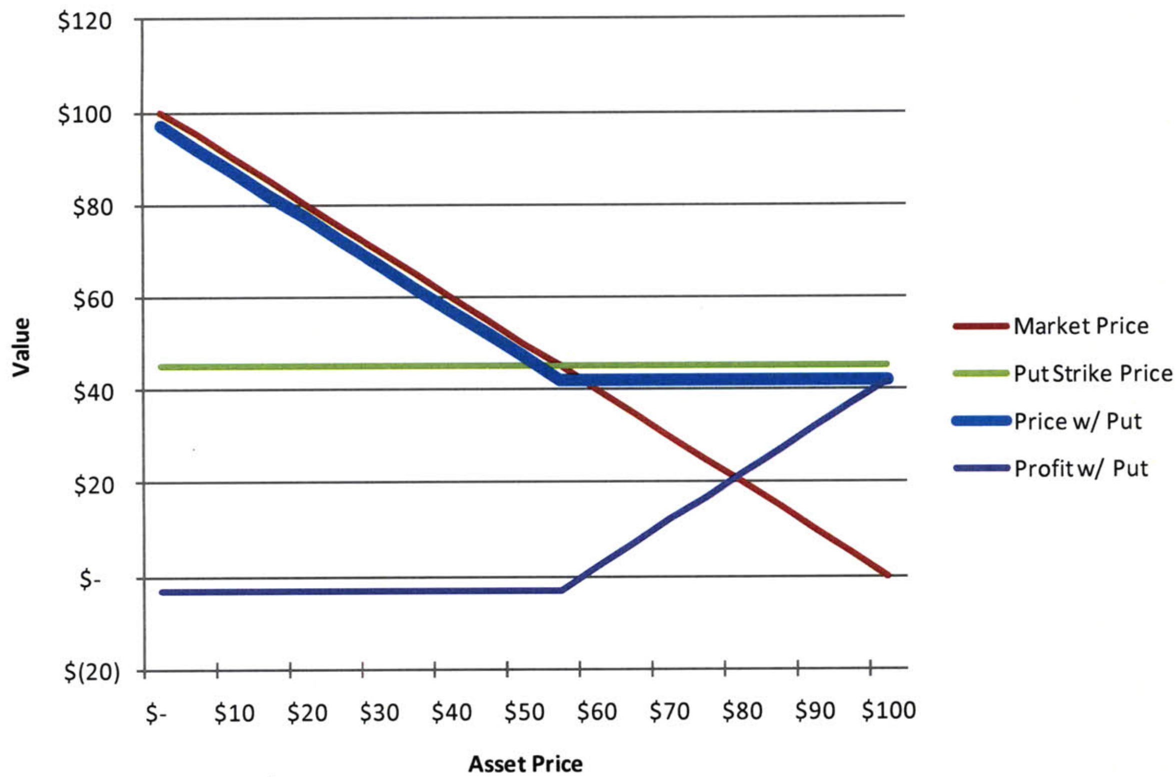


Figure 3.4 – Put Option with Falling Prices

In Figure 3.4, the market price again decreases from $100. An American put option contract was purchased for $3,000 with a strike price of $45 for 1,000 units. The same principle holds as before, since the market price is steadily falling, the contract is profitable when (if) the option is executed while the market price is less than $48 (strike price of $45 plus option purchase price of $3,000 / 1,000 units, or $3 per unit, $45 + $3 = $48). Conversely, the option contract is unprofitable while the market price is above $48. This risk situation is somewhat similar to that of Figure 3.1, where the downside risk is still fixed and irrelevant to the price of the underlying asset, as the cost of the option contract will be the only expense should it not be executed. The put option contract upside is limited by the strike price of the underlying asset in the contract, as its maximum value is at the point when the underlying asset become worthless (price of $0).

The previous examples show how an option contract works. We will now shift to futures contracts, which like option contracts, are a very popular type of derivative.

3.1.2 Futures

Futures contracts, unlike options contract, commit the buyer to ownership in the underlying asset. One example would be the purchase of a one month T pass on Boston's Massachusetts Bay Transportation Authority (MBTA) mass transit system. Suppose the below:

Table 3.2 – MBTA Fare Schedule (MBTA, 2010)

Type	Cost	Duration	Break even
Single fare	\$1.70	One entry	-
Daily pass	\$9.00	All day	5th trip
Weekly pass	\$15.00	All week	8th trip
Monthly pass	\$59.00	All month	34th trip

Table 3.2 shows four fare schedules available for passage on the MBTA's Boston T subway system. For a single entry and one-way passage, the cost is \$1.70. Alternatively, one may purchase a one-day pass, entitling the individual to unlimited passage for the entire day for a cost of \$9. Or, one may purchase a weekly pass, entitling the individual to unlimited passage for the entire week for a cost of \$15. Finally, one may purchase a one-month pass, entitling the individual to unlimited passage for the entire month for a cost of \$59 (rates current as of April 2010). The forecasted volume of T usage determines which pass is the best option, as shown in Figure 3.5 below.

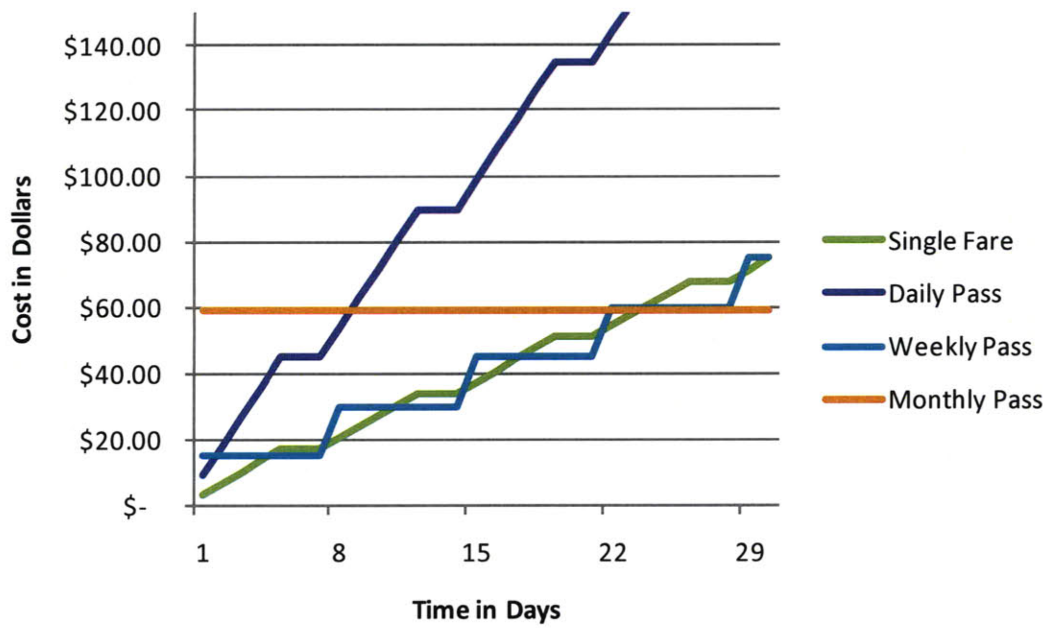


Figure 3.5 – MBTA Fare Comparison for a Month

For someone looking for a single ride with no other anticipated usage, the single pass is best. However, for someone using the T for daily transportation commuting to and from work, the monthly pass is best, assuming two rides per day for twenty-two work-days per the month. The fundamental part of this decision is the forecasted volume of usage, as the pass must be purchased before any transit occurs, and is not retroactive. This is an example of a hedging opportunity. The purchase of any pass is a hedge against a higher total cost. As explained above, one using the T for their monthly commuting is forecasting forty-four rides which would cost $74.80 under the normal fare of $1.70, but only $59 with a monthly pass. Usage higher than the forecast would only improve the hedge position, or upside. While lower than forecasted usage will weaken the hedge, or downside, with usage below 34 trips making the monthly pass a poor hedge decision. This is a hedging opportunity on volume, which directly links to total cost.

Supplementing an MBTA T-pass for a derivative contract, and T rides as a traded asset, and you have a typical hedging opportunity available on the regulated markets.

From a technical standpoint, a futures contract is a contract requiring the purchase of an asset (i.e. stock or commodity) at a specified price and at a date in the future. Unlike options, buying a futures contract obligates one to buy the asset and involves greater risk as the price of the asset can increase or decrease in value between the agreement date and delivery date. Futures contracts are settled in two ways: delivery and cash settlement.

Delivery on a futures contract is when one delivers the asset on the contract specified date and location. For example, one might purchase a crude oil futures contract to deliver the actual asset on the contract date in the future at New York Harbor. Alternatively, one could use a square position, two offsetting positions, transitioning the delivery to fulfill another contract. This is commonly done with another derivative type called a swap, which is explained in more detail later in the section.

Cash settlement is paying the difference between the futures price and the spot price (real price in the market) of the asset. For example, one sells an oil futures contract worth $100 and the price of the contract on expiry date is $110, the seller will have to pay the buyer the difference on $10 if they wish to utilize a cash settlement for the futures contract. This can resemble a square position, when treating cash as another position. With options and futures being the common derivative types for fuel hedging, as is confirmed in our survey later in the paper, both still contain delivery exposure. That is where the squaring position and cash settlement can be useful methods.

We will apply the same market situations and strategies to future contract positions as we did with option contracts to provide greater detail.

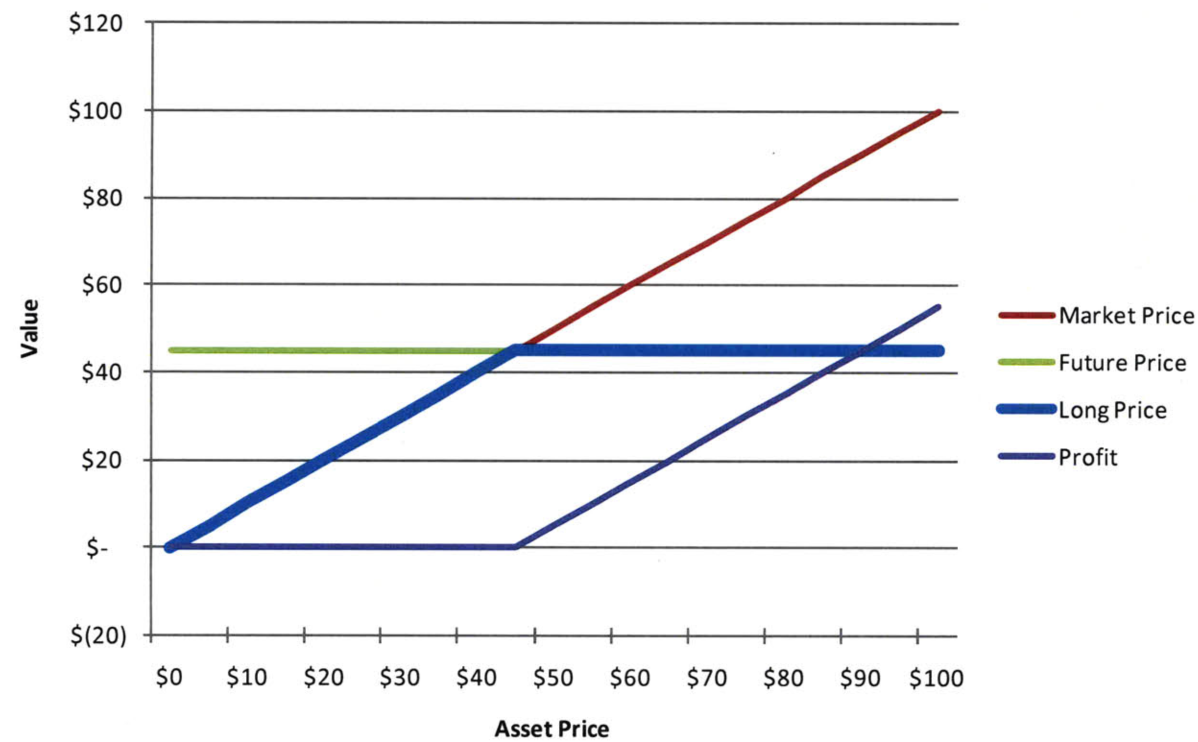


Figure 3.6 – Long Future with Rising Prices

In Figure 3.6, the market price increases to $100. A long future was purchased for $45. This means that one is obligated to purchase the asset for $45 on the contract date. Since the market price is steadily rising, one can make a net profit once the market price exceeds $45, in this example the end profit would be $55 for the transaction (market price of $100 – future price of $45 = $55). This illustrates the upside potential in a market with rising prices. Since a minimum price has been agreed upon, this upside is infinite. The downside is limited by the fact that the commodity cannot go below the price of $0.

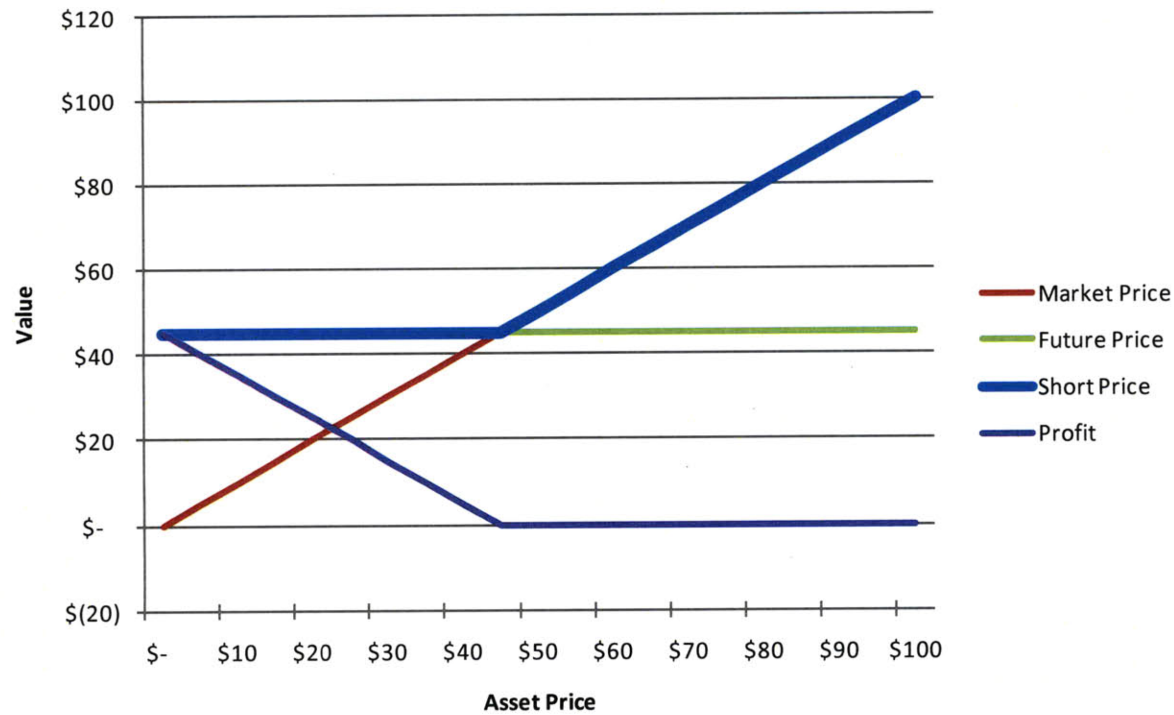


Figure 3.7 – Short Future with Rising Prices

In Figure 3.7, the market price is again increasing to $100. A short future was purchased for $45. This means that one is obligated to purchase the asset on the contract date for $45. Since the market price is steadily rising, one can make a net profit when the market price is below $45. Contrary to the last technical example, the downside is not limitless, as every tick upwards in price is a larger loss. The upside is limited by the price of the underlying asset reaching $0.

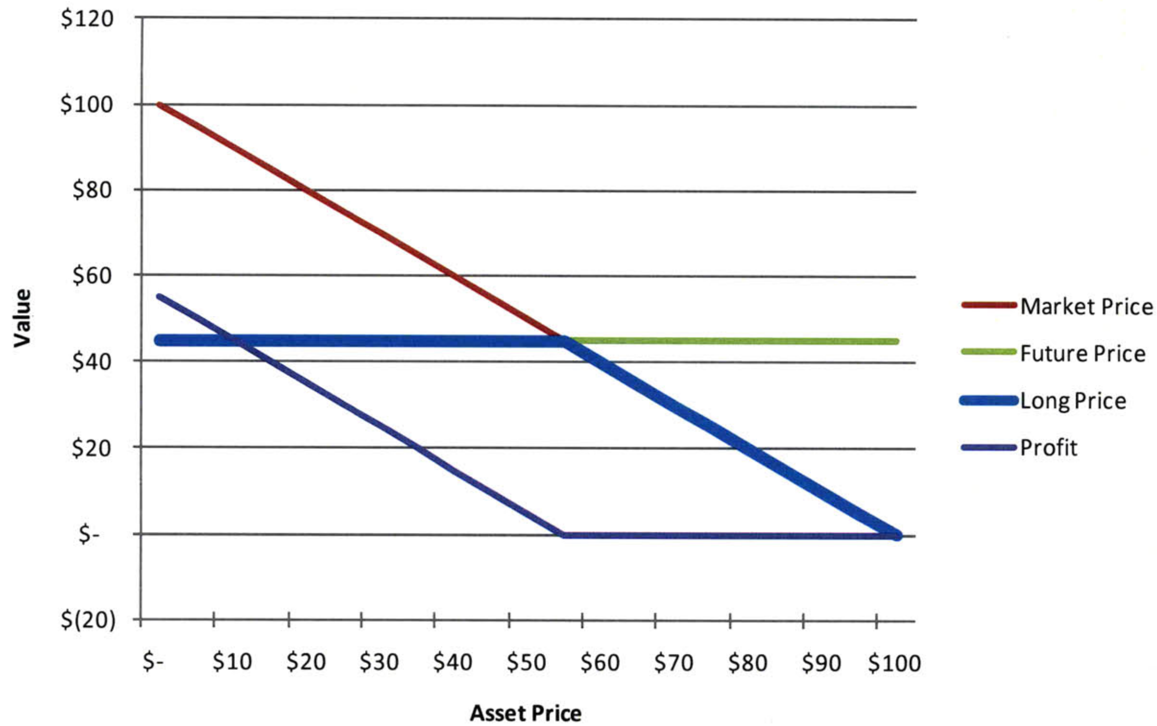


Figure 3.8 – Long Future with Falling Prices

In Figure 3.8, the market price falls from $100. A long future was purchased for $45. This means that one is obligated to purchase the asset on the contract date for $45. Since the market price is steadily falling, one will only make a net profit when the market price exceeds $45. The upside potential is limitless, but not probable with falling prices. The downside is limited by the asset value reaching zero.

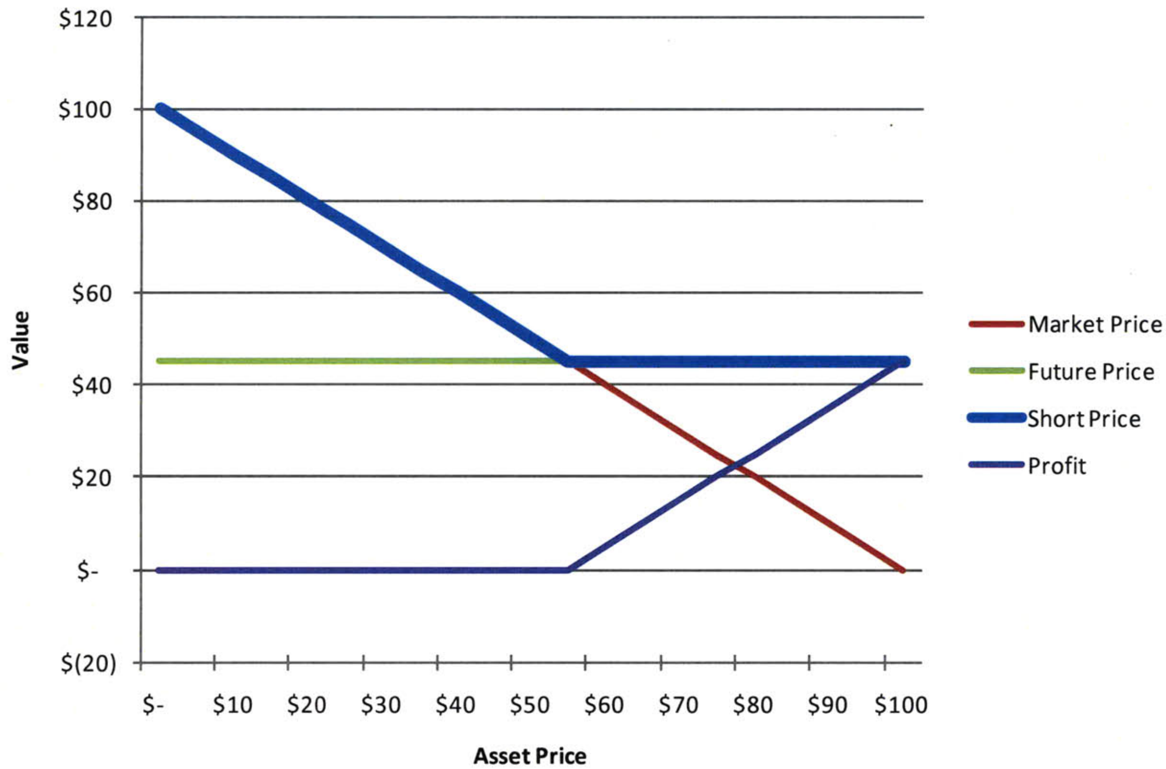


Figure 3.9 – Short Future with Falling Prices

In Figure 3.9, the market price again falls from $100. A short future was purchased for $45. This means that one is obligated to purchase the asset on the contract date for $45. Since the market price is steadily falling, one will make a net profit when the market price is below $45. A short position flips the upside and downside potential. The upside is limited by the value reaching $0, and the downside is limitless, yet unlikely with prices falling.

For practical application of all the above situations, the variance between delivery location and desired consumption location should be factored in to the value of the contract, as a higher priced contract may prove to be more valuable than a lower priced contract once transportation costs are factored into the equation. This is relevant to those hedging fuel with the intent to take delivery, as the derivative owner is responsible for the transit cost of the asset to their desired location, such as a fuel storage tank at a company's dispatch site.

Now that we have reviewed in detail the two most popular derivative types, we will briefly touch upon their applicability to stability. Each technical example included the upside and downside risks for its respective situation. Stability can be achieved by combining these positions along with the market conditions to turn a volatile price in the market to a fixed price via a derivative contract. Yet, as the examples showed, there are risks inherent to this practice. We will now continue with some less common derivative types.

3.1.3 Swaps

A swap contract is an agreement between two parties to transfer ownership of agreed upon asset(s). The contract specifies a spot price, date, as well as other potential assets, possibly including another derivative contract and/or cash. Swap contracts are very popular in foreign currency transactions. The vast majority of commodity swaps involve crude oil. Swaps have no delivery exposure, as no physical asset is exchanged, making it purely a financial transaction.

To illustrate a swap, we will use an asset created by the United State Postal Service's introduction of the Forever Stamp in April 2007. To briefly explain, this special stamp is different from the normal first class stamp in one distinct feature: value. The Forever Stamp is always the same price as a current first class stamp at the time of purchase, 44 cents as of April 2010. Unlike the first class stamp, it will not need to be subsidized with additional postage once postal rates are increased. Thus creating the valuation differential. Ultimately, purchasing a Forever Stamp is hedging against future postal rate increases.

To complete an example of a swap, one would combine the asset of a Forever Stamp with a predetermined future date and agreed upon price for said asset. At the time of maturity on the future date, rather than the asset transferring hands, instead the valuation differential would be paid out. So if the price of a first class stamp is agreed to be 48 cents on the maturity date, but is really 45 cents, 3 cents would be swapped, or paid, for each stamp agreed to in the contract.

3.1.4 Forwards

A forward contract is very similar to that of a futures contract, with the main distinction being that forward contracts are not exchange traded. This means they are not regulated, and can have varying structures determined only by the contractual parties.

3.1.5 Exotic - Hybrids

While two parties can create any type of derivative they chose, limited only by law and their imagination, listing these on an exchange would be impossible. However, some are more common than others. One being a swaption. This derivative would be classified as exotic, and thus be an over-the-counter security not traded on an exchange. Typically used with interest rates, a swaption's fundamentals combine that of a swap and an option. The benefit is that it provides possession protection for the buyer, avoiding the delivery risk usually associated with an option contract.

3.2 Valuation

In order to utilize any of the above derivatives, and decide whether or not to purchase or sell, a value must be determined for the derivative. Due to the fundamental differences of the derivatives, different models must be used to compute their value. Three commonly used models are: Black-Scholes, Binomial and Present Value. These valuation models vary in their complexity, and are commonly associated with certain derivative types.

3.2.1 Black-Scholes

European options are commonly valued using the formula created by Fischer Black and Myron Scholes in their paper titled "The Pricing of Options and Corporate Liabilities" from 1973. This model is rather simple, similar to the structure of the option, since it can only be acted upon on one day. Thus its value must be determined for only a discrete point in time. The value is calculated by multiplying the price of the asset by its delta and comparing it to the cost of a bank loan:

$$\text{Value of a call} = [\text{delta} * \text{asset price}] - [\text{bank loan}]$$

Figure 3.10 – Value of a Call Simplified (Brealey, 2000)

$$\text{Value of a put} = [\text{bank loan}] - [\text{delta} * \text{asset price}]$$

Figure 3.11 – Value of a Put Simplified (Brealey, 2000)

The symbolic notation is as follows:

$$\text{Value of a call} = [N(d1) * P] - [N(d2) * PV(EX)]$$

Figure 3.12 – Value of a Call (Brealey, 2000)

$$\text{Value of a put} = [N(d2) * PV(EX)] - [N(d1) * P]$$

Figure 3.13 – Value of a Put (Brealey, 2000)

where:

delta 1 (d1) = $\dfrac{\ln\left(\dfrac{P}{PV(EX)}\right)}{\sigma\sqrt{t}} + \dfrac{\sigma\sqrt{t}}{2}$

N(d) = cumulative normal probability function

PV(EX) = present value of exercise price

σ = standard deviation per period of continuously compounded rate of return on asset

delta 2 (d2) = $d1 - \sigma\sqrt{t}$

T = number of periods to exercise

P = current price of asset

ln = natural logarithm function

Illustrating Black-Scholes for an oil based European option contract opportunity, let the current price of a barrel of crude oil be $100, with the option contract specifying an exercise price of $100 in one month. Let the volatility of the asset be 30% per year with an annual interest rate of 6%. Delivery issues are ignored for simplicity. The formula would be applied as follows:

PV(EX) = 100 * (1 + .06) ^ (1/12) = $100.49

$$d1 = \frac{-0.00486}{.3\sqrt{\frac{1}{12}}} + \frac{.3\sqrt{\frac{1}{12}}}{2} = -0.01277$$

inputting the present value of the exercise price as well as delta one (d1) gives us:

$$\text{Value of a call} = [N(-0.01277) * 100] - [N(-0.01277 - .3\sqrt{\tfrac{1}{12}}) * 100.49]$$

$$\text{Value of a call} = [\ 0.4949 * 100\ ] - [\ 0.4354 * 100.49\ ] = \$5.74$$

Thus, the value of a long call European option contract with an exercise price of $100 in one month is $5.74.

The Black-Scholes model was used by the Department of Energy when forecasting the price of crude oil. These forecasts were used in the simulation to follow later in this paper.

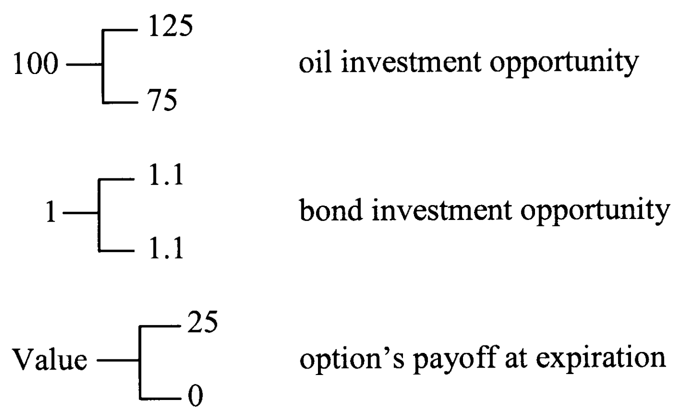
3.2.2 Binomial

Because American options can be exercised on any day up to and including the expiry date, they must also be valued for any date up to and including the expiry date. For this reason, the simpler Black-Scholes model cannot be used. Instead, the Binomial model must be used. The Binomial Model follows the following three steps, similar to a decision tree (Brealey, 2000):

1) generate a price tree for both the asset and the opportunity cost
2) create a portfolio of the asset and the opportunity cost replicating the call option's payoff
3) calculate the option value at each final node
4) progressively calculate the option value at each earlier node, where the value at the first node is the value of the option

Monte Carlo simulation is often required to solve this type of options, especially as they extend into multiple time periods, making the computation complex.

Illustrating the Binomial model for an oil based American option contract opportunity, let the current price of a barrel of crude oil be \$100, with the option contract specifying an exercise price of \$100 in 1 month. The price of crude oil will either go up to \$125 or down to \$75. The borrowing and lending rates are 10%. Since this is a commodity, no dividends exist. Again delivery issues are ignored for simplicity. The model would be applied as follows:



where *a* represents the share of the asset, in the case barrels of oil, and *b* represents the dollars in a riskless bond, such that:

$$125\ a + 1.1\ b = 25$$

$$75\ a + 1.1\ b = 0$$

And solving for *a* and *b* unique values results in $a = 2$ and $b = -136.36$, meaning one would buy 2 barrels of oil and sell \$136.36 worth of the bond. The present value of the call option must equal that of the replicating portfolio, thus:

$$\text{Value} = 100 * a + b = 100 * 2 - 136.36 = \$63.64$$

Thus, the value of a long call American option contract with an exercise price of \$100 in one month is \$63.64, in this example.

3.2.3 Present Value (PV)

Since three of the five derivative types, forwards, futures and swaps, are similar in financial nature, they can be valued using a standard present value calculation for the expected cash flows. This is calculated by summing the nominal values of all expected cash flows (both positive and negative) and then adjusting each by a discount rate, which accounts for the time-value of money, to bring the sum into a single time period value. It is common for the same discount rate to be applied to each cash flow, as in the below formula:

$$Present\ Value = \frac{C}{(1+i)^t}$$

Figure 3.14 – Present Value (Brealey, 2000)

where:

C = Investment in today's dollars

I = Interest rate

T = Duration of the investment in years

The formula in Figure 3.16 is a common valuation method for everyday business decisions, such as capital investments involving periodic revenues (pay-outs) and costs (loan interest). It accounts for compound interest, and is the same logic used for most bank loans.

The present value logic, the time-value of money burden, underlies a common pricing model for future contracts. This model incorporates the underlying asset's price at the time the contract is purchased and burdens it with the London Interbank Offered Rate (LIBOR) and then deducts the subjective value one has with holding the asset versus the contract, net convenience yield.

Finally, just like the PV function, it is burdened with the length of time for the contract, measured in years.

$$Future\ Price = Spot\ Price\,(1 + LIBOR - Net\ Convience\ Yield)^{Time}$$

Figure 3.15 – Present Value of Future Contract (Brealey, 2000)

The LIBOR is a common benchmark for interest rate calculations of international scope and is published daily to support real time market conditions. It is calculated using an inter-quartile mean of contributor banks (ranging from eight to sixteen).

4 FUEL SURCHARGE

As was emphasized by Gross (2006), Leak (2009) and Kilcar (2004) in section 2.2 of this paper, a fuel surcharge is a critical component for a carrier to manage fuel costs. This is done by separating the linehaul and fuel costs. The fuel cost is turned into a surcharge which is passed on to the shipper. The linehaul cost, now independent of fuel, should remain rather stable throughout a given year, assuming no major changes in labor, equipment, or market demand, among other inputs. This stability is preferred by both the shipper, ease to compare carrier rates, and the carrier, no longer absorbing the full fuel price volatility. Following is an explanation of the types of fuel surcharges and the basic structure of a fuel surcharge matrix.

4.1 Types

While the use of a fuel surcharge is common across the transportation industry (Kilcar, 2004), the implementation of this surcharge varies, especially by transportation mode. The most common surcharge types are:

- Value based
- Linehaul based
- Distance based

Value based fuel surcharge programs base the amount paid on the value of the product being transported, calculated by taking the value of the cargo and multiplying it by the set percent of value surcharge. This method is common for ocean and air freight movements.

Linehaul based and distance based fuel surcharge programs utilize the same formula. The former uses a percent of the linehaul charge while the latter uses a cents per mile calculation. While linehaul based fuel surcharges are commonly used for less-than-truckload and intermodal freight movements, distance based fuel surcharge, or cents per mile (CPM), is standard among over-the-road truckload movements. When utilizing the cents per mile distance based fuel surcharge program, the issue of calculating the distance for the movement can be a point of contention. While this seems trivial, it can have a significant impact on the cost and timeliness of the load. There are four generally used methods for calculating the distance:

- Shortest distance
- Practical miles
- Highway route
- Fastest route

Despite the self-explanatory nature of the above, each has an underlying behavior which is used to control the cost and timeliness of the transportation. Several software programs are available to provide this data and standardize the measurements. The programs allow the user to input many variables, such as fuel efficiency, trailer height and speed tolerances. Shortest distance looks for the absolute shortest distance, regardless of road type, but still permitting adequate clearance for the indicated trailer height. Practical miles balances both time and distance (cost), accounting for the route a driver would normally take, including highways but also accounting for the cost of tolls. Highway route optimizes the route to keep the driver off minor roads and on major roads while ignoring tolls. Fastest route allows speed limits to trump distance (taken from PC Miler website). Thus, if cost is more important than time, the shortest distance should be applied, which will look at all available roads regardless of speed limits. On the contrary, if time is more important than cost, the fastest route should be used, as it will factor in speed limits and distance. The shipper, being the payor of the surcharge, typically sets the fuel surcharge type, matching the surcharge's elements to the desired behavior of the carrier.

4.2 Formula

A distance or linehaul based fuel surcharge is a simple math formula, shown in Figure 4.1 below:

$$FSC = INT\left(\frac{P - B}{E}\right) * S$$

Figure 4.1 – Fuel Surcharge Formula (Bohman, 2005)

where:

- P = Price of fuel
- B = Base or Peg rate
- E = Escalator
- S = Surcharge

Explaining the variables above, the actual price is meant to represent the price paid by the carrier. A common source for this variable is the Department of Energy's (DOE) national average, as stated by Bohman (2005) and confirmed by our survey. But others include the DOE's regional average, which divides the continental US into nine regions. Prices is published weekly at http://www.eia.doe.gov/oog/info/wohdp/diesel.asp. The peg or base rate represents the amount of fuel covered in the linehaul portion of the transportation cost. When subtracting the peg rate from the actual price, the difference is then the fuel cost to be covered in the fuel surcharge. The escalator, dividing the difference of the actual price and the peg rate, converts the price difference into a cost per gallon of fuel price. The quotient is turned into an integer and multiplied by the surcharge rate, commonly one cent per mile. The product of this last calculation is the amount the carrier is compensated per mile for the lane. The key variable is the escalator, as it is a proxy for fuel efficiency. Sensitivity testing in the next section shows the influence of this variable in a fuel surcharge.

5 ANALYSIS

This section contains three sets of analysis conducted to find a recommended method for utilizing hedging and a fuel surcharge program to stabilize the cost of fuel. A market benchmarking survey was conducted to establish current industry practices by companies with respect to hedging and fuel surcharges, as well as risk perceptions. Utilizing this data, sensitivity testing was conducted on a fuel surcharge program, and a simulation was performed to determine a hedging strategy. Each of the three sections will be introduced with its methodology and followed by its results, respectively.

5.1 Survey

In order to understand current industry practices, a survey was distributed to approximately 588 contacts across the supply chain industry with 'Logistics' or 'Supply Chain' in their job title; a copy of this survey is included in the appendix. Many were partner members of the Massachusetts Institute of Technology Center for Transportation and Logistics program at some point. The survey was distributed on March 10, 2009. The survey was divided into five core sections: role identification, fuel surcharge, risk sharing, hedging and general information.

Since not all survey recipients were involved surveyed activities, dynamic routing was included in the background structure of the survey. Thus, a respondent taking the survey indicated that she was not actively utilizing a fuel surcharge, she was not asked further questions such as the exact structure of the surcharge matrix. Of the 54 questions in the survey, no one is asked more than 49, or less than 26.

Of the 588 contacts, 157 emails bounced back as invalid addresses, leaving 431 valid addresses. Of these, it is not known how many are active addresses. 92 contacts, or 21%, replied by starting the survey, yet 33 were incomplete with no useable data and 16 respondents whose incomplete information was judged to be of questionable reliability, missing gross amounts of data. This was the only grounds for which data was removed from the response set. The following analysis is based on data from the remaining 43 respondents, comprising a 9.9% response rate from valid addresses.

5.1.1 Results

Of the 43 valid respondents, the following industries are represented: Aerospace, Chemical, Consumer Packaged Goods, Energy, Food & Beverage, Healthcare, Retail, Transportation, and other. Figure 5.1 shows the distribution across industries, with the majority, just under 25%, coming from Retail.

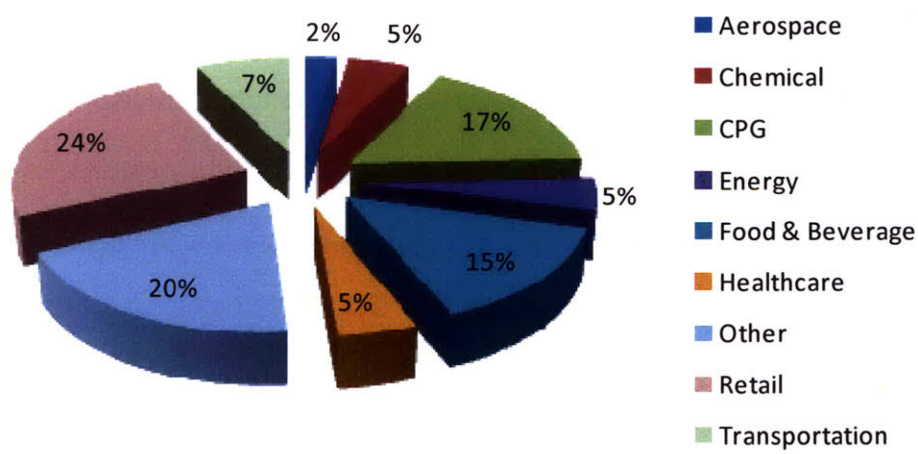


Figure 5.1 – Respondent Industry Representation

Over half of the respondents had annual revenues in excess of $10 billion, with 75% being greater than $1B in annual revenue, as shown in Figure 5.2.

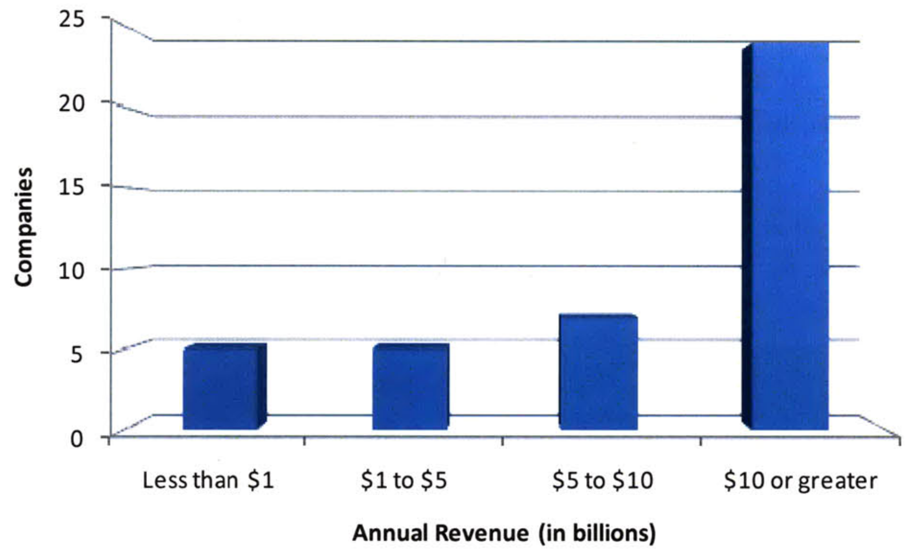


Figure 5.2 – Respondent Company Size

The respondents were primarily shippers (84%) that do not directly consume fuel. The remainder consisted of 9% 3PLs, 0% carriers, and 7% indicated other.

The range of fuel consumption levels varied greatly, from as low as 60 thousand gallons annually to over 100 million gallons; the median was approximately 8 million gallons consumed per year. Fuel consumption trended with company size, as measured by annual revenue, with larger companies consuming more fuel. The median fuel consumption of eight million gallons is used in the simulation, yet behaves as a scalar for other consumption levels.

5.1.1 Fuel Surcharge (FSC)

Almost three-quarters of respondents, 84% of which are shippers, utilize a fuel surcharge for TL freight movement, with 84% of those using the National Average published by the Department of Energy (DOE) updating weekly, as shown in Figure 5.4. Regional averages, published by the DOE, were also used. Most base their FSC matrix upon distance, with almost half using practical mileage calculations. 77% maintain a standard matrix across their carrier base.

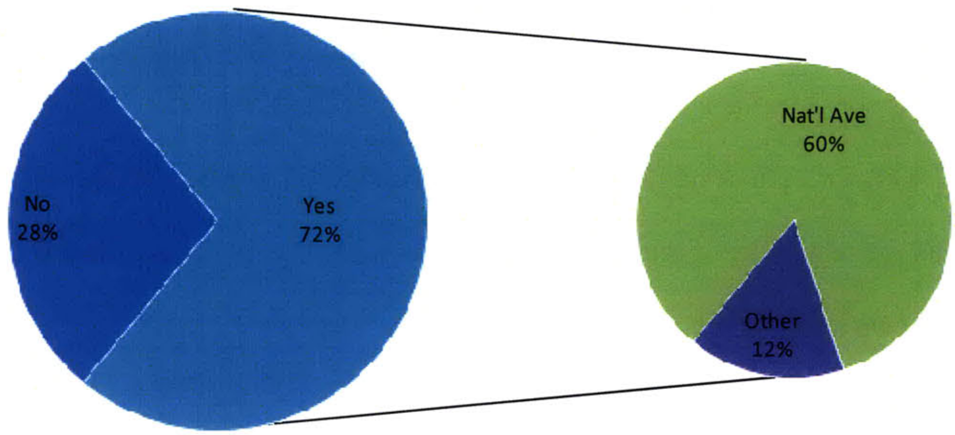


Figure 5.3 – Respondent Fuel Surcharge Usage and Related Peg Rate Source

A fuel surcharge program is less popular for less-than-truckload (LTL) freight movements, yet still comprises the majority with 54%. All respondents followed the National Average from the DOE, with over three-quarters adjusting weekly. Almost two-thirds employ a linehaul based rather than a distance based surcharge. 91% have a standardized surcharge matrix across all their carriers.

The majority of respondents do not use a fuel surcharge for intermodal freight movements, yet those that do greatly favor the National Average from the DOE, updating weekly. Ninety-five percent have a common surcharge matrix for their carriers.

The survey showed a variety of different fuel surcharge matrixes, as shown in Figure 5.5. Three respondents do not use a peg rate in their FSC computation, while the remaining have an average peg rate of $1.35. Table 5.1 contains the quartile breakdown for the peg rate, escalator and surcharges as indicated by survey respondents. This confirms Bohman's research as stated in section 2.2. The peg rate shows a nickel increase per quartile despite the high average, as one respondent indicated a $2.33 peg rate distorting the average from the median. The escalator is consistent around a nickel, closely reflecting current fuel efficiencies of five miles per gallon. The surcharge is consistent at a penny, as only three respondents indicated a different surcharge of two cents or higher. Those outliers, such as the $0 and $2.33 peg, $0.07 escalator and $0.05 surcharge, had the remainder of their FSC components within the norm, or first and third quartiles, as shown in Table 5.1.

Table 5.1 – Quartiles of TL FSC Components

	Peg Rate	Escalator	Surcharge
Minimum	$0.00	$0.050	$0.010
1st Quartile	$1.15	$0.050	$0.010
Median	$1.20	$0.050	$0.010
3rd Quartile	$1.25	$0.060	$0.010
Maximum	$2.33	$0.070	$0.050

5.1.2 Fuel Risk Sharing

While trying to decide who, between carriers and shippers, should bear the burden of fuel costs in the value chain, shippers felt that they should bear less of the burden than carriers, but not by much, as shown in Figure 5.4. On average, shippers felt they should bear 45% of the fuel burden with the carrier handling the remainder, regardless of the mode of transportation. Yet that hides some of the strong perceptions, as 18% of shippers felt they should bear no burden, 15% felt they should bear the entire burden, with an overall perception that 67% felt they should bear less than half the fuel burden.

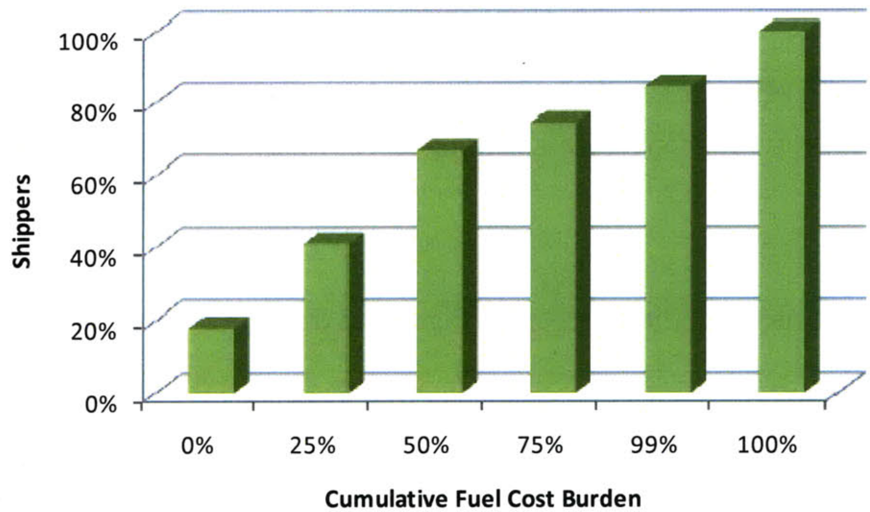


Figure 5.4 – Cumulative Fuel Cost Burden for Shippers

While the use of a fuel surcharge to disperse risk is a common practice between shippers and carriers, as shown by the survey results, applying that same concept down the value chain is less common. Only 12% of the respondents, 80% of which are shippers, indicated that they have established a fuel risk sharing program with their customers.

Seven respondents, 71 % of which are shippers, handle fuel costs is via a cost pass through, where fuel is treated as an overhead charge and directly passed through to the customer. This acts much like a fuel surcharge does for a carrier, but exists between the shipper and customer. With 11% of shippers that share fuel cost risk with customers, only 6%, or half, pass the entire cost through. 31% absorb the entire fuel cost and another 17% employ some combination of cost absorption and pass through.

However, once the customer was included as a potential recipient of the fuel cost burden, the balanced distribution of burden shifted further to that of the carrier. Shippers felt they should bear 25% of the fuel cost burden, carriers should have a larger stake in this cost exposure, or

40% on average, and customers bearing the remainder. In follow-up discussion with some survey respondents, several indicated that they are including fuel in their service contracts, locking in the fuel cost for a longer term, shifting more of the fuel cost burden back onto the carrier.

Furthering this risk responsibility perception, Figure 5.5 displays those perceptions graphically. These perceptions were separated into quadrants, with quadrant one containing all respondents that believe the shipper should bear over half the fuel burden. The same applies for quadrant two and four for customers and carrier, respectively. Quadrant three contains respondents that perceive a balanced fuel risk burden distribution, not giving over half the burden to any single party.

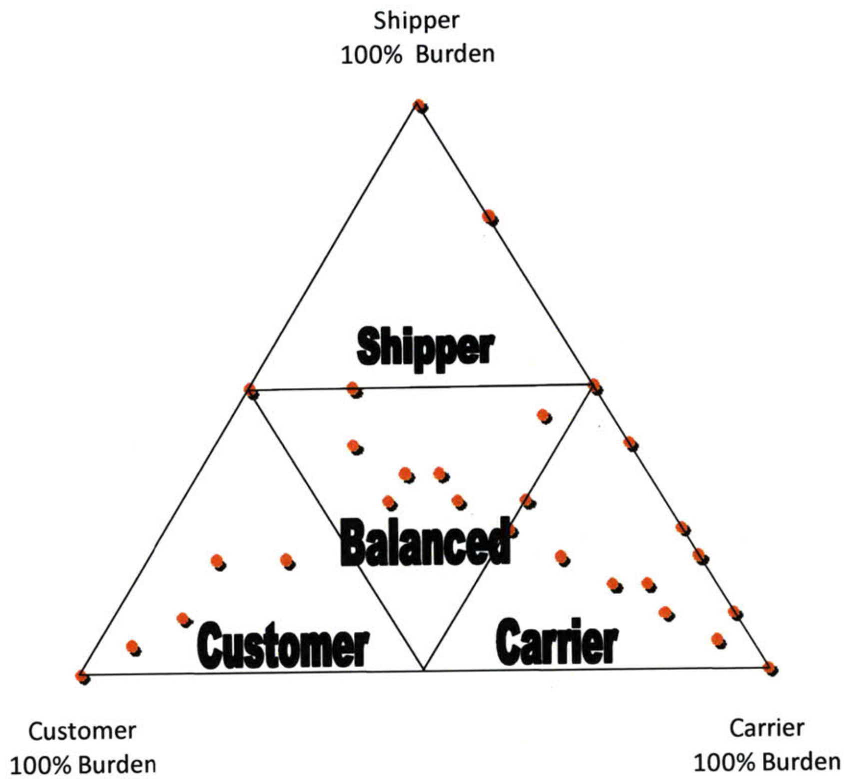


Figure 5.5 – Fuel Cost Burden Distribution Across Shippers, Carriers and Customers

Figure 5.6 accounts for the density of responses in each quadrant in Figure 5.5, showing that 44% of the respondents felt that the carrier should bear over half the fuel risk burden, 85% of which were shippers. Together Figures 5.4 and 5.5 have shown shippers feel they bear too much of the fuel cost burden. When given another party to place the burden upon, the average shipper's fuel cost burden dropped from 45% to 25%.

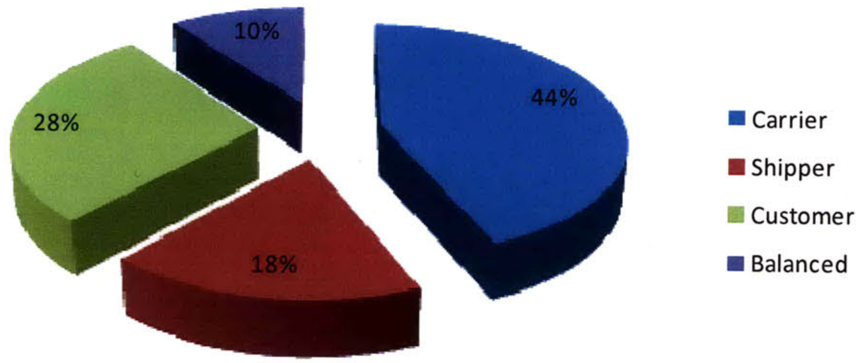


Figure 5.6 – Fuel Cost Burden Density Across Shippers, Carriers and Customers

5.1.3 Fuel Surcharge Sensitivity

Gross (2006) and Leak (2009) support the use of a fuel surcharge, and is confirmed by our survey results, yet it's unclear how to properly set up the fuel surcharge. Carriers have three ways of controlling their fuel cost, either through fuel efficiency, deadhead efficiency, or price paid for fuel. These need to be considered when examining the fuel surcharge. Considering the elements of the matrix, referring to Figure 4.1, the difference of the actual price component and peg rate values the portion of fuel not covered in the linehaul charge, with adjustments to either probably resulting in a reverse adjustment to the linehaul charge, nullifying the initial adjustment. The surcharge component simply complements the difference of the actual price and peg portion, valuing this difference into a monetary value. However, the function of the escalator leaves room for exploration. Sensitivity testing was conducted with respect to carrier efficiency in fuel consumption and deadhead miles, or miles traveled without freight on board, and the impact of wholesale fuel discounts was reviewed to lend insight into the construction of a fuel surcharge matrix and its impact upon a shipper.

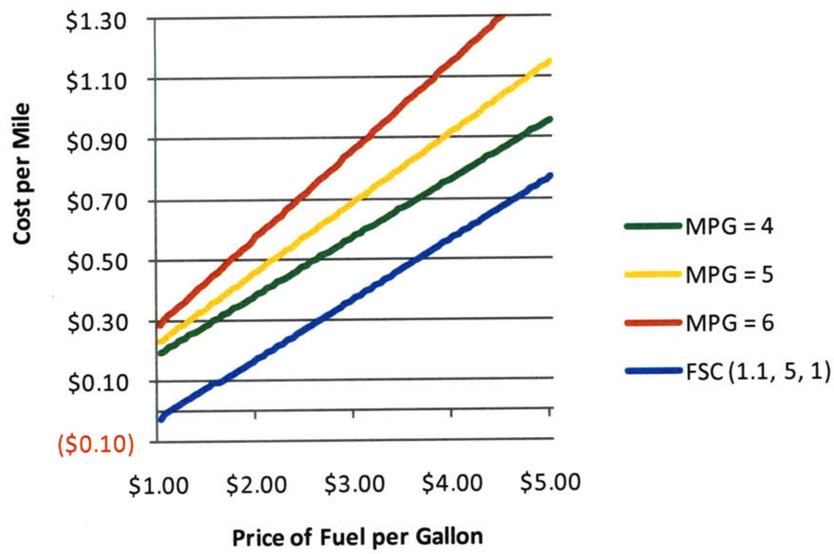


Figure 5.7 – Interaction between Carrier Fuel Efficiency and FSC Escalator

Figure 5.7 highlights the interaction between a fuel surcharge matrix escalator and the carrier's fuel efficiency. The FSC matrix in this example has a peg of $1.10, an escalator of $0.05 per gallon, and a surcharge of $0.01 per mile. Deadhead efficiency is held constant at 15% of total miles traveled, with 250 miles being the distance for this example, not impacting the results in Figure 5.7.

A five MPG fuel efficiency matches that which the example FSC escalator is expecting for the carrier. Figure 5.7 shows how a six MPG fuel efficiency causes the cost per mile to decrease as the cost of fuel increases, rewarding the carrier for the better fuel efficiency. Thus, a carrier with a fuel efficiency better than the escalator of the FSC stands to benefit. This situation creates a competitive advantage for the carrier, as it can either pocket the additional revenue resulting from the fuel surcharge program, lower linehaul rates with an effort to attract more business, or reinvest in more efficient equipment, further promoting this reinforcing loop of benefits, just as Manning (2003) stated in his research. Regardless, the carrier has an incentive to improve its fuel efficiency, with their bottom line increasing with every additional mile of freight hauled.

The contrary is true for a carrier with a fuel efficiency of four MPG, being solely responsible for this additional cost burden. A carrier could be motivated to raise linehaul rates, especially under high fuel pressures, undermining the objective of the fuel surcharge. Depending upon the carriers in that lane, the carrier could lose business, or the shipper might be at the carrier's mercy due to a lack of competition in the lane.

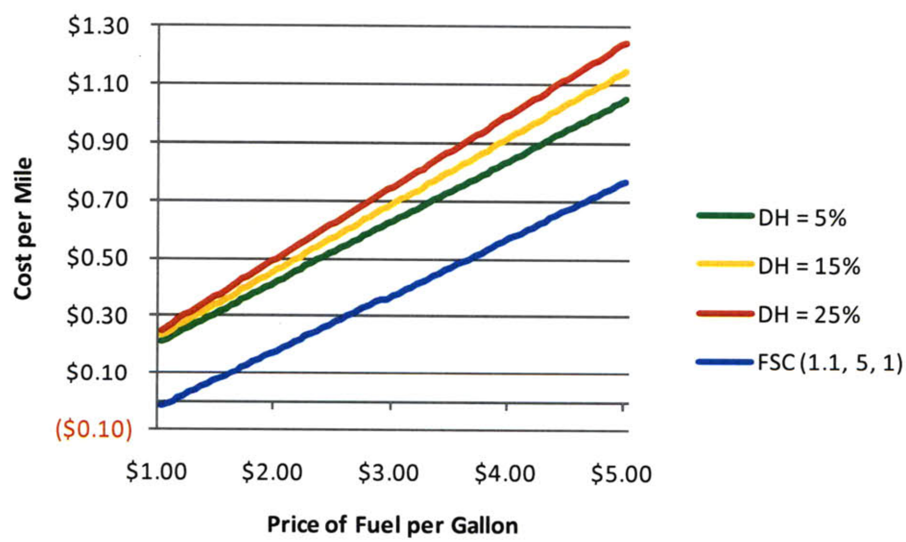


Figure 5.8 – Interaction between Carrier Deadhead Efficiency and FSC Escalator

Deadhead efficiency will also impact a carrier's behavior. Figure 5.8 demonstrates the same situation as in Figure 5.7, but with varying deadhead efficiencies and a common fuel efficiency of five MPG. A deadhead efficiency of 5% reaps lower fuel costs per mile traveled for every uptick in the cost of fuel. Nevertheless, carrier's costs are still rising, albeit slower than that of a carrier with a worse deadhead efficiency. One with a deadhead efficiency of 25% might again consider increasing linehaul rates to compensate for their inefficiencies. Yet the fuel surcharge doesn't factor in deadhead, thus any unloaded miles will increase fuel costs for the carrier. Carriers currently have to deal with this unavoidable cost, doing their best to minimize deadhead miles.

Both can encourage specific behaviors with carriers since they bear the full cost burden. A carrier with better than normal fuel efficiency can afford to incur more deadhead miles and still remain price competitive. Shippers can use the escalator aspect of their fuel surcharge program to encourage improvements to a carrier's fuel efficiency, and thus reducing the overall fuel cost burden so long as the carrier achieves the desired fuel efficiency. Standardizing the fuel surcharge across all carriers, regardless of deadhead or fuel efficiency, will promote the reduction of both inefficiencies, encouraging a more competitive carrier base and reducing the shipper's exposure to fuel.

Figure 5.9 illustrates the fuel cost burden trade-off created by the fuel surcharge. This example maintains the same fuel surcharge components as the two previous examples. It also introduces a wholesale discount, or the discount when a carrier buys diesel fuel from a refinery at a wholesale price versus the retail price at the pump. Note that our survey showed DOE retail is commonly used in fuel surcharges. The wholesale five-year average, as reported by the DOE, of 23% (Petroleum Navigator, 2010) was used in Figure 5.9.

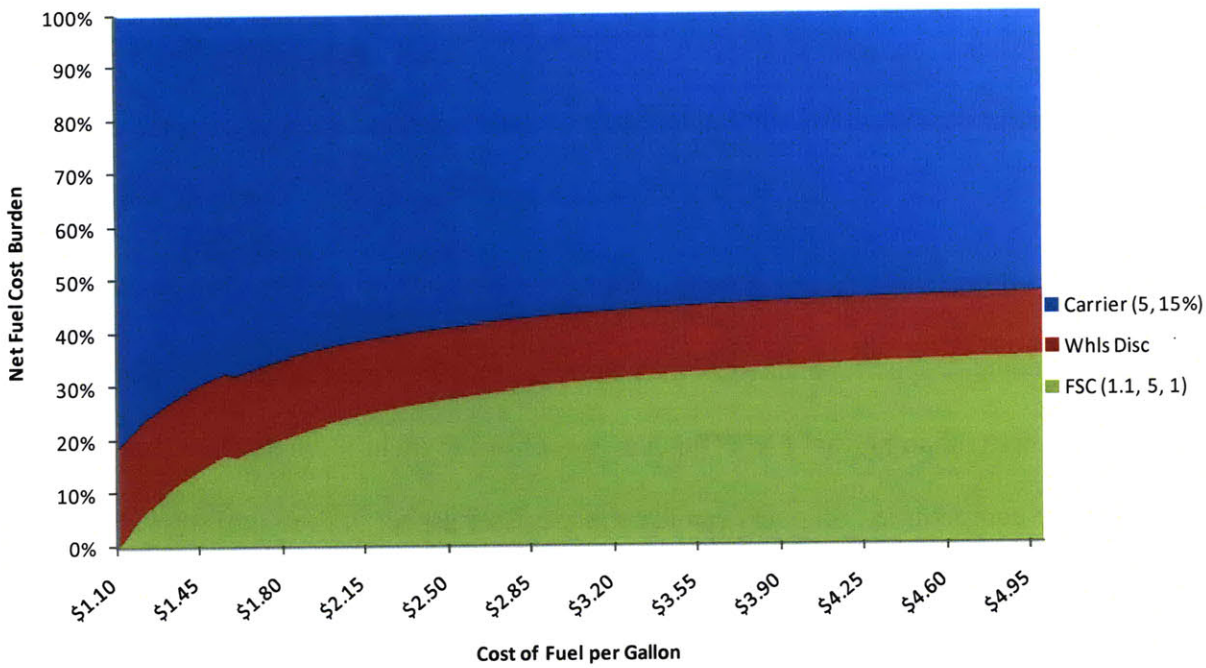


Figure 5.9 – Fuel Surcharge Trade-Off Between Carrier and Shipper

As the cost of fuel rises, the shipper pays a higher percentage of the net fuel cost. As Figure 5.7 showed, this is only true when the fuel surcharge escalator and the carrier's fuel efficiency match with zero deadhead miles. The inclusion of the wholesale discount creates a margin for a carrier able to secure it, but does not impact the increasing burden on the shipper. Thus, a fuel surcharge tied to an efficient carrier does shift the cost burden to the shipper. The shipper has a vested interest in adjusting its fuel surcharge matrix to encourage efficient behaviors, minimizing its fuel exposure.

5.1.4 Hedging

Of the 43 respondents, only 30% reported to be actively hedging any commodity, whether energy, agricultural, mineral or currency based, and 90% of those hedging are shippers. Almost half hedge a major portion of their exposure, over 80%. Yet, none stated that they hedged beyond their full exposure, as that was found to be transitioning from a cost stabilization motive to that of a profit driven motive. Follow up interviews with some respondents revealed that because they are not in the financial sector, it would be inappropriate to exceed their exposure. Half of the respondents agreed that severe market conditions could motivate them to begin hedging, like high price volatility.

Shippers were the sole party reported to be hedging, with thirteen engaged in non oil-based commodities and fourteen actively hedging any oil-based commodities, and seven companies hedging both oil and non-oil based commodities. Seventy-five percent of hedging companies indicated annual revenues of greater than $10 billion. Several of those companies indicated that they are active in multiple oil-based commodities, as both companies hedging the crack spread are doing so in conjunction with other oil-based commodities. Thus, companies that hedge partake in a wide array of strategies.

For those companies hedging diesel fuel in particular, exposure levels also vary, as over 70% of respondents hedge greater than 60% of their exposure, of annual fuel consumption. On the other end, over 20% hedge below 20% of their fuel exposure. Both are shown in Figure 5.10 which highlights the two distinct strategies on exposure levels. Retailers preferred a lower exposure level, comprising 75% of that total, while consumer packaged goods and food and beverage companies accounted for 80% of those preferring higher exposure levels.

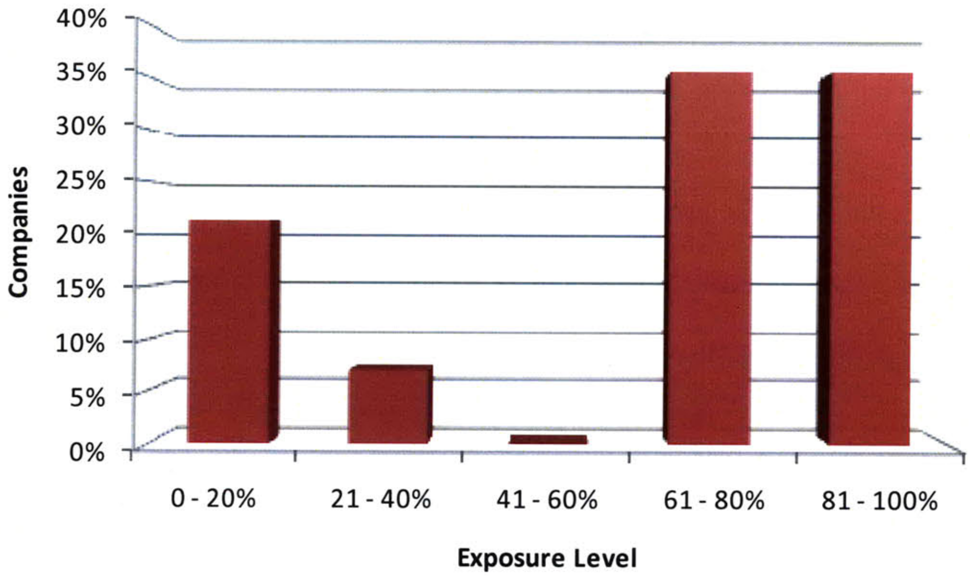


Figure 5.10 – Hedging Exposure Levels

Companies appear to use different review policies for oil and non-oil commodities. For non-oil commodities, most firms review continuously with some quarterly, while this is just the opposite for oil commodities. Forty percent showed activity, whether it be execution of trades or reviewing or strategy changes, on a continuous basis for non-oil based commodities. Another 25% preferred a quarterly review cycle. For oil based commodities, 38% preferred the quarterly approach versus 28% leaning towards the continuous review cycle.

When the respondents were asked about the types of derivatives they used, a small portion stated they used non-conventional, or exotic, derivatives. Figure 5.11 shows the distribution of derivative preference, with six companies using more than one derivative type. It shows little preference variation between options, future, and swaps.

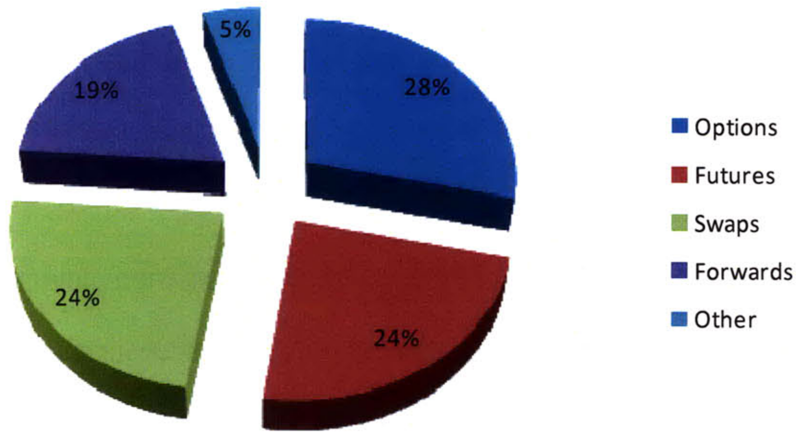


Figure 5.11 – Derivative Type Preference

Few respondents are participating in hedging activities, showing little concern for the stabilization of fuel costs. Yet, those that do hedge do so aggressively, favoring over 80% exposure levels. Figure 1.1 and 1.2 demonstrated the rising price and volatility of fuel, even though most non-hedging respondents indicated these as a reason to start hedging. Companies have clearly segmented themselves by whether or not they hedge. Additionally, the elements of that hedge, including commodity types, exposure levels, and review cycles vary widely. Considering the research of Stutlz (1984), Hentschel (2001) and Kothair (2003) showed a correlation between derivative usage and better stock returns, is it better to hedge or not? The simulation, presented next, tests this research.

5.2 Simulation

In order to evaluate when to use a different hedging policy, we created a simulation using the future contract valuation from Figure 3.15 and statistical forecasts pertaining to the price of crude oil from the DOE. Since the DOE only forecasted out on a monthly level through

December 2011, 19 months in total, there was not enough data points to reasonably evaluate the 18 month future contract. To overcome this, we extended the forecast another 12 months, making the simulation 31 months in total. This was done by following the trend of the DOE forecast.

The model simulated 100 independent instances of the time period ranging from June 2010 to December 2012. Each month the fuel price was simulated independently using individually forecasted means and standard deviations from the US Department of Energy along with our extended projections. A normal distribution was assumed for the fuel price for each month.

The simulation was for one commodity, crude oil. Four coverage lengths were tested, ranging from three month to eighteen month contracts. Future contracts were chosen for simplicity as well as their commonality to the other derivative types, making it easy for one to interpret the substitution of another derivative.

5.2.1 Results

We incorporated the average fuel consumption for a shipper from our survey, eight million gallons annually. Despite this preset, the annual fuel consumption variable can be changed and its impacts reflected in the model. In addition to having easily adjustable consumption levels, the LIBOR, net convenience and at-the-pump taxes were treated in the same manner. Annual fuel consumption was uniformly distributed on a monthly level over the year. The aggregate difference between the spot and future contracts was used for assessment, which was enabled by the uniform distribution of fuel consumption.

Keeping with the common elements of true fuel costs, the simulation includes a tax feature. Nonetheless, since this tax is applied at the pump at the point of consumption, this variable does not have any impact on the decision to hedge or not. It will, however, help one better estimate fuel cost.

The forecasted DOE mean and standard deviations from June 2010 through December 2011, with our own projection through to December 2012, are depicted in Figure 5.12. They demonstrate an overall stable market. Yet the magnitudes of variance follow intuition, with market risk increasing over time.

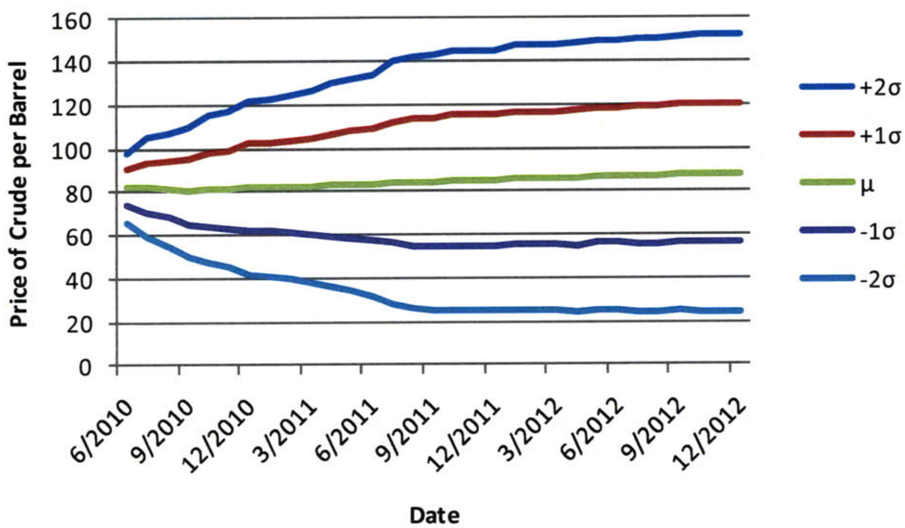


Figure 5.12 – Forecasted Price of Crude Oil

Since the survey results displayed a varying array of exposure levels, the simulation was conducted for five exposure levels ranging from 0% to 100%. The 0% exposure level was used as a baseline for comparison to purchasing fuel at the spot price on a monthly basis, i.e. not hedging, reflecting pure spot market exposure and no future market exposure. The other exposure levels are compared to this baseline and displayed as a difference from the pure spot market exposure for the corresponding month. The exposure levels are scalar in nature, as an exposure level of 50% would result in half the impact of an exposure level of 100%.

Looking at the results of the simulation, Figure 5.13 shows the quartile expectations for a 3-month future contract. The LIBOR was set at 3% and net convenience yield at 11%, typical values for each. For this derivative, the expected return is $10,820,199, with a range of $52,628,112, showing a lot of volatility. However, as this figure shows, in more years than not it was a good decision.

3-Month Futures					
Year	0%	20%	50%	75%	100%
Min	$ -	$ (2,390,226)	$ (5,975,565)	$ (8,963,347)	$ (11,951,129)
1st Quartile	$ -	$ 326,653	$ 816,633	$ 1,224,950	$ 1,633,266
Median	$ -	$ 1,967,272	$ 4,918,180	$ 7,377,270	$ 9,836,360
3rd Quartile	$ -	$ 3,711,120	$ 9,277,799	$ 13,916,699	$ 18,555,598
Max	$ -	$ 8,135,397	$ 20,338,492	$ 30,507,737	$ 40,676,983

Figure 5.13 – 3-Month Futures Quartiles

Moving to the 6-month future contract, as depicted in Figure 5.14, the expectations aren't as high. In fact, this derivative has the worst outcome, with an expected return of $641,658, spanning $26,111,869 between the worst and best case simulated years. Even the median quartile barely showed a gain of $33,533.

6-Month Futures					
Year	0%	20%	50%	75%	100%
Min	$ -	$ (2,630,059)	$ (6,575,147)	$ (9,862,721)	$ (13,150,295)
1st Quartile	$ -	$ (652,143)	$ (1,630,357)	$ (2,445,536)	$ (3,260,715)
Median	$ -	$ 6,707	$ 16,767	$ 25,150	$ 33,533
3rd Quartile	$ -	$ 745,106	$ 1,862,764	$ 2,794,146	$ 3,725,529
Max	$ -	$ 2,592,315	$ 6,480,787	$ 9,721,181	$ 12,961,574

Figure 5.14 – 6-Month Futures Quartiles

The 12-month future contract performed best, in Figure 5.15, resulting in an expected return of $35,441,355, over triple that of the 3-month derivative. Yet, with a range of $116,864,387 between good and bad years, there is a high element of risk.

12-Month Futures					
Year	0%	20%	50%	75%	100%
Min	$ -	$ (4,753,587)	$ (11,883,966)	$ (17,825,950)	$ (23,767,933)
1st Quartile	$ -	$ 3,536,181	$ 8,840,452	$ 13,260,678	$ 17,680,904
Median	$ -	$ 6,839,139	$ 17,097,847	$ 25,646,770	$ 34,195,693
3rd Quartile	$ -	$10,321,474	$ 25,803,684	$ 38,705,526	$ 51,607,368
Max	$ -	$18,619,291	$ 46,548,227	$ 69,822,340	$ 93,096,454

Figure 5.15 – 12-Month Futures Quartiles

The 18-month future contract also performed profitably, Figure 5.16, showing an expected return of $35,171,890, very similar to the 12-month contract, but a larger range of $119,998,921. With both 12 and 18-month contract performing better to shorter-term contract, the simulation contradicts the research of Stultz (1984).

18-Month Futures					
Year	0%	20%	50%	75%	100%
Min	$ -	$ (6,016,478)	$ (15,041,194)	$ (22,561,791)	$ (30,082,388)
1st Quartile	$ -	$ 4,036,234	$ 10,090,585	$ 15,135,878	$ 20,181,171
Median	$ -	$ 6,528,021	$ 16,320,052	$ 24,480,078	$ 32,640,104
3rd Quartile	$ -	$10,471,552	$ 26,178,879	$ 39,268,318	$ 52,357,758
Max	$ -	$17,983,306	$ 44,958,266	$ 67,437,399	$ 89,916,532

Figure 5.16 – 18 Month Futures Quartiles

The above quartile results were limited to a fixed 3% LIBOR and 11% net convenience yield. The sensitivity to change in LIBOR and net convenience yield rates was tested, varying these future contract pricing inputs from Figure 3.15. The four coverage lengths are compared side by side in Figure 5.17, and show the vast differences between short and long-term contracts. The boxes encompass the range between the first and third quartiles, with the tail of each coverage length extending to its respective minimum and maximum value. The 6-month contract, as described previously, has the tightest range. The 12 and 18-month contracts have very similar ranges, with the 12-month having a slightly better upside and downside, but the 18-month containing a tighter inter-quartile distribution, as shown by a smaller range between the first and third quartiles.

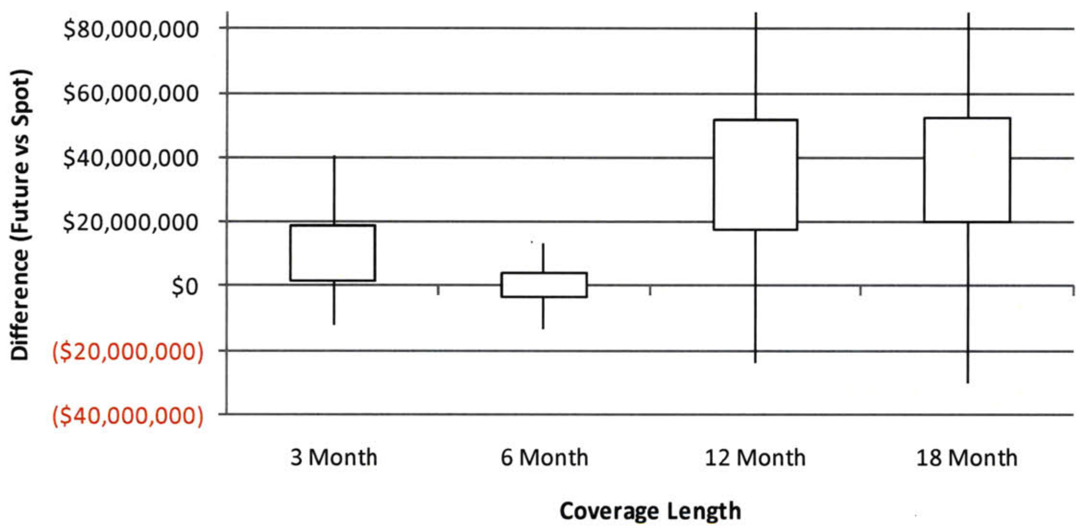


Figure 5.17 – Quartile Analysis by Coverage Length

Using the mean outcomes for each coverage length and varying LIBOR and the net convenience yield to range from 0% to 10%, the outcomes presented an offsetting behavior, as the future pricing formula would suggest. These results, in thousands of dollars, are depicted in Figure

5.18 and show the results for the 3-month derivative.

Net Convenience Yield	LIBOR										
	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
0%	$ 1,546	$ 427	$ (684)	$ (1,787)	$ (2,882)	$ (3,970)	$ (5,049)	$ (6,121)	$ (7,185)	$ (8,242)	$ (9,292)
1%	$ 2,674	$ 1,546	$ 427	$ (684)	$ (1,787)	$ (2,882)	$ (3,970)	$ (5,049)	$ (6,121)	$ (7,185)	$ (8,242)
2%	$ 3,811	$ 2,674	$ 1,546	$ 427	$ (684)	$ (1,787)	$ (2,882)	$ (3,970)	$ (5,049)	$ (6,121)	$ (7,185)
3%	$ 4,956	$ 3,811	$ 2,674	$ 1,546	$ 427	$ (684)	$ (1,787)	$ (2,882)	$ (3,970)	$ (5,049)	$ (6,121)
4%	$ 6,110	$ 4,956	$ 3,811	$ 2,674	$ 1,546	$ 427	$ (684)	$ (1,787)	$ (2,882)	$ (3,970)	$ (5,049)
5%	$ 7,273	$ 6,110	$ 4,956	$ 3,811	$ 2,674	$ 1,546	$ 427	$ (684)	$ (1,787)	$ (2,882)	$ (3,970)
6%	$ 8,445	$ 7,273	$ 6,110	$ 4,956	$ 3,811	$ 2,674	$ 1,546	$ 427	$ (684)	$ (1,787)	$ (2,882)
7%	$ 9,627	$ 8,445	$ 7,273	$ 6,110	$ 4,956	$ 3,811	$ 2,674	$ 1,546	$ 427	$ (684)	$ (1,787)
8%	$ 10,818	$ 9,627	$ 8,445	$ 7,273	$ 6,110	$ 4,956	$ 3,811	$ 2,674	$ 1,546	$ 427	$ (684)
9%	$ 12,019	$ 10,818	$ 9,627	$ 8,445	$ 7,273	$ 6,110	$ 4,956	$ 3,811	$ 2,674	$ 1,546	$ 427
10%	$ 13,230	$ 12,019	$ 10,818	$ 9,627	$ 8,445	$ 7,273	$ 6,110	$ 4,956	$ 3,811	$ 2,674	$ 1,546

Figure 5.18 – 3-Month LIBOR Net Convenience Yield Sensitivity

The 6-month contract is depicted in Figure 5.19. As this contract's poor performance before suggests, the sensitivity testing did not show any improvements to the appeal of this coverage length.

Net Convenience Yield	LIBOR										
	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
0%	$ (135)	$ (230)	$ (324)	$ (418)	$ (512)	$ (605)	$ (698)	$ (790)	$ (882)	$ (973)	$ (1,064)
1%	$ (40)	$ (135)	$ (230)	$ (324)	$ (418)	$ (512)	$ (605)	$ (698)	$ (790)	$ (882)	$ (973)
2%	$ 56	$ (40)	$ (135)	$ (230)	$ (324)	$ (418)	$ (512)	$ (605)	$ (698)	$ (790)	$ (882)
3%	$ 152	$ 56	$ (40)	$ (135)	$ (230)	$ (324)	$ (418)	$ (512)	$ (605)	$ (698)	$ (790)
4%	$ 249	$ 152	$ 56	$ (40)	$ (135)	$ (230)	$ (324)	$ (418)	$ (512)	$ (605)	$ (698)
5%	$ 347	$ 249	$ 152	$ 56	$ (40)	$ (135)	$ (230)	$ (324)	$ (418)	$ (512)	$ (605)
6%	$ 444	$ 347	$ 249	$ 152	$ 56	$ (40)	$ (135)	$ (230)	$ (324)	$ (418)	$ (512)
7%	$ 543	$ 444	$ 347	$ 249	$ 152	$ 56	$ (40)	$ (135)	$ (230)	$ (324)	$ (418)
8%	$ 642	$ 543	$ 444	$ 347	$ 249	$ 152	$ 56	$ (40)	$ (135)	$ (230)	$ (324)
9%	$ 741	$ 642	$ 543	$ 444	$ 347	$ 249	$ 152	$ 56	$ (40)	$ (135)	$ (230)
10%	$ 841	$ 741	$ 642	$ 543	$ 444	$ 347	$ 249	$ 152	$ 56	$ (40)	$ (135)

Figure 5.19 – 6-Month LIBOR Net Convenience Yield Sensitivity

The 12-month future contract reverses the trend of the 6-month derivative and shows to hold strong against rate fluctuations, as seen in Figure 5.20, along with a best case scenario being over three times as good as the worst case scenario.

Net Convenience Yield \ LIBOR	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
0%	$ 11,476	$ 8,481	$ 5,487	$ 2,492	$ (503)	$ (3,498)	$ (6,492)	$ (9,487)	$ (12,482)	$ (15,477)	$ (18,471)
1%	$ 14,471	$ 11,476	$ 8,481	$ 5,487	$ 2,492	$ (503)	$ (3,498)	$ (6,492)	$ (9,487)	$ (12,482)	$ (15,477)
2%	$ 17,466	$ 14,471	$ 11,476	$ 8,481	$ 5,487	$ 2,492	$ (503)	$ (3,498)	$ (6,492)	$ (9,487)	$ (12,482)
3%	$ 20,460	$ 17,466	$ 14,471	$ 11,476	$ 8,481	$ 5,487	$ 2,492	$ (503)	$ (3,498)	$ (6,492)	$ (9,487)
4%	$ 23,455	$ 20,460	$ 17,466	$ 14,471	$ 11,476	$ 8,481	$ 5,487	$ 2,492	$ (503)	$ (3,498)	$ (6,492)
5%	$ 26,450	$ 23,455	$ 20,460	$ 17,466	$ 14,471	$ 11,476	$ 8,481	$ 5,487	$ 2,492	$ (503)	$ (3,498)
6%	$ 29,445	$ 26,450	$ 23,455	$ 20,460	$ 17,466	$ 14,471	$ 11,476	$ 8,481	$ 5,487	$ 2,492	$ (503)
7%	$ 32,439	$ 29,445	$ 26,450	$ 23,455	$ 20,460	$ 17,466	$ 14,471	$ 11,476	$ 8,481	$ 5,487	$ 2,492
8%	$ 35,434	$ 32,439	$ 29,445	$ 26,450	$ 23,455	$ 20,460	$ 17,466	$ 14,471	$ 11,476	$ 8,481	$ 5,487
9%	$ 38,429	$ 35,434	$ 32,439	$ 29,445	$ 26,450	$ 23,455	$ 20,460	$ 17,466	$ 14,471	$ 11,476	$ 8,481
10%	$ 41,424	$ 38,429	$ 35,434	$ 32,439	$ 29,445	$ 26,450	$ 23,455	$ 20,460	$ 17,466	$ 14,471	$ 11,476

Figure 5.20 – 12-Month LIBOR Net Convenience Yield Sensitivity

Finally, the 18-month future contract, displayed in Figure 5.21, backed away slightly from the results of the 12-month derivative. Yet, one must keep in mind that for this derivative, there was limited data due to the DOE's limited monthly forecast and our supplemented projection only extended the trends of the DOE forecast.

Net Convenience Yield \ LIBOR	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
0%	$ 11,294	$ 8,240	$ 5,171	$ 2,087	$ (1,013)	$ (4,127)	$ (7,256)	$ (10,400)	$ (13,559)	$ (16,732)	$ (19,920)
1%	$ 14,333	$ 11,294	$ 8,240	$ 5,171	$ 2,087	$ (1,013)	$ (4,127)	$ (7,256)	$ (10,400)	$ (13,559)	$ (16,732)
2%	$ 17,357	$ 14,333	$ 11,294	$ 8,240	$ 5,171	$ 2,087	$ (1,013)	$ (4,127)	$ (7,256)	$ (10,400)	$ (13,559)
3%	$ 20,365	$ 17,357	$ 14,333	$ 11,294	$ 8,240	$ 5,171	$ 2,087	$ (1,013)	$ (4,127)	$ (7,256)	$ (10,400)
4%	$ 23,357	$ 20,365	$ 17,357	$ 14,333	$ 11,294	$ 8,240	$ 5,171	$ 2,087	$ (1,013)	$ (4,127)	$ (7,256)
5%	$ 26,335	$ 23,357	$ 20,365	$ 17,357	$ 14,333	$ 11,294	$ 8,240	$ 5,171	$ 2,087	$ (1,013)	$ (4,127)
6%	$ 29,296	$ 26,335	$ 23,357	$ 20,365	$ 17,357	$ 14,333	$ 11,294	$ 8,240	$ 5,171	$ 2,087	$ (1,013)
7%	$ 32,242	$ 29,296	$ 26,335	$ 23,357	$ 20,365	$ 17,357	$ 14,333	$ 11,294	$ 8,240	$ 5,171	$ 2,087
8%	$ 35,172	$ 32,242	$ 29,296	$ 26,335	$ 23,357	$ 20,365	$ 17,357	$ 14,333	$ 11,294	$ 8,240	$ 5,171
9%	$ 38,086	$ 35,172	$ 32,242	$ 29,296	$ 26,335	$ 23,357	$ 20,365	$ 17,357	$ 14,333	$ 11,294	$ 8,240
10%	$ 40,984	$ 38,086	$ 35,172	$ 32,242	$ 29,296	$ 26,335	$ 23,357	$ 20,365	$ 17,357	$ 14,333	$ 11,294

Figure 5.21 – 18-Month LIBOR Net Convenience Yield Sensitivity

Notice that the LIBOR and net convenience yield, as suggested by the formula, have an offsetting relationship, where a 10% LIBOR and 10% net convenience yield has the same impact as a 0% LIBOR and 0% net convenience yield.

Considering the offset characteristic of the interest rate in the future pricing model, with the net convenience yield being subtracted from the LIBOR, Figure 5.22 looks at the impact on each coverage length across that net interest rate.

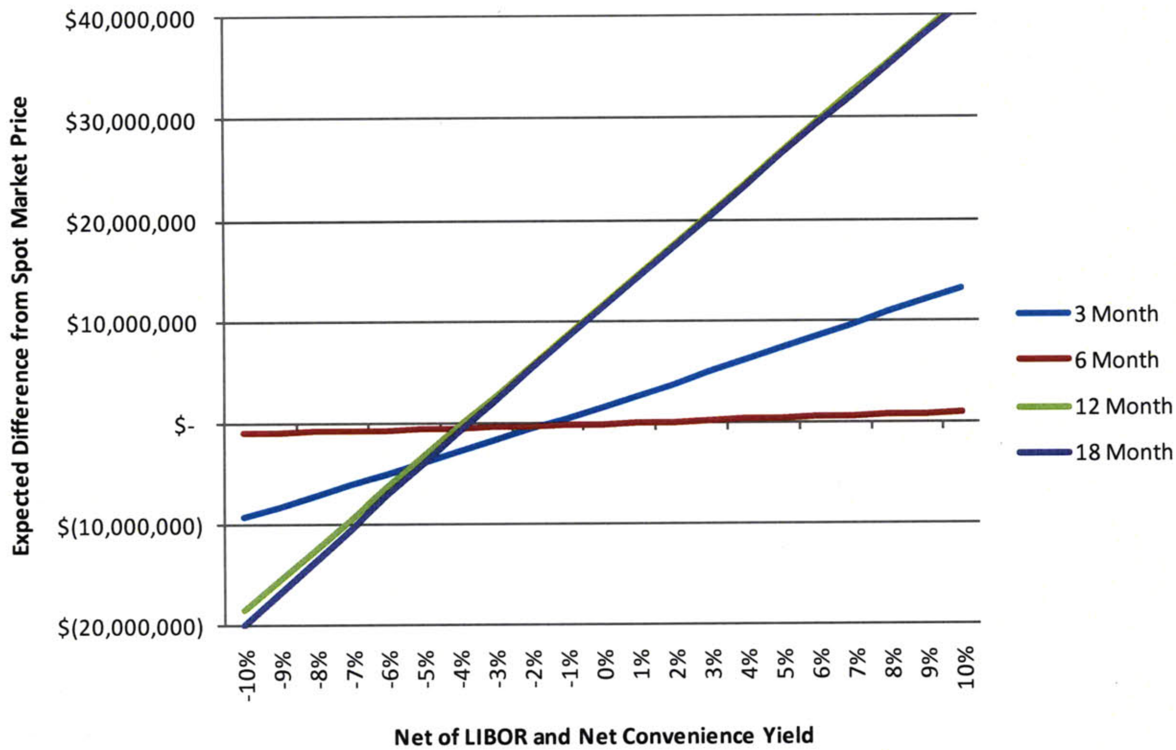


Figure 5.22 – Expected Difference from Spot Market Price for Net Rate

Figure 5.22 shows the four coverage lengths by comparing short term, 3 and 6-month contracts, against long-term contracts, 12 and 18-month contracts. As a reminder, academic research has advised that shorter-term investments were favorable, enabling greater flexibility to cope with changing market conditions. However, the market survey showed companies across industries prefer longer term positions.

The simulation confirms the results of the survey for normal market conditions, when the net convenience yield, or the valued preference of holding the asset over the future contract for that asset, is less than four points greater than the interest rate, or LIBOR. Normal market conditions would consist of an annual LIBOR of 3%, as the ten year average is 3.36% (Wall Street Journal, 2010), and a net convenience yield of 11% (Casassus, 2005). With deflationary periods being rare, interest rates typically range between 2% and 5%. So long as the net convenience yield ranges between 6% or greater, the longer term contracts show a better value proposition. Otherwise, shorter term contracts favor these rarer market conditions.

Reviewing both the above analysis and academic research, fuel surcharges are commonly used for good reason, with their ability to shift the fuel burden from the carrier, who is unable to handle the cost volatility burden, to the shipper. Additionally, the sensitivity of the escalator with respect to the carrier's fuel efficiency has a large influence over the intended objective of the fuel surcharge and controlling carrier behavior. Lastly, hedging does show to be a good consideration for companies with high fuel cost exposure under normal market conditions. From this information, we will provide recommendations and areas of future research in the area.

6 CONCLUSION

The purpose of this paper has been to find a recommendation for stabilizing the cost of fuel utilizing hedging and a fuel surcharge. Due to the unfamiliar nature of these concepts, the markets of both crude oil and truckload transportation were reviewed. Additionally, the linkage between crude oil and diesel fuel was explained. This provided an understanding of the markets and the magnitude of the problem, rising cost factor of fuel as well as its volatility. The tools were then highlighted, providing connections to everyday experiences to heighten the understanding.

Analysis proceeded in the form of a market benchmarking survey, providing insight into the status quo. The survey complimented the research, showing that a fuel surcharge was widely used, and for good reason, bringing cost stability to the carrier, but at the burden of the shipper. A fuel surcharge was tested for sensitivity, showing the escalator was the key lever in the matrix, and that fuel efficiency was the driver for this lever.

A simulation followed with the intent of determining the proper strategy for hedging, varying coverage length and exposure. The survey provided insights, as larger companies, $10 billion and above in annual revenue, preferred higher exposure and longer term contracts. The simulation confirmed this insight, with the best long term contract, 12-month future, performing approximately 250% better than the best short term contract, the 3-month future. Albeit, risk was correlated with expected return, as the longer term contracts added a significant range of results. Yet, the expected return was found to be highly variable on the market condition, as higher interest rates, represented by the LIBOR, will erode such expectations, and a lowering net convenience yield will only add to the erosion. However, such erosion will prompt one not to hedge rather than shift from long term contracts to short term contracts.

Thus, our research has shown that a fuel surcharge and hedging work towards the same means, shifting risk through the value chain, with the fuel surcharge aiding the carrier and bringing stability. This also aides the shipper, but hedging brings the desired stability to the shipper. With costs being relevant, the fuel surcharge should be tied to the escalator, encouraging carrier efficiency. Hedging positions should favor longer-term contracts, under normal market conditions.

Future research should go into the implications of demand, and its non-uniform distribution throughout the year. Additionally, how the above strategy might vary over other commodities, whether oil or non-oil based. Expansions to the analysis could include the simulation of the LIBOR and net convenience yield along with the price of crude oil. Additionally, adding a sticky feature to each month's simulated value, permitting historical influence on the simulated value. Lastly, due to the limited forecasting data available from the DOE, more research into longer-term contracts would help clarify whether it is in fact better than shorter-term contracts.

APPENDIX

Survey:

MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

1. Introduction

6%

This survey is part of a MIT graduate thesis project at the MIT Center for Transportation & Logistics focusing on understanding how companies implement fuel hedging strategies and fuel surcharges (FSC) for surface transportation modes.

The results of this survey are anonymous and your participation is greatly appreciated as this survey will take approximately 10 minutes to complete.

The survey contains the following sections, beyond this title page:

I. Fuel Surcharge (FSC) Practices
II. Risk Sharing
III. Hedging Practices
IV. General Information

Please contact directly if you have any questions or concerns about this survey. The results of the survey will be compiled on April 1, 2010. Thank you for your assistance.

Regards,

Charles Shehadi
Email: cshehadi@mit.edu

Next

MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

2. Identification

11%

1. Do you identify yourself primarily as a Shipper or a Carrier?

- Shipper
- Carrier
- 3PL
- Other

Other (please specify)

2. Do you buy diesel fuel directly?

- Yes
- No

Comments:

3. Approximately how many gallons of diesel fuel do you buy per fiscal year?

Gallons

Prev Next

MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

3. TRUCKLOAD (TL) Fuel Surcharge (FSC)

17%

1. Do you currently utilize a TRUCKLOAD (TL) Fuel Surcharge (FSC) Program for transportation?

- Yes
- No

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MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

4. TRUCKLOAD (TL) Fuel Surcharges (FSC) (cont.)

22%

This section explores what your firm does/does not do with respect to TRUCKLOAD (TL) Fuel Surcharges (FSC).

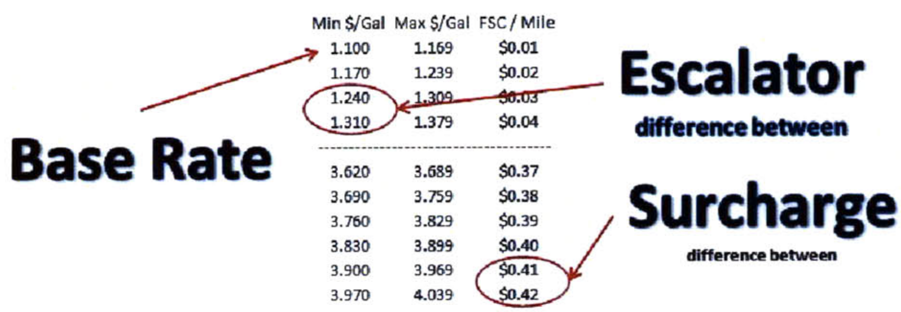
1. For your TRUCKLOAD (TL) FSC program, what is the structure? For example, Base Rate of $1.24 per gallon, with a $0.07 escalator that pays $0.03 per mile fuel surcharge (FSC) (See image below for details). [When entering in the pricing structure for FSCs: please do not utilize a decimal point and/or dollar sign. For example, please enter 124 for $1.24; 007 for $0.07; 003 for $0.03, etc.]

Base or Peg Rate ($ per gallon)

Escalator ($ per gallon)

Surcharge ($ per mile)

Distance Value of Linehaul (%)



2. For your TRUCKLOAD (TL) FSC program, where do you get your benchmark price for diesel?

- National average (published by DOE)
- Regional average (published by DOE)
- Other

Other (please specify)

3. For your TRUCKLOAD (TL) FSC program, how often do you review/update the price of diesel?

- Weekly
- Bi-weekly

- ◌ Monthly
- ◌ Quarterly
- ◌ It depends upon market conditions

Other (please specify)

4. For your TRUCKLOAD (TL) FSC program, what system do you utilize for distance calculated?

- ◌ Shortest Route
- ◌ Practical Route (Average Speed)
- ◌ Highway Route
- ◌ Other (please specify)

5. For your TRUCKLOAD (TL) FSC program is it the same for each carrier you utilize?

- ◌ Yes
- ◌ No
- ◌ N/A

Comments:

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MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

5. NO to Truckload (TL) Fuel Surcharge (FSC)

28%

1. Since you do NOT utilize a TRUCKLOAD (TL) Fuel Surcharge (FSC) Program for transportation; how do you handle fluctuating fuel prices? Do you use any other system of reimbursement for fuel expenses?

Prev Next

MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

6. Less-Than-TruckLoad (LTL) Fuel Surcharges (FSC)

33%

1. Do you currently utilize a LESS-THAN-TRUCKLOAD (LTL) Fuel Surcharge (FSC) Program for transportation?

- Yes
- No

Prev Next

MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

7. Less-Than-TruckLoad (LTL) Fuel Surcharges (FSC) (cont.)

39%

This section explores what your firm does/does not do with respect to Less-Than-TruckLoad (LTL) Fuel Surcharges (FSC).

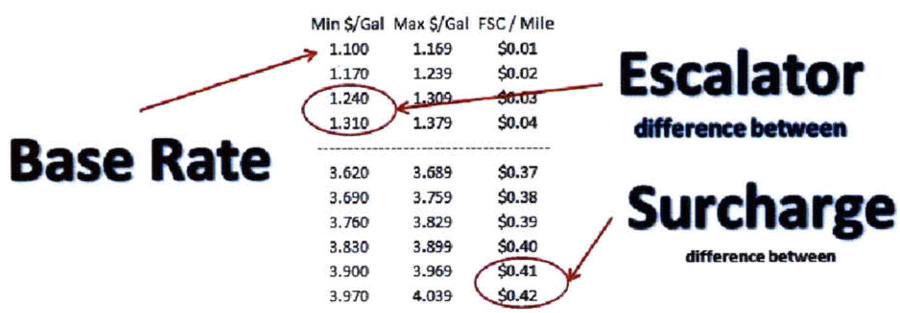
1. For your LESS-THAN-TRUCKLOAD (LTL) FSC program, what is the structure? For example, Base Rate of $1.24 per gallon, with a $0.07 escalator that pays $0.03 per mile fuel surchage (FSC) (See image below for details). [When entering in the pricing structure for FSCs: please do not utilize a decimal point and/ or dollar sign. For example, please enter 124 for $1.24; 007 for $0.07; 003 for $0.03, etc.]

Base or Peg Rate ($ per gallon)

Escalator ($ per gallon)

Surcharge ($ per mile)

Distance Value of Linehaul (%)



2. For your LESS-THAN-TRUCKLOAD (LTL) FSC program, where do you get your benchmark price of diesel?

- National average (published by DOE)
- Regional average (published by DOE)
- Other

Other (please specify)

3. For your LESS-THAN-TRUCKLOAD (LTL) FSC program, how often do you review/ update the price of diesel?

- Weekly

- Bi-weekly
- Monthly
- Quarterly
- It depends upon market conditions

Other (please specify)

4. For your LESS-THAN-TRUCKLOAD (LTL) FSC program is it the same for each carrier you utilize?

- Yes
- No
- N/A

Comments:

5. For your LESS-THAN-TRUCKLOAD (LTL) FSC program, what system do you utilize for distance calculated?

- Shortest Route
- Practical Route (Average Speed)
- Highway Route
- Other (please specify)

Prev Next

MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

8. NO to Less-Than-TruckLoad (LTL) Fuel Surcharges (FSC)

44%

1. Since you do NOT utilize a LESS-THAN-TRUCKLOAD (LTL) Fuel Surcharge (FSC) Program for transportation; how do you handle fluctuating fuel prices? Do you use any other system of reimbursement for fuel expenses?

Prev Next

MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

9. INTERMODAL Fuel Surcharge (FSC)

50%

1. Do you currently utilize a INTERMODAL Fuel Surcharge (FSC) Program for transportation?

- Yes
- No

Prev Next

MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

10. INTERMODAL Fuel Surcharge (FSC) (cont.)

56%

This section explores what your firm does/does not do with respect to INTERMODAL Fuel Surcharges (FSC).

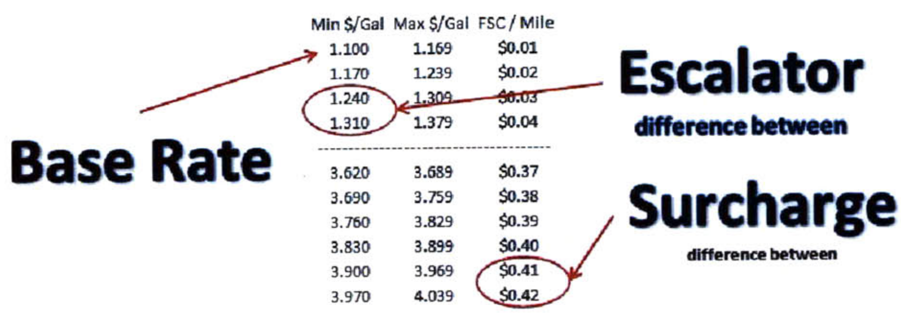
1. For your INTERMODAL FSC program, what is the structure? For example, Base Rate of $1.24 per gallon, with a $0.07 escalator that pays $0.03 per mile fuel surcharge (FSC) (See image below for details). [When entering in the pricing structure for FSCs: please do not utilize a decimal point and/or dollar sign. For example, please enter 124 for $1.24; 007 for $0.07; 003 for $0.03, etc.]

Base or Peg Rate ($ per gallon)

Escalator ($ per gallon)

Surcharge ($ per mile)

Distance Value of Linehaul (%)



2. For your INTERMODAL FSC program, where do you get your benchmark price of diesel?

- National average (published by DOE)
- Regional average (published by DOE)
- Other

Other (please specify)

3. For your INTERMODAL FSC program, how often do you review/update the price of diesel?

- Weekly
- Bi-weekly

http://www.surveymonkey.com/s.aspx?sm=DUCasvcqLqY8%2b%2bgOgkDMJQ%3d%3d 3/25/2010

- Monthly
- Quarterly
- It depends upon market conditions

Other (please specify)

4. For your INTERMODAL FSC program, what system do you utilize for distance calculated?

- Shortest Route
- Practical Route (Average Speed)
- Highway Route
- Other (please specify)

5. For your INTERMODAL FSC program is it the same for each carrier you utilize?

- Yes
- No
- N/A

Comments:

Prev Next

MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

11. NO to INTERMODAL Fuel Surcharge (FSC)

61%

1. Since you do NOT utilize a INTERMODAL Fuel Surcharge (FSC) Program for transportation; how do you handle fluctuating fuel prices? Do you use any other system of reimbursement for fuel expenses?

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MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

12. Fuel Risk Sharing

67%

This section will explore fuel risk and impact on the supply chain.

1. What percentage of fuel risk do you feel is FAIR (please ensure both percentages add up to 100)?

	Carrier should pay...	Shipper should pay...
Percentage of Fuel Costs		

Comments:

2. What percentage of fuel risk do you feel is FAIR (please ensure both percentages add up to 100)?

	Shipper should pay...	Customer should pay...
Percentage of Fuel Costs		

Comments:

3. What percentage of fuel risk do you feel is FAIR across the ENTIRE SUPPLY CHAIN (please ensure all three percentages add up to 100)?

	Carrier should pay...	Shipper should pay...	Customer should pay...
Percentage of Fuel Costs			

Comments:

4. Do you have an established fuel risk sharing program with your customer?

Yes

◯ No

If so, please describe:

Prev Next

MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

13. Commodity Hedging

72%

This section explores what your currently doing in response to the volatility in commodity prices.

1. Does your company utilize hedging for ANY commodities (OTHER THAN FUEL) over a public exchange?

- Yes
- No

Please state the type(s) of commodities you currently hedge for:

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MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

14. Hedging ANY Commodities (cont.)

78%

This section explores what your currently doing in response to the volatility in commodity prices.

1. If you currently hedge commodities (OTHER THAN FUEL), what percentage of exposure do you hedge?

- 0 - 20%
- 21 - 40%
- 41 - 60%
- 61 - 80%
- 81 - 100%
- N/A or Do Not Hedge Commodities

Comments:

2. If you currently hedge commodities (OTHER THAN FUEL), how frequently do you:

	EXECUTE your strategy (buy/sell derivatives)	REVIEW your strategy	Make CHANGES to your strategy
Continuously	☐	☐	☐
Daily	☐	☐	☐
Weekly	☐	☐	☐
Monthly	☐	☐	☐
Quarterly	☐	☐	☐
Yearly	☐	☐	☐

Other (please specify)

Prev Next

MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

15. DIESEL FUEL Hedging

83%

This section explores what your currently doing in response to the volatility in DIESEL FUEL prices.

1. Has your firm implemented any hedging strategies to manage DIESEL FUEL price risk in the past?

- Never have hedged diesel fuel
- Hedged diesel fuel in the past, but NOT now
- Currently hedge diesel fuel
- Planning to hedge diesel fuel in the future

Comments:

2. What market conditions encourage (would encourage) you to hedge on DIESEL FUEL (% change in price of fuel, change in dollars per gallons, etc.)? Please explain.

Prev Next

MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

16. Hedging on DIESEL FUEL (cont.)

89%

This section explores what your currently doing in response to the volatility in DIESEL FUEL prices.

1. If you currently (or are planning to) hedge DIESEL FUEL, do (will) you utilize a third party resource or do (will) you conduct it internally?

- ○ Third Party Resource
- ○ Internal
- ○ Not applicable

Comments:

2. If you (or are planning to) internally hedge DIESEL FUEL price exposure, what is (will be) the job title and primary job function of this person? Which department (will) own this function (ex: Finance, Logistics)?

3. What commodity do (will) you currently hedge against to manage price volatility in DIESEL FUEL prices (check all that apply)?

- ☐ Heating Oil
- ☐ Crude Oil
- ☐ Diesel Fuel
- ☐ Crack or Basis Spread
- ☐ N/A
- ☐ Other

Other (please specify)

4. If you currently (or are planning to) hedge on DIESEL FUEL, what percentage of fuel exposure do (will) you hedge?

- ○ 0 - 20%
- ○ 21 - 40%

- 41 - 60%
- 61 - 80%
- 81 - 100%
- N/A

Comments:

5. If you currently (or are planning to) hedge DIESEL FUEL, how frequently do you:

	EXECUTE your strategy (buy/sell derivatives)	REVIEW your strategy	Make CHANGES to your strategy
Continuously	☐	☐	☐
Daily	☐	☐	☐
Weekly	☐	☐	☐
Monthly	☐	☐	☐
Quarterly	☐	☐	☐
Yearly	☐	☐	☐

Other (please specify)

6. If you currently (or are planning to) hedge DIESEL FUEL, what type of financial derivatives do (will) you utilize in this process (check all that apply)?

- ☐ Options
- ☐ Futures
- ☐ Swaps
- ☐ Forwards
- ☐ Other
- ☐ None of the above/not applicable

Other (please specify)

7. If you (or are planning to) currently hedge DIESEL FUEL, what type of financial derivatives do (will) you utilize in this process (check all that apply)?

- [ ] Flat Price
- [ ] Simple Collar
- [ ] Vertical Call Structure
- [ ] Leverage Tools
- [ ] Other
- [ ] None of the above/not applicable

Comments:

8. If you currently (or are planning to) hedge DIESEL FUEL, what is (will be) the coverage length of the financial derivatives (check all that apply)?

- [ ] less than 3 months
- [ ] 3 months (Quarterly) to less than 6 months (Biannually)
- [ ] 6 months (Biannually) to less than 9 months
- [ ] 9 months to less than Annually
- [ ] Annually
- [ ] None of the above/not applicable

Other (please specify)

9. If you currently (or are planning to) hedge DIESEL FUEL, what is (will be) the time horizon of the financial derivatives?

- ( ) Rolling % coverage monthly
- ( ) Dependent on Fiscal Year
- ( ) None of the above/not applicable
- ( ) Other

Comments:

10. If you currently (or are planning to) hedge on DIESEL FUEL exposure, do (will) you hedge to add firm value or to keep transportation costs stable?

	Add Value (Create Revenue)	Mainly to Add Value, but also to stabilize costs	Mainly to Stabilize Costs, but also to add value	Stabilize Costs
DIESEL FUEL Hedging	○	○	○	○

comments:

11. Please add any additional comments that you think will be helpful in relation to DIESEL FUEL hedging:

Prev Next

MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

17. No to Hedging on DIESEL FUEL

94%

This section explores what your currently doing in response to the volatility in DIESEL FUEL prices.

1. If you do NOT currently utilize FUEL hedging strategies, how do you handle fluctuating fuel prices?

- Pass Through
- Absorb
- Other

Other (please specify)

2. Please add any additional comments that you think will be helpful in relation to DIESEL FUEL hedging:

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MLOG Thesis - Hedging and Fuel Surcharge

Exit this survey

18. General

100%

This section explores some general information on your company.

1. Annual revenue for my company in 2009 was...

- Less than $50 Million
- $51M to $250M
- $251M to $500M
- $501M to $1 Billion
- $1.1B to $5B
- $5.1B to $10B
- $10 Billion or greater

2. What is your primary industry?

3. What was your approximate expenditures for transportation in 2009?

	Truckload (TL)	Less-Than-Truckload (LTL)	Railroad (Intermodal)
Less than $1 Million	○	○	○
$1.1M - $10M	○	○	○
$11M - $25M	○	○	○
$25.1M - $50M	○	○	○
$51M - $100M	○	○	○
Greater than $100M	○	○	○

Other (please specify)

4. What was your average length of haul in FY2009 (in miles)?

	Truckload (TL)	Less-Than-Truckload (LTL)	Railroad (Intermodal)
Less than 100	○	○	○
101 - 500	○	○	○
501 - 750	○	○	○

	Truckload (TL)	Less-Than-Truckload (LTL)	Railroad (Intermodal)
751 - 1000	○	○	○
1001 - 1500	○	○	○
Greater than 1500	○	○	○

Other (please specify)

5. What percentage of your transportation needs are met by the following (please ensure the numbers add up to 100%)?

	Private Fleet	3PL/Broker	Contract Carriers	Other
TL				
LTL				
Intermodal				
Other				

Other (please specify)

6. Are you interested in receiving the results of this survey?

○ Yes

○ No

Other (please specify)

7. Specific company information. This information is OPTIONAL, and will not be shared. It will only be used to ask followup questions, if necessary, based on your responses.

Company Name

Your First Name

Your Last Name

Your Title

Your Email

Contact Number

8. Please provide any additional comments:

Prev Done

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