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Do Fuel Hedging Derivatives Provide any Economic Benefit to Commercial Airlines within the United States?

Nicholas Volpe
Skidmore College

Skidmore College Department of Economics

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Nicholas Volpe

ROUGH DRAFT

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Abstract:

This paper investigates whether the common practice of hedging the cost of fuel provides any economic benefits to participating airlines. Our study looks at 7 publically traded U.S. airlines over the course of 8 years, from 2008-2015, to determine whether revenue, income, financial leverage, credit quality, or the percentage of yearly fuel hedged contributes to an increase or decrease in overall firm value. We use Tobin's Q, which incorporates a company's market capitalization, outstanding stock, and assets and liabilities, as a proxy for firm value. We find statistically significant evidence that during this time period, a 1% increase in fuel hedge position results in a 0.01 point decrease in Tobin's Q. When considering that changes in hedge position are often greater than 10%, it is evident that this trend could be very detrimental to airlines value. Our findings are consistent with the previous assertion that fuel hedging practices could have the potential of causing speculative factors that negatively influence US airline's stock price.

Introduction

The airline industry is a notoriously cut-throat sector known for frequent bankruptcies, ever increasing consolidation, and paper thin profit margins. One reason for the industries' cyclical nature is it's volatility to a number of key global economic drivers; most notably the price of crude oil. The recent volatility within the crude oil market has put some airlines hedge books far into the red. As with any hedge position, however, the actual economic value of the derivative can not be known until the position has expired. If the price of oil increases while the position is still active, the derivative could become much less detrimental to the airlines bottom line. Many airlines have historically put great emphasis and importance on their yearly hedge positions, and almost every airline in the U.S. currently holds fuel hedge derivatives. Due to its almost universal use within the sector, it is important to understand what potential benefits arise from the practice. Unfortunately, prior literature has become outdated in its analysis on the influence of hedging: In the past decade crude oil markets have drastically changed, the commercial airline sector has evolved, and technology has increased investors ability to access pertinent data. With the present volatility in the global economy, do fuel hedging derivatives provide any economic benefit to commercial airlines within the United States?

The recent increase in the volatility of the global crude oil market created an economic environment in the commercial aviation sector where a study of this nature is more pertinent than it has previously ever been. In a little under two years, the price of WTI Crude Oil (CL.1 NYMEX) has fallen from over $90 a barrel to just above $30 a barrel. This extreme drop off in the price of oil has been joyously welcomed by the sector as a whole, as one of its largest expenses is now 200% cheaper than in 2013. It has also, however, placed many airlines in the national spotlight for the wrong reasons. Southwest Airlines, which had slashed its fuel bills for many years in the later 2000's, has now found itself on the cover of USA Today (2016) due to reports that it is financially liable, at current market prices, for $1.8 billion in fuel hedging costs through 2018. Similarly, Delta Airlines saved over $700 million in 4Q2015, however, fuel savings would have totaled over $1 billion dollars had it not hedged its fuel consumption in that quarter. The losses created in times of low crude prices have led to some airlines ditching their hedge programs all together, yet it is typically these airlines that tend to loose the most when the price of crude jumps back up, as it did in 2008/2009.

Although paying below market price for crude oil is a welcomed benefit of a hedging program, it is often not even the main objective. Fuel accounts for around 30% of an airline's costs when oil is around $50 a barrel [Morrell & Swan (2006:1)]. As the price of oil fluctuates, it creates large swings in unhedged airlines costs. Due to this, the main goal of a hedging program is to stabilize costs and, in-turn, profitability. In broad terms, hedging means locking in the cost of future purchases, and it gives airlines a better understanding of their costs for the year. This, in turn, gives airlines a better understanding of what it must do, and how it must perform, in order to obtain acceptable profitability. Stable fuel prices result in stable costs, which result in stable cash flows and, in turn, stable profits. This stability, according to hedge theory and airline management, results with a higher price for the airline's stock [Morrell & Swan (2006)]. While the theoretical justification for hedging fuel costs is historically weak, the assumption that hedging programs carry positive effects on firm value is one that is corroborated by the analysts who forecast airline stock prices. The aim of this paper is to evaluate the affects that fuel hedging has on firm value in the hopes of easing the on-going debate by both scholars and executives regarding the practice's reported economic benefits, or lack there-of.

In the next section we will explore the historical changes in the U.S. airline industry that spurred the increased use of fuel hedging; we will also explain the fundamental premise and types of hedges used in the industry today. We will then introduce previous literature relating to the question we have presented, in order to show what researchers have looked at in the past, and how they themselves have tried to answer this difficult question. Section 3 will present the financial and economic theory behind the concept of hedging. From there, we will start to present our study; first by presenting our hypothesis to this question, then by explaining the rationale behind how we conducted our research and data computation, and lastly by presenting our final econometric model and the results we obtained through regressing this model. We will conclude this paper by engaging in a discussion about our results, issues that arose during the course of our study, the potential policy implications of our results, and future research possibilities regarding commercial airline fuel hedging.

Background

In order to gain a better understanding of where the industry is going in the future, it is important to understand where it has come from in the past. One of the most important historical shifts in U.S. commercial aviation happened in 1978, with the Airline Deregulation Act. This policy change shifted control of route entry, route exit, and route pricing from the governmental Civil Aeronautics Board (CAB) to the private airlines. This economic liberalization of air travel meant that airlines—who historically only competed on food, crew quality, flight experience, and frequency—would now compete on ticket price [Smith and Cox (2006)]. The new competitive price market resulted in fares dropping much lower, allowing many more people to fly, and, in turn, increasing route frequency and load factors. In fact, fares (adjusted for inflation) have fallen 25% since 1991, and are 22% lower than they would have been had regulation continued—saving passengers over $19 billion a year [Smith and Cox (2006)]. Although airline deregulation was great for the passengers, it created fierce competition, allowed new entrants, and drastically slimmed margins within the commercial airline industry. The fierce nature of the industry has led to a huge amount of bankruptcies, mergers, and take-overs. Since 2001, Trans World Airlines (TWA) merged with American Airlines, US Airways merged with American West (retaining the US Airways name), Northwest Airlines and Delta Airlines (both in and out of bankruptcy at the time) merged, United and Continental merged (retaining the United name), Southwest Airlines acquired AirTran Airways, and American Airlines acquired U.S. Airways (Retaining the American name). In fact, just prior to the completion of this paper, on April 4th, 2016, it was announced that Alaskan Airlines had acquired Virgin America as well.

Despite the consolidation within the industry, its fierce competition mixed with the recent drop in crude oil has shown that there is still the possibility of economic viability for future hedging orders within the sector. Risk exposure is playing an increasing role within commercial aviation because, as we have highlighted above, there has been a decrease in airfares due to increasing competition. This, in turn, has made air travel a commodity market; making it impossible for airlines to raise ticket fares in response to higher fuel prices. In fact, fuel has increased as a percentage of average operating costs from 12% in 2001 to 33% in 2012 [IATA (2012)]. The influence of fuel cost fluctuation on an airlines bottom line also depends greatly on what business model the airline operates. There are two predominant types of models in commercial aviation today—legacy carriers and low-cost carriers (LCCs). “Legacy Carriers”, most notably Delta Airlines, United Airlines, and American Airlines, are airlines that had established interstate routes before the time of the Airline Deregulation Act. While changing business models and times have made the service of legacy carriers more undistinguishable between their low-cost rivals, principally, legacy carriers are known for more luxurious service. For example, historically, legacy carriers have been known for their free-baggage service, catering on short *and* long haul flights, and an overall fancier and more personal service.

Low-cost-carriers, on the other hand, cut costs at all corners in order to offer the cheapest ticket prices on the most travelled flight legs. Because of their cost cutting attempts, research has found that fuel costs account for a higher percentage of operating costs with LCCs than with legacy carriers. The reason for this is due to the fact that LCCs can influence the costs of staff, cleaning, airport fees, and operations; however, with fuel, these carriers must obey the market and pay the same price as legacy carriers**.**

With a greater understanding of where the sector is today, it is important to understand what hedging is. Hedging is the strategy of transferring or decreasing risk by taking an equal and opposite position in two different markets. Specifically regarding large fuel consuming companies (like airlines), fuel hedges allow the companies to lock in prices and margins in advance, therefore reducing the potential risk of volatility within the fuel market. It also allows these companies to stabilize their fuel expenses, giving investors and executives a better understanding of where the company is going and what they must do to get there. While most companies who are overly dependent on fuel for daily operations engage in some form or percentage of fuel hedging, there are still some that do not. There are two main reasons why a company would not hedge. First, it may be because the company is not worried about volatility in the fuel market because it can pass on any and all increases in fuel prices to its consumers without affecting margins. Secondly, the company could be confident that the market price of fuel will drastically fall [Corley (2008)].

Specifically within the commercial aviation sector, there are three main types of contracts used for fuel hedging. The first option is over-the-counter (OTC) contracts such as swaps, options, and combinations (collars). The risks of OTC contracts will be explored later in this review. The second option that airlines have is futures contracts that are traded on an exchange. While this option tends to be slightly less risky than its OTC counterparts, its inherent risks will also be explored later in this review. Lastly, airlines have the option not to hedge their fuel consumption.

Literature Review

Carter, Rodgers, and Simkins (2004) studied the economic sense of hedging fuel for airlines. In order to do this, they obtained the fuel hedging data of all US airlines between the years of 1994 to 2000. Using a two-factor model incorporating weekly time-series regressions, the researchers figured out the sensitivity of stock returns to jet fuel price changes. Carter, Rodgers, and Simkins found that in times of higher fuels costs, unhedged airlines tended to have negative cash flow exposures, while hedged airlines tended to have positive cash flows. It was also found that the largest carriers (also found to be the most active hedgers of jet fuel) tended to have a smaller relation between jet fuel prices and cash flows than most other carriers. The researchers concluded that the higher cash flows associated with lower fuel costs is mainly the result of an airline decreasing its outside investment. This resulted in what the researchers argue is the principle benefit of hedging; a reduction in underinvestment costs. Underinvestment costs are a problem within a company where it refuses to invest in low-risk assets, and instead seeks out bigger streams of income, even if the risk potentially comes close or outweighs the reward.

In examining the use of foreign currency derivatives (FCDs) and their potential impact on firm value, George Allayannis and James P. Weston (2001) find corroboratory evidence of the importance of financial hedging. Their paper “The use of Foreign Currency Derivatives and Firm Market Value” looked at 720 large U.S. nonfinancial firms between the years of 1990 and 1995. While not all of these companies were airlines, the study is still extremely important to financial hedging research, as it shows the importance of companies hedging large costs. The 720 firms in this study were all very active within the export/import market, causing exchange rate fluctuations to be their largest and most volatile costs—similar to how jet fuel is airline’s largest and most volatile cost. Allayannis and Weston used a fixed effects model that incorporated Tobin’s Q as a proxy for firm value and variables accounting for firm size, profitability, leverage, growth opportunities, the ability to access financial markets, geographic and industrial diversification, credit quality, and time. In using these other variables, they aimed to explain whether the hedging premium can be explained by other factors that theories suggest may affect firm value and Q. Tobin’s Q, alternatively referred to as the Q Ratio, is a measure of firm value. A Q ratio between 0 and 1 means that the value of a company’s stock is less than the cost it would take to replace the firm’s assets, creating the perception that the stock is undervalued. Alternatively, the stock of a company is viewed as overvalued if its Q value is greater than 1. Allayannis and Weston found that users of currency derivatives (risk hedging) had consistently higher mean and median Qs than nonusers. In addition, they found that hedging added value both during the dollar’s appreciating and depreciating period; however, the hedging premium was much larger (and statistically significant) during years in which the dollar was appreciating.

Britta Berghöfer and Brian Lucey (2014), it their article “Fuel Hedging, Operational Hedging and Risk Exposure – Evidence from the Global Airline Industry”, find results that are contrary of both Carter, Rodgers, Simkins, and Allayannis and Weston. Berghöfer and Lucey looked at the effectiveness of operational and financial hedging within the global airline industry by analyzing 20 European airlines, 20 Asian airlines, and 24 US airlines in a 10-year span from 2002 to 2012. In order to measure the effect of financial hedging, they used a fixed effects regression model, while incorporating panel data, and regressed the dependent variable —an exposure coefficient measuring for both specific airline and year—on the percentage of next year's fuel requirements hedged, the maximum hedging maturity in months, the amount of fleet diversity, as well as the long term debt to asset ratio—which takes financial distress into account, and the logarithm of average flight distance. The researchers concluded that highly exposed airlines have higher leverage and are larger in size. While these airlines had greater fleet diversification and longer routes, they did not differ significantly in their percentage of fuel hedged or percentage of periods hedged. In other words, jet fuel hedging did not reduce exposure.

Similar to the results obtained in the study conducted by Allayannis and Weston, it is important to understand how different hedging strategies affect airlines stock price— whether that is based on the airline's fundamentals or on more speculative factors. In order to test for this, Carter, Rodgers, and Simkins returned to their model using a dependent variable of the company's rate of common stock return in week *t*, and regressed this on the return to the Center for Research in Security Prices (CRSP) value weighted market portfolio, the percentage change in Oil Price Information's (OPIS) jet fuel prices, and an estimated coefficient measuring the sensitivity of a firm's stock price to changes in jet fuel prices. Through this analysis, they found that fuel price risk management (hedging) does not materially alter the exposure of airline stock prices to changes in jet fuel prices. Therefore, hedging apparently has no effect on the sensitivity of an airline's stock price to jet fuel prices. It is important to note, however, that if the market expects airlines to invest marginal cash flow in positive net present value projects, then investors should place positive value on jet fuel hedging. The researchers also explain, however, that if investors view an airlines investment unfavorably, hedging could have negative value consequences.

Berghöfer and Lucey, to the contrary, found that hedging practices could have the potential of causing speculative factors that influence the price of US airline's stock prices. Out of the Asian, European, and American airlines that they looked at in their study, American airlines were the most exposed to fuel prices. The researchers believe that this potentially sprung from investor concerns (speculation); because if fuel priced induced market expectations led to changes in airline stock prices the exposure coefficients could then be affected simultaneously.

As was described previously, there are both issues and alternatives to aviation fuel hedging. One of the major issues with aviation fuel hedging is that kerosene (jet fuel) is not actively traded on any exchange funds, such as the New York Mercantile Exchange (NYMEX) or the Intercontinental Exchange (ICE). Due to this, hedging of jet fuel must be done over-the-counter (OTC). There are, however, inherent risks with trading OTC, such as illiquidity and associated counterparty risks. Since kerosene is only traded OTC, and OTC trades carry more risk, airlines typically "cross-hedge" their fuel demand with commodities that trade on commodity exchanges such as the ones highlighted above. Commodities that share the most similar characteristics as kerosene are crude oil, heating oil, and gasoil. Although gasoil typically shows the strongest correlation, crude and heating oils are most often used by airlines. In fact, in the US aviation industry, crude oil accounts for the biggest share of underlying commodities with 39.1% (heating oil – 30.9%, kerosene – 24.6%). Kerosene spot prices and crude oil spot prices, however, have correlation factor of only 0.63 since 2002. The imperfect correlation of the price of an underlying cross hedge instrument with its purchased asset price is called "basis risk"

[Carter et al. (2004)]. Meanwhile, the specific difference between crude oil spot prices and jet fuel spot prices is referred to as the "crack spread". It is extremely important to note that the "crack spread" is shown to widen during times of higher volatility in crude oil prices.

Due to the inherent risk involved in hedging, many researchers have explored alternatives to the practice. One alternative, put forward by Berghöfer and Lucey, is operational hedging. Operational hedging, in the form of fleet diversification, would allow airlines to deploy smaller aircraft to counteract lower demand within a market, often due to a weakening economic environment and/or higher fuel prices. In theory, this operational hedge would allow load factors to be maintained at high or higher levels. There are, however, some potential drawbacks to this strategy. First, different aircraft types require different type ratings; with each additional type rating creating greater training costs for pilots and their subsequent airlines. Furthermore, different aircraft require different spare parts, different flight crews, and different ancillary equipment. Berghöfer and Lucey tested this hedging alternative by applying a variable that accounts for the amount of fleet diversification within an airline. They found that a more diverse fleet increases airline risk exposure as opposed to decreasing it. In fact, a 1% increase in fleet diversity would lead to an increase of the risk exposure coefficient by 1.83%. This result, however, is not advising against an airline having a diverse fleet, but it is advising against an airline purposely diversifying its fleet in order to decrease risk. Some airlines have strictly domestic route structures and, therefore, have the ability to operate one type of aircraft. Examples of this would be Southwest Airlines and its fleet of Boeing 737, or JetBlue Airlines and its fleet of Airbus 320 ad 321's (which do not require different type ratings). On the other hand, some airlines (especially legacy carriers) have business models that *require* the need for different aircraft. For example, United Airlines has a fleet of wide body Boeing 747's that are used for long haul service. Within the US, however, United flies Boeing 737, 717, Airbus 320, 319 and other aircraft on their shorter-haul routes. United has clearly done a cost-to-benefit analysis and has concluded that this route model—which requires different aircraft—can bring in more profits than the cost savings the company could make through operating only one aircraft type.

Another alternative to fuel hedging is, in fact, no hedging at all. According to the Modigliani Miller Paradigm, risk management is irrelevant to individual firms because shareholders can do risk management on their own through a well-diversified investment portfolio [Sprčić, D. M. (2013)]. A study done by DeMarzo and Duffie (1995) find conflicting results to this theory, however, as they find that even though shareholders can hedge on their own, hedging is optimal when managers have private information on the firm's expected profits.

Lastly, we look at Allayannis and Weston's exploration of the theory of reverse causation. Reverse causation states that firms with high Tobin's Q have an incentive to hedge because they may already have high growth opportunities. Likewise, firms that remain unhedged and firms that quit hedging in the next period will do so because these firms *already* have lower values than firms that remained unhedged. In simpler terms, the theory states that hedging practices are determined by firm value, but firm value is not determined by hedging practices—hence *reverse* causation. These authors tested for reverse causation before running their preliminary regressions in order to rule it out. They rejected the hypothesis that firms with larger Qs choose to hedge, and firms with lower Qs choose to remain unhedged.

Through the analysis of past literature, there are many things that are apparently clear. Fuel hedging is a form of risk management investment derivative that is both tremendously complex and also financially risky. The reason why it is so important for airlines to understand the complexity and risks involved in hedging is because, as specifically seen in this age, by agreeing to a fixed price of fuel, airlines are facing the potential of losing or gaining a lot of money. Unfortunately for airlines, the extreme drop in crude prices today has created great losses in the hedge books of many airlines worldwide. The understanding of what hedging strategies can do to an airlines value will give airline executives a better foundation to make hedging strategies in the future. In a current market of extremely volatile crude prices, that this is an extremely important foundation to have.

Relevant Theory

The basic rational behind financial hedging implies that possible economic success is attainable due to inherent friction in the Modigliani Miller (M&M) Paradigm. The M&M Paradigm was first theorized by Franco Modigliani and Merton Miller in 1958. The original propositions under the theory were: A.) A firm's total market value is independent of its capital structure, and B.) A firm's cost of equity increases with its debt-equity ratio [Haas (N/A)] . Due to these assumptions, risk management is irrelevant to the firm because investors can attain their desired risk level through a well diversified portfolio. For example, an investor who owns shares in an airline can hedge the potential risk of fuel price increases by also purchasing shares in oil companies. Being so, the transaction costs an airline would incur through hedging practices would completely eliminate the economic benefit of risk management. Moreover, according to the "irrelevance theorem" within the paradigm, corporate hedging could actually harm shareholders, as it would skew the risk level in their own portfolio [Krawiec (2004:3)]. In order for this to be true, however, several assumptions must hold. Investors must have accurate information regarding all firms systemic risk exposure in order to formulate a portfolio that aligns with he/she's desired risk level, and capital markets must be perfect. "Perfect", in this sense, means the market has no taxes, bankruptcies, or agency costs. The friction is introduced into the theory because in the real world, most capital markets are imperfect.

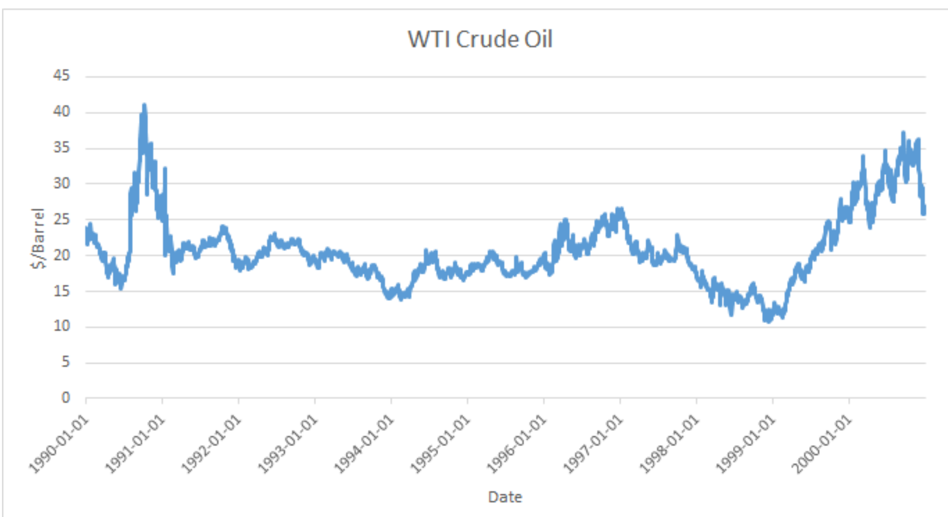
Although this theory is based more firmly in finance than in economics, its intellectual power has led many economists to form relevant theory rooted in M&M. Joseph Stiglitz, Professor of Economics at Stanford University, once wrote (1988):

> *"What has not been sufficiently emphasized is the importance of the paper to the development of economic theory and practice. Indeed, it is ironic that a paper which purportedly established that one need not pay any attention to financial structure—that financial structure was irrelevant—should have focused economists' attention on finance."*

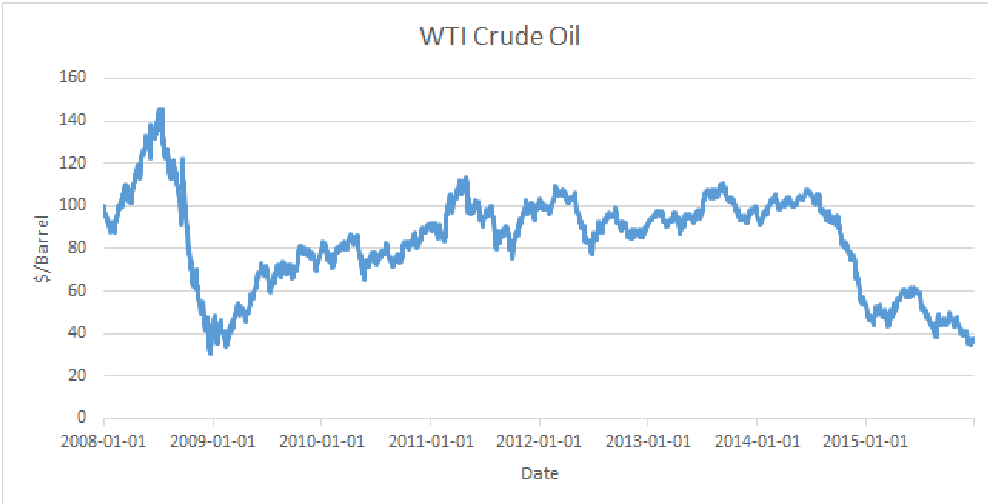
One of the most important theories coming out of M&M is investment theory. In their study of this theory, Froot, Sharfstein, and Stein (1993) found that hedging adds value to the corporation by ensuring that it has sufficient funds available to take advantage of attractive investment opportunity; similar to the findings of Carter, Rodgers, and Simkins regarding hedging's role in reducing underinvestment costs. This shows that while the basic principles behind the M&M Paradigm are uprooted in modern economics, the economic principles presented in the theory still have great importance in today's research.

Hypothesis

It is important to note that our proxy for firm value, Tobin's Q (*Q*), accounts for both changes in an airlines fundamental's (through changes in its assets), and changes in the markets view of the firm: by accounting for both market cap and the value of outstanding preferred stock. Carter, Rodgers, and Simkins found that hedging practices had no effect on the exposure of stock prices to jet fuel. They also found that hedged airlines have greater positive cash flows, therefore, creating the potential of increased assets (through a reduction in underinvestment). Allayannis and Weston found concluding evidence regarding the effects of hedging: that hedge positions increase *Q* value. Our hypothesis corroborates the findings of these researchers. We base this assumption on the fact that investors typically look for greater stability within the company that they choose to invest in, especially in today's volatile markets. As we have explained within the literature review section, hedge positions typically increase this stability. The time frame which we studied played an important role in our hypothesis. Previous literature conducted by Carter, Rodgers, Simkins, Allayannis, and Weston all took place between the years of 1990 to 2000. As the graph below shows, the price of West Texas Intermediate (WTI) crude oil was relatively stable during this period; climbing no higher than $46 a barrel, and no lower than $11 a barrel.



Our data, on the other hand, was collected between 2008 and 2015, which, as the graph below shows, was a very volatile time for crude oil. During this 8 year span, the price of WTI crude oil climbed to over $140 a barrel in 2008, preceded to fall to around $35 a barrel in 2009, and then steadily climbed back up to over $100 a barrel, until finally dropping to below $40 just last year. These graphs show the clear macro-economic differences between the studies.



This is important because we believe that in highly volatile times, investors will put an even greater emphasis on cost stability. It is our assumption, then, that the airlines in our study with larger hedge books will be rewarded with higher Tobin's Q values, because, in-theory, these airlines will be more stable.

Research Methodology

In order to conduct the research, 7 airlines were evaluated based on 6 variables spanning 8 years. In order for an airline to qualify for the study, it had to fulfill two requirements. The first requirement was that the airline had to be based in the U.S. and actively traded on a U.S. stock index (NYSE, Dow Jones, S&P 500). This requirement eliminated large operators in North American such as Air Canada (Canada), WestJet (Canada), Volaris (Mexico), Interjet (Mexico), and British Airways (England). The second requirement was that the airline must operate a fleet of at least 50 aircraft. This requirement was used to control for the size of airline operations; it eliminated Sun Country Airline (U.S.). It is important to note that *most* "regional" airlines operations were included in our study despite the airline not being accounted for. The reason for this is because of an operational tactic used within the commercial aviation sector where a regional carrier (Such as Republic Airlines, fleet size 151) conducts operations on behalf of

United Airlines. Under the agreement, United Airlines covers the fuel costs of those operations. It would therefore be irrelevant to include regional airlines because they have no fuel costs, but instead, their fuel costs from operations are included within the data for the respective non-regional carriers for which they operate. In addition, American Airlines, Frontier Airlines, and Delta Airlines were excluded from this study due to a lack of data. This is an area we hope can be included in further studies as Delta and American are two of the larger players within the current market. The lack of data pertaining to the two airlines, however, created large gaps in our dataset that could otherwise not be accounted for. Based on these requirements, the carriers that we evaluated in this study were United Airlines, Alaska Airlines, Southwest Airlines, Allegiant Airlines, Spirit Airlines, Hawaiian Airlines, and JetBlue Airways. In order to accurately study the effects of hedging position on each airline, we used Tobin's Q as a measure of firm value. Tobin's Q data for each of the 7 airlines was obtained from YCharts. YCharts is a financial data research platform that has been used by the Chicago Tribune, Forbes, Barron's, and Investment News for data research and analytics. Although it is a web service, because of its wide usage by accredited journals and news outlets, we believe in the validity of the Tobin's Q values we obtained. The calculation of Tobin's was progressed by Kee H. Chung and Stephen W. Pruitt and can be calculated as follows (4):

Approximate Q = (Market Cap + Value of firm's outstanding preferred stock + Value of firm's short term liabilities net of short-term assets) / Total Assets (Book Value of Total Assets of the Firm)

As we explained in the literature review section, a *Q* value between 0 and 1 means that a stock is undervalued in the market. Alternatively, if a stock's *Q* value is greater than one, it is overvalued in the market. We also analyzed each airline based on the profitability metrics of revenue and net income. Although some may argue that including both revenue and net income can create multicollinearity within our data, our post-estimation tests conclude that there was none present. We believe it is especially important to account for both metrics within the aviation sector because, as we said above, profit margins are historically low for all airlines. An airline that brings in a high revenue figure in one year, therefore, does not necessarily make a higher income that year, as the reduction of costs is often one of the largest reasons for financial success in the sector. We also account for revenue and net income in order to exclude the effects that these two variables could have on firm value. According to Allayannis and Weston (2001):

> *"A profitable firm is likely to trade at a premium relative to a less profitable one. Thus if hedgers are more profitable, they will have higher Qs."*

We obtained revenue and net income data from Yahoo! Finance and from the various airlines 10-Ks when the data was otherwise not available. Financial leverage was also accounted for due to the possibility that a firm's capital structure may play a role in its overall value. We obtained our data from Morningstar Investment Research, which calculates financial leverage as follows:

Financial Leverage = Total Assets / Total Shareholders' Equity

The sixth variable we used accounted for the credit quality of each airline. We obtained the credit ratings of all corporate debt issued by the airlines over the eight year time span from Moody's. Moody's rates corporate debt on a 20 tier system with "Aaa" being the best (Investment Grade: Minimal Credit Risk) and "C" being the worst (Speculative Grade: In Default, with little chance of recovery). While no corporate debt issued by the airlines in this time frame fell below

"Caa3" (Speculative Grade: Very High Credit Risk), or went higher than "Aa3" (Investment Grade: Very Low Credit Risk), it was not practical for us to find a way to quantify each rating so that it was acceptable for STATA. Instead, we assigned dummy variables based upon the movements of debt ratings over the 8 year span. Debt that stayed the same or increased in a fiscal year was assigned the value "0", while debt that was downgraded in rating was assigned a value of "1". The goal of this study was to assess how *changes* in one variable effect firm value, we therefore felt that this is an appropriate way to account for credit rating as it explored the effects of *negative changes* in credit rating. We understand that positive changes in rating (a credit upgrade) will not be accounted for in this study, but we felt that the potential influence that a credit downgrade would have on *Q* was more pertinent to our potential conclusions, and therefore accounted for that in our regression analysis.

The last variable used in this study is the percentage of yearly fuel hedged by each airline. This information was found in each airlines yearly 10-K. An example of how JetBlue stated its hedging strategy within its annual report is as follows (2013):

> *"We maintain a diversified fuel hedge portfolio by entering into a variety of fuel hedge contracts in order to provide some protection against sharp and sudden volatility as well as further increases in fuel prices. In total, we hedged 21% of our total 2013 fuel consumption."*

Based upon the strategy that JetBlue has highlighted above, it will take the value of 21.00 for the percentage hedged variable in 2013. It is important to note that the exact percent of fuel hedged is not something that airlines are required to disclose, although almost all do. The percentage hedged variable is, therefore, not always exact. For instance, Hawaiian Airlines does not disclose the percent of fuel they hedged out each year, the Airline does, however, provide the values of fuel consumed per year and fuel hedged per year in gallons. In this instance, we calculated the percentage of fuel hedged each year. Additionally, fuel hedging can be done in a variety of ways (as was explained in the literature review) but for the purposes of this study, the aggregate of all the various methods was only accounted for. This was done for two reasons; first, the aggregate percent was given more frequently in each 10-K, we were therefore more confident in its overall efficacy. Second, it follows what was done in the previous literature. Lastly, it is important to note that Allegiant Airlines *does not* hedge its fuel consumption. Allegiant's percentage hedged variable therefore took on the value of 00.00 for all years including and in-between 2008 and 2015, which is still very important for our regression analysis. Table 1, in the list of tables at the end of this paper, provides descriptive statistics for all of our variables.

The Final Econometric Model

In order to observe the data that we have highlighted above, we use a longitudinal, or panel, data set. The final population regression function is as follows:

$$Tobins_{it} = \alpha + \beta 1rev_{it} + \beta 2income_{it} + \beta 3finlev_{it} + \beta 4dummy_{it} + \beta 5hedge_{it} + \varepsilon_{it}$$

Where:

Tobins: Individual Airline's Tobin's Q

Rev: Individual Airline's Yearly Revenue

Income: Individual Airline's Yearly Income

Finlev: Individual Airline's Yearly Financial Leverage

Dummy: Credit Quality Dummy

Hedge: Individual Airline's Yearly Fuel Hedged (%)

ε_{it}: Error Term

In accordance with our theoretical model and previous literature, we expected an increase in fuel hedge position to have a positive effect on firm value, making its sign positive in our regression analysis. We expected a debt rating decrease, which is signified by a dummy quantity of "1", to have a negative effect on firm value. We also expected an increase in leverage (*finlev)* to negatively affect *Q*. Lastly, we expect *rev,* and *income* to have a positive influence on firm value.

We benefit from using a panel data set because it allows us to observe our data in the cross sectional dimension (airlines) and the time series dimension (years). The main advantages of this style of data analysis is its ability to improve the efficiency of the econometric estimates found in this study by allowing for more degrees of freedom and more sample variability. This, in-turn, allows for a more accurate inference of model parameters.

Prior to running our regression, we had to run two tests in order to guarantee the validity of our results. A Hausman Test was first conducted to determine whether a fixed or random model was the appropriate model to conduct our regressions. A Hausman Test compares a weighted square of the difference between the two β estimators of the random and fixed models [University of Vermont (2009:2)]. The resulting X_2 statistic is what determines if we reject, or fail to reject, the null hypothesis. Under the null hypothesis, the random effect model is appropriate; the fixed model, on the other-hand, is appropriate under the alternative hypothesis. Our Hausman test resulted in an X_2 value of 0.559, which is much greater than 0.05. Under this conclusion, we failed to reject the null hypothesis, and we used the random effects model to conduct our regression.

A Variance Inflation Factor (VIF) test was also conducted prior to running our regressions. This was done to test for multicollinearity within our model. The VIF scores for all six variables remained under the threshold value of five, therefore indicating that the model does not contain multicollinearity. Table 2, in the list of tables at the end of this paper, provides a more in depth look at the results of the VIF test. After conducting these robustness checks on our variables, we concluded that the OLS estimates for our final model were the best linear unbiased estimator (BLUE) and, therefore, ready to be regressed.

Regression Analysis

The data obtained through our regression analysis violated three out of the five expectations we had for the independent variables. According to our regression analysis, a $1 billion dollar increase in revenue results in a 0.006 point decrease in Tobin's Q. Considering that the minimum Tobin's Q value in our dataset was 0.317 and the maximum value was 3.24, a decrease of 0.006 could actually be very negative to a firm. It is also important to note, however, that the p-value for this variable was statistically insignificant. A decrease in credit quality (*dummy*) also violated our assumption as our regression showed that a credit quality downgrade resulted in a 0.29 point increase in *Q*. This result is also statistically insignificant, with a p-value of 0.910. Income and financial leverage matched our expectations that an increase in income would increase *Q* and an increase of leverage would decrease *Q*. The values we obtained from both variables were not exceptionally pertinent, however, as their results were both statistically insignificant and showed extremely small changes in *Q*. According to our results, a one point increase in financial leverage resulted in a 0.0004 point decrease in *Q* while a $1 million increase in income led to a 0.00007 increase in *Q*. Our regression results did yield a very interesting result regarding hedge percentage. According to our regression analysis, a 1% increase in an airlines hedge position for year *t* resulted in a 0.009 point decrease in the company's *Q*. This result shows that in the volatile crude market period spanning from 2008 to 2015, fuel hedging had a *negative* effect on firm value. The hedge variable's p-value was statistically insignificant at 0.057, however, the value we obtain provides an economic trend that was seen in the U.S. commercial aviation sector between 2008 and 2015. This regression explains 35% of the variability of the response data around its mean. The descriptive statistics of model 1 are shown in Table 3 of the list of tables at the end of this paper.

As we have said above, however, we found fundamental issues regarding the inclusion of our dummy variable accounting for credit quality. We feel that the dummy variable does not accurately account for the effects that a credit downgrade would have on firm value. Due to this, we decided to run a second regression analysis on a model which did not include this dummy variable. This dummy variable was not included in the regressions run by previous researchers, so we feel that excluding it from this regression would not be an example of "data mining"--or the intentional deletion of variables to seek a predetermined result. The new model (Model 2) is as follows:

$$Tobins_{it} = \alpha + \beta 1rev_{it} + \beta 2income_{it} + \beta 3finlev_{it} + \beta 4hedge_{it} + \varepsilon_{it}$$

The regression of this new model explains 38% of the variability of the response data around its mean. Revenue (*rev*) and financial leverage (*finlev)* still negatively influence *Q* value, and income still positively influences *Q* value. As we saw with the previous model, all of these variables yield statistically insignificant results. Where the model gets interesting is in its result for the hedge percentage variable. According to this model, a 1% increase in an airlines hedge position for year *t* results in a 0.01 point decrease in *Q*. Similar to the previous model's regression, this outcome suggests that an increase in fuel hedging negatively effects an airlines value. The outcome of this variable is statistically significant at the 5% level. Although 0.01 is a rather small change in *Q*, it is important to note that this change is observed only a 1% increase in yearly fuel hedged. When an airline changes its hedge position, it is often by 10%, 20%, and sometimes even 50%. Due to this, that 0.01 point figure could be drastically larger depending on an airlines strategy. This shows the economic significance of the trend. For a more in-depth view of Model 2's descriptive statistics, please consult Table 4 of the list of tables at the end of this paper

Discussion

Prior to discussing our results, we first aim to acknowledge the limitations and deficiencies within our study. First, we believe that the method by which we incorporated credit quality into our first model was inherently flawed and could have skewed our results. To remedy this problem, we excluded the dummy variable from our second model and are therefore more confident in this new model's results. Secondly, the airline industry within the U.S. is a highly consolidated industry by nature. Due to this, all research that studies the industry at the airline level—as we have done in our study—lacks a significant amount of observations. In fact, the number of observations within our study is 46, which is considered low. Due to the low number of observations, it would be inappropriate for us to extrapolate our findings to other time periods and other countries. Our rather low r-squared value also indicates that it would be inaccurate to imply that our findings would be similar to that of findings during times of less volatility within crude markets. We are confident, however, that our regression analysis shows that in times of highly volatile crude markets, increases in hedge percentage decreases firm value. One might say that this outcome is expected, because by hedging in times of crude oil price declines, airlines typically lessen their potential gains had they simply purchased fuel at market price. We believe that this is a fair argument, and definitely a possible reasoning behind our results. It is important to note though, that from March 2009 until March 2011, the price of crude oil rose rapidly. It is expected that during this time, airlines that were engaged in hedging activity were consuming jet fuel at a price below market value. Since the time period we studied included a period of rapid crude price increase (03/2009-03/2011), of relative stability (04/2011-02/2014), and of rapid crude price decrease (03/2014-12/2015), it is far too simplistic to connect the negative relationship of hedge percentage and *Q* to the assumption that it's because airlines are now paying more than market price for fuel.

It is important to note that a decrease in *Q* indicates an airline's stock is becoming less valued in the market place. Remember, a *Q* value between 0 and 1 indicates that a stock is undervalued. It is possible that an airline included in this study could increase hedge percentage in a year and still remain an overvalued stock, as it could have already been well above that 1 ceiling, however, our results indicate that the stock would start trending towards becoming undervalued ($Q<1$). A potential for this drop in *Q* could be speculative factors that are affecting the stock's market cap or value of outstanding stock. Regardless of the reason, a decline in *Q* is almost always a cause for concern for public companies. This is due to the fact that as the company's stock becomes undervalued, the cost to replace the firm's assets are greater than the book value of its equity [Damodaran (2000:3)].

This outcome contradicts Allayannis and Weston's finding that risk hedging adds firm value during times when the hedged commodity gains and loses value; as we find that increases in hedging actually reduces firm value. Our finding also contradicts the Modigliani Miller

Paradigm, as we find evidence that risk management is relevant to shareholders even though they can do risk management through the asset allocation of their own portfolio's. We do, however, consult Berghöfer and Lucey's study for potential reasons behind our result. As we specified previously, these researchers concluded that hedge strategies could have a negative influence on stock price if investors speculated against airline stocks citing concerns in the crude oil market. This assumption could also be a potential reasoning behind our results. Perhaps, the common investor does not have a complete understanding of fuel hedging programs and the cost stability that they provide, instead, the investor simply fears the potential volatility that airline stocks may have in response to jumps in crude price. In fact, according to the research done by Carter, Rodgers, and Simkins, hedging does not effect the sensitivity of an airline's stock price to jet fuel price. This finding could potentially support the theory that airline stock prices are traded not by what an airline is hedged out to pay per gallon, but what the market price per gallon of jet fuel is instead. If this theory holds, airline management may re-think the efficacy of spending great amounts of time and capital on fuel hedging divisions when the market does not value the cost stability that the program may generate.

While this discussion is done solely to connect different findings in the various literature on risk hedging, and is therefore speculative in nature, our results still show an important result that could reshape managements rationale behind hedging programs and strategies. While some airlines make out very well on hedge positions in times of rising crude prices, today we see the negative effects that hedge positions have on airlines during times of declining crude prices. While the theory behind hedging is to minimize the swings within an airline's cost structure, if the market does not value this stability, but actually penalizes the practice which enables it, is hedging still a worth wile financial tool for airlines in the US?

Conclusion

The goal of our research was to determine whether changes in an airline's hedge positon provided any economic benefit to the airline's overall firm value. We believed that an increased hedge position would increase Tobin's Q as the market rewarded, through an increased stock price, the airline for the cost stability that the hedge position provided. By analyzing 7 U.S. based airlines over an 8 year span and regressing the data that we compiled, we found that an increased hedge position actually decreases firm value. According to our regression, a 1% increase in an airlines yearly hedge position resulted in a .01 point decrease in that airline's Tobin's Q value. This result was statistically significant at the 5% level. It is important to note that the U.S. commercial aviation sector is a highly consolidated segment, and due to this, our model lacked a large amount of observations. While our conclusions cannot help anticipate how hedging practices could affect airline value in other countries or during periods of stability within crude markets, we believe that our findings are important for the U.S. commercial aviation sector during periods of high price volatility within the crude oil market.

The recent drop in the price of crude oil has led many airlines in the U.S. to reduce their hedge positions and, in some cases, to abandon the practice overall. History shows, however, that as the price of crude oil increases again, airlines will subsequently begin to increase or reinstate their hedge practice. This leads to the interesting question of whether the current policies in place are sufficient to allow for the appropriate use of financial derivatives within the commercial aviation sector moving forward.

Due to the dearth of evidence linking the Financial Crisis of 2008 to illegitimacies in the OTC derivatives market, in 2010, great pressure was put on legislatures to implement greater regulations on the rather opaque $650 trillion market [Centre for Aviation (2010)]. The Wall

Street Transparency and Accountability Act (2010) was one step in that direction. According to the Air Transport Association (ATA), this legislation greatly helped to close loopholes, increase transparency, and promote stability in commodity markets. These benefits were crucial to making sure that the market speculation, which caused the dramatic 2008 spike in crude oil prices, would not happen again. While this bill excluded end users, such as airlines, from having to trade through clearinghouses, it had great affects on curbing volatility and increasing transparency in the OTC market as a whole. While this legislation may have made it more difficult for airlines to lock down favorable hedge positions, the broader security that the bill provided to the market was one that the U.S. aviation industry hailed. The main reason why the industry was so supportive of the bill was because of its goal to reduce fuel price volatility caused by excessive speculation. In conclusion, the increased regulatory pressure and control put on the OTC derivatives market, and all almost all financial markets, after the Financial Crisis of 2008 has led to increased transparency and financial safety in the marketplace. Due to this, we do not believe any additional policy's need to be implemented in the commercial aviation fuel hedging market in the near future.

Lastly, we would like to address what we believe would be some future possibilities going off this study. First, in order to mitigate the issue of low observations, the data we used could be evaluated on a quarterly basis as opposed to a yearly basis. This would allow for a much greater number of observations, which may give our model greater accuracy in explaining the variability of the response data around its mean, therefore giving a higher r-squared value. A higher number of observations would also allow for a more intricate and in-depth analysis of our variables. The reason we choose to use yearly aggregates for our variables is simply because more data is currently available for yearly figures than for quarterly figures. In the future, however, quarterly data may become more readily available. We also believe our study could greatly benefit from the inclusion of Frontier Airlines, American Airlines, and Delta Airlines. The reason, again, for the exclusion of these three airlines was due to a lack of data regarding each airline's Tobin's Q and financial leverage figures. We hope that in the future, YCharts and Morningstar Investment Research will begin to calculate and include this data for these three airlines. Lastly, we began accumulating our data just prior to when the Wall Street Transparency Act was passed, and no other studies incorporate the years before and after the act was passed. The act, as we have explained above, created clear-cut changes in the OTC derivatives market, changes that we believe may have modified the way airlines hedge their fuel; whether that be the percentages that they hedge, the intermediaries for which they engage in trading, or the type of hedge practice they use. Due to this, we believe it would be very interesting to explore the potential changes caused by this act.

Although our study has some shortcomings that prevent our results from predicting the future behavior between hedge practices and firm value in commercial airline markets worldwide. We believe that our results are pertinent to the U.S. commercial aviation sector in the near future. It appears that crude oil prices are going to continue to be rather volatile in the coming months, if not years, and we believe our data and results can give members of the commercial aviation sector a solid basis for the economic affects hedging has in the U.S. We believe the economic trends that we discover in our research point to potential market-based problems that airlines may have to weigh when making future decisions regarding their hedge practices.

List of Tables

Table 1. Descriptive Statistics

Variable	**Obs**	**Mean**	**Std. Dev**	**Min**	**Max**
tobins	54	1.042	0.652	0.289	3.243
rev	56	8.505	11.038	0.504	38.900
income	56	276.234	1,291.784	-5,396	7,340
finlev	53	6.434	11.281	1.54	78.230
hedge	54	28.166	18.552	0	70

Table 2. Variance Inflation Factors

Variable	**VIF**	**1/VIF**
rev	2.55	0.393
finlev	2.11	0.474
income	1.83	0.546
dummy	1.22	0.817
hedge	1.04	0.964
Mean VIF	**1.75**	

Table 3. Dependent Variable *tobins* in Model 1

	Model 1
Dependent Variable	tobins
Constant	1.370127 (.316)
X_1	-0.0059521 (.017)
X_2	0.0000761 (.000)
X_3	-0.0004835 (.009)
X_4	0.0290273 (.255)
X_5	-0.0093278 (.005)
R^2	0.3527
N	46

Note:

All standard errors (se) are in parenthesis

Table 4. Dependent Variable *tobins* in Model 2

	Model 2
Dependent Variable	tobins
Constant	1.43968 (.266)
X_1	-0.0102645 (.015)
X_2	0.0000748 (.000)
X_3	-0.0005875 (.007)
X_4	-0.0103274 (.005)
R^2	0.3837
N	46

Note:

All standard errors (se) are in parenthesis

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