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Master Thesis

Does Jet Fuel Hedging Impact the Firm Value in the Aviation Industry?

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Bradie J. Manning

–*Abstract*–

Does Jet Fuel Hedging Impact the Firm Value in the Aviation Industry?

By Bradie J. Manning

This thesis examines the relationship between firm value (in this case proxied by *Tobin's Q*) and the hedging position of future fuel requirements for airlines in the global aviation industry. Airlines that buy fuel in advance can benefit from the fact that they can plan ahead with a set future cost knowing it will neither increase or, decrease. In addition, fuel providers, i.e. Air BP, Shell, Exxon Mobil etc., have the certainty of agreed future revenue too, therefore mitigating the cost exposure for both parties. Sampling data from 2008-2018 of thirty global airlines, with 1320 firm-year observations, this paper extends on the previous literature of Carter et al 2004, by revisiting the question in a more recent timeframe. It also establishes the difference in estimates between two diverging business models in the market: the traditional legacy carriers and the low-cost carriers. The paper revisits the inconclusive arguments in this field of corporate finance: whereby, does jet fuel hedging contribute positively on average to firm value? Our findings are consistent with the more comprehensive work of Carter et al (2004), with an increase in firm value between 2%-10% in our estimates.

Contents

Abbreviations (A-Z)

10-K – Annual Report US
Cap-ex – Capital Expenditure
LCC – Low Cost Carrier
Legacy – Traditional legacy/flag-carrier airline
OVB – Omitted Variable Bias
Tobin's Q – a proxy for Firm Value
VIF – Variance in Inflation

Chapter I

Introduction

Aviation has remained a key economic driver for fostering trade liberalisation, connectivity and proliferating globalisation. Since its inception, the industry has evolved to become increasingly dynamic and competitive; particularly with the entry of the insurgent low-cost carriers that aggressively compete on price and route frequency. Given the low-margin and costly business it is; airlines seek to mitigate the external pressures of cost that this industry is particularly exposed to—oil price volatility.

Low margins and high costs place airlines into a financially vulnerable position during periods of macroeconomic uncertainty and downturns, particularly as airlines are relatively homogenous in their cost composition. Therefore, when airlines can exercise even the slightest cost advantage it can enable the business to gain a competitive advantage in the market. Airlines are fairly limited in their capacity to mitigate external cost volatilities placed onto their business; however, jet fuel hedging has been recognised as a tool to mitigate oil price volatility and therefore reduce the airline's exposure to shocks, thus improving the firm's financial position. This paper examines whether an increased Jet Fuel Hedging position generates increased value for the firm over the previous ten years (2008-2018). Using data obtained on the World's thirty largest airlines by passenger numbers over a 10-year timeframe, the paper will use a series of econometric approaches to evaluate the impact that hedging could have in driving the firm value of airlines.

Recent literature in the segment of financial economics has aimed to deliver an improved understanding on why non-financial firms may practice hedging as a means to reduce cost exposure and the impact of cost volatility. Allayannis et al (2013) place a more general focus on non-financial firms exercising foreign currency hedging on *Tobin's Q*, evidencing that an increased hedged position can contribute to approximately a five-percentage increase in a firm's value. More specifically to this paper, Carter et al (2004) focuses on hedging of jet fuel in the US airline industry. They use quarterly financial data during 1992-2003 to examine if an increased hedging position leads to an improvement in the firm's value, proxied by *Tobin's Q*.

They summarize in their findings that for airlines, an increased hedging position can contribute to as much as a ten-percentage increase to the airline's *Tobin's Q* value.

This paper builds upon the aforementioned literature in the field of corporate risk management in two keyways. Firstly, it extends the work of Carter et al by sampling global airlines, and revisits the question in more recent, volatile times by sampling the previous ten years of hedging activity for the largest airlines. In addition, the study will extend this field of research by examining hedging on firm value for low-cost airlines which are particularly exposed to cost-volatility through their very low margins.

The aviation market is unique in the fact that it is generally homogenous by nature when it comes to cost structure of airlines. The only noticeable distinction in business models would be low-cost carriers (LCCs) and traditional legacy carriers. While both types of businesses reflect different cost and operating structure, they interestingly take similar approaches (on average) when it comes to exercising hedging. This paper examines whether hedging can be used as an instrument in achieving economic objectives in the field of the aviation industry. The purpose of using jet fuel — and, more specifically in the aviation industry — is due to it constituting a significant proportion of operating expense for airlines. Jet fuel is also highly volatile in price and thus these volatilities are usually driven by macroeconomic and geopolitical uncertainties. Given the unpredictable nature of oil price volatile, it therefore creates an incentive for airlines to hedge jet fuel, and '*smooth* the bumps' (easyJet, 2016).

We use pooled data of two samples of the fifteen largest airlines: the largest legacy carriers, and largest LCCs. In addition, we use a series of control variables to capture the publicly listed financial information which is available to investors; to build a specification that minimises endogeneity concerns and can thus be unbiased in estimating the causal effect of hedging on airline's firm value.

The motivation for studying the aviation industry is that it is compatible with the framework developed by Froot et al (1993) in two ways: (1) the industry capital expenditure has largely a positive relationship with jet fuel costs, and (2) in times of financial difficulty, airlines face high financial distress costs. For instance, in times of financial distress, weaker airlines will typically underinvest their assets by selling aircraft at a suboptimal price to raise cashflow (Froot et al, 1993).

The aviation industry serves as a good candidate to examine the complex question: can hedging be positively linked to firm value? More widely, aviation is a relatively homogenous industry by nature and, fuel which is highly correlated with Brent Crude Oil prices, constitutes one of the highest input costs for all airlines. Moreover, oil is on average more volatile than foreign exchange fluctuations.

Other reasons why aviation is an interesting industry to examine the research question is due to the fact that airlines are at the same relative footing when it comes to cost structure (despite the LCC and legacy carrier models which we control for). For instance, airlines typically operate similar or identical aircraft manufactured by the so-called 'Boeing-Airbus duopoly', jets are relatively similar in structure and design, and, the industry cost exposure to oil fluctuations is similar for every major airline. This is evident in previous studies focusing on the economics in the global aviation market, and in particular the work of Carter et al (2004), who focused their research question on a time when the industry was similar. Since their study, the industry homogeneity has remained relatively similar in terms of the pace of innovation and other factors that could be a concern for endogeneity. However, it has to be recognised that there is a clear disparity in business and operating models that has widened more recently. I.e. the rise of growth-focused younger entrants, such as the low-cost carriers (LCC) Ryanair and easyJet for example have dramatically challenged competition in more recent years. Therefore, to account for such difference, this thesis will aim to address the question for global legacy carriers and LCC carriers separately.

The benefits of choosing an industry that shares similar cost structure airline to airline serves as a good base to hypothesise the question. This is because if there were any benefits of hedging as authors in this field of corporate finance have long-been debating, then they would arguably be enjoyed by an industry that faces such a significant amount of risk to fluctuating cost exposure.

Chapter II

Background

In order to examine the question, it is important to initiate the paper with some industrial context of the aviation industry that has explained the more recent increase in hedging activity of airlines. Firstly, the global aviation industry has undergone significant structural change in the previous fifty years. State-owned carriers, referred to as 'legacy airlines' in this paper, originally dominated the global aviation industry. Governments decided how many airlines flew between countries (usually only one flag carrier), the number of flights, and the level of fare too. Airport slots were zealously guarded by the legacy carriers, therefore preventing any new entrants, thus supressing competition and restricting choices for consumers. Since the global deregulation and privatisation of airlines, the industry has seen the rise of the insurgent and disruptive low-cost carriers. The market has rapidly become more competitive and evolved with real vigour and dynamism; expanding access to travel for all consumers through lower fares, increased destinations and indeed higher frequencies. This in turn has supported the global economy through the exponential growth in mobility, enhanced trade, the movement of skills, and increasing tourism (Davies, 2015).

The rise of privatised legacy airlines and new low-cost carriers entering the market, placed particular cost-pressure on airlines competing with lower fares and the renewed incentive to generate profit. LCCs have grown in size and scale, competing directly with the traditional legacy carriers on short-haul networks and thus driving increased competition. The LCC business model lends itself to a relentless focus on cost, high asset utilization and increased scale in order to drive lower fares and remain competitive. This wave of competition has served to increase consumer surplus through lower prices and more choices, but it has also evidentially made it more challenging for traditional incumbents to survive. Legacy airlines have typically been entrenched with higher labour costs, unionisation and administrative complexity surrounding their operating model.

Competition, and increased cost-pressures have consequently placed airlines to be more disciplined and prudential with their cost-base. In a setting whereby price competition is a large determinant to the success of an airline, low-margins and profitability remain the focus of most major airlines. In particular, oil accounts for on average 30-40% of an airline operating expense, often representing the largest input cost into the running of an airline. Given that oil is one of the largest and most volatile commodities globally but is particularly sensitive to macroeconomic and geopolitical uncertainties, it poses a particular risk for the financial health of airlines in times of volatility (European Commission, 2018).

Figure I. (below), displays the operating expenses of American Airlines which typically hedges a minority share of its fuel consumption, in two significant periods of our sample. The financial year of 2012 experienced the peak of oil in our sample of $132.83/barrel, reflecting an expense of 38% for American Airlines of total operating expenses. Whereas, compared to 2016, the space of just four years (and indeed many fluctuations in between), oil reached its lowest in January at $29.78/barrel accounting for only 15.42%. During this time, fuel consumption for the airline remained relatively stable, however, the two panels below show the large swings in fuel prices and therefore how one business that remains similarly structured is exposed to such cost exposure to external forces.

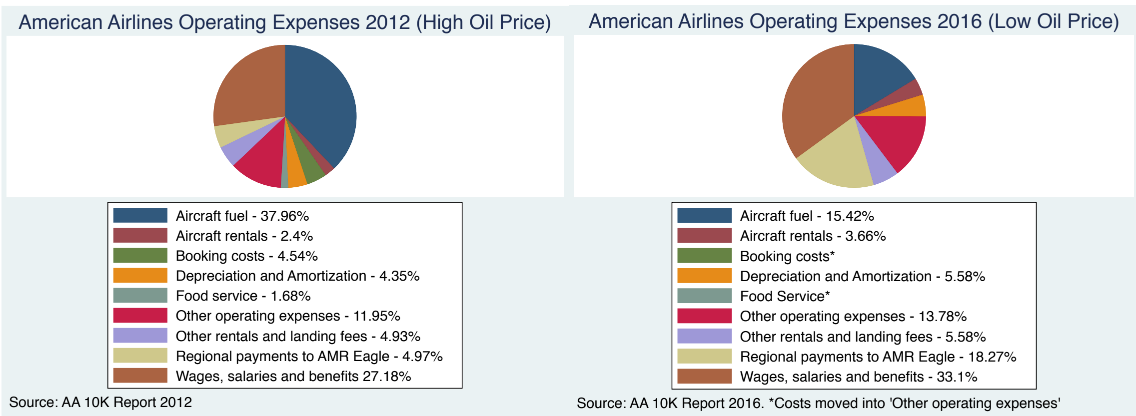

Figure I. – American Airlines Operating Expenses 2012 (L), 2016 (R); American Airlines

Here, we look at one airline arbitrarily during a time of a peak and trough of global oil prices. To further this, the story of significant cost (around 30-40% on average) is also true industry wide as *Figure II.* demonstrates. This significant cost that remains unpredictable by nature, places the decision-making agents of the airlines into a precarious world of either second-guessing and predicting the future, or, as the airlines in this study presents: adopt a hedging strategy.

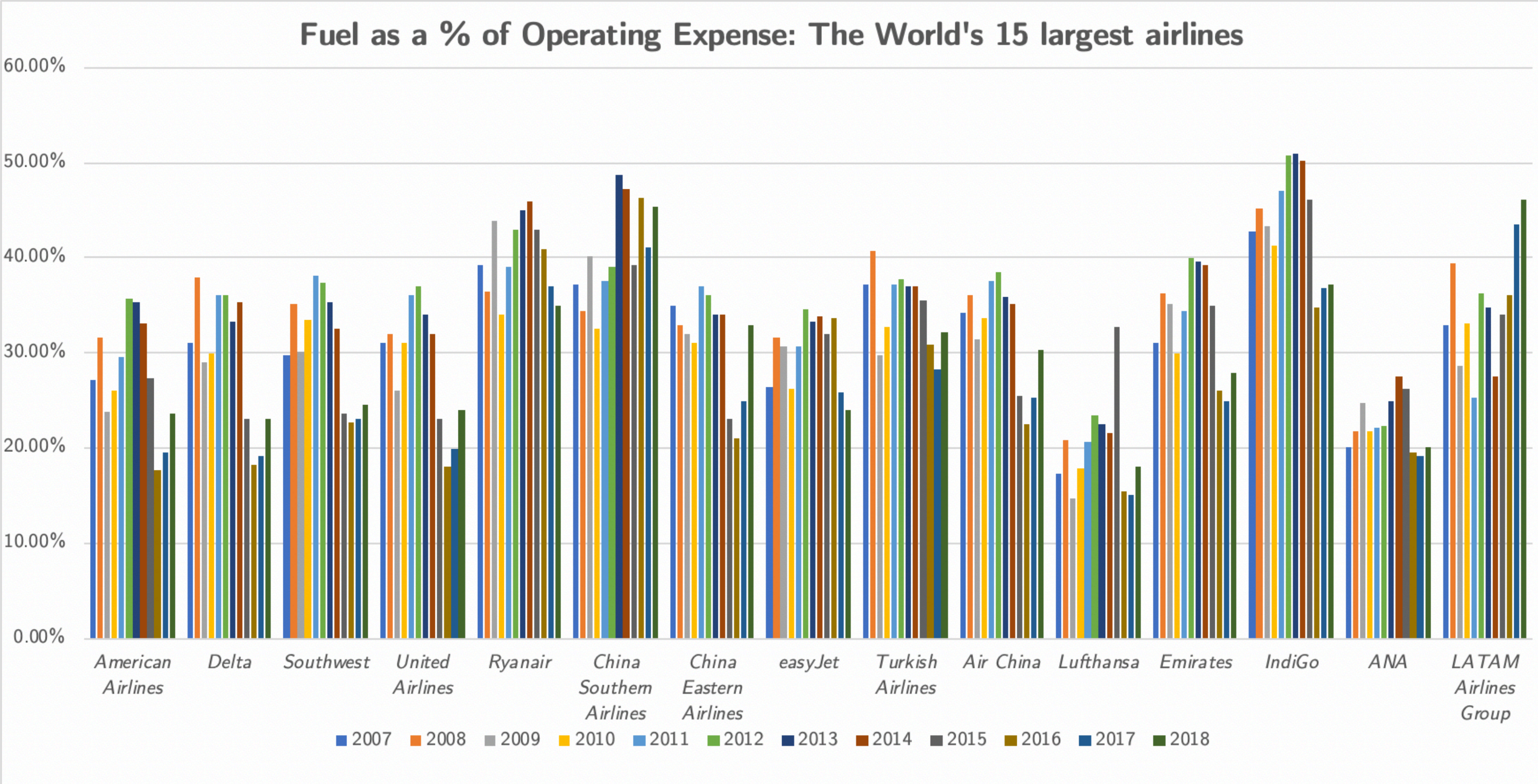

Figure II. – Graph of Fuel as a Percentage of Operating Expense for the World's 15 Largest Airlines

The above graph highlights the percentage of Jet Fuel expense as a share of total operating expense for the World's 15 largest airlines (ordered in size of passenger numbers left to right). The exact composition of jet fuel to operating expense from 2008-2018 is detailed in the appendix. All airlines in the above sample exercise jet fuel hedging apart from: China Southern, IndiGo and Emirates. Data sourced from annual reports and accounts (10-K) of each airline.

The aviation market is a good candidate to examine this complex question as it is relatively homogenous given the fact that the single biggest cost for airlines is usually oil and that airlines are particularly exposed to such volatility. And moreover, airlines exercising hedging as a financial instrument, can therefore allow the hypothesis to be examined in a more recent setting: Does Jet Fuel Hedging Impact Firm's Value in the Aviation Industry?

In this thesis we put forth the framework published by Carter et al (2004), and with the extension of a more recent time period (2008-2018). This in turn displays a period of increased fluctuations and volatility in the oil price presenting significant challenges to the industry. In addition, we take the study on a different path by examining the more prevalent phenomenon of low-cost aviation separately to a legacy carrier sample. Therefore, we incorporate this industrial structural change by allowing for a separate sample of legacy and LCC airlines into our statistical observation. This, we believe is crucial in examining the question given that our sample size is limited due to the structure of the market size, and that we observe the causal effect of the determinants of *Tobin's Q* (firm value).

Motivation

The purpose of researching this field of economics, and more particularly, corporate risk management in the form of hedging adds a further insight into how organisations can better manage and mitigate exogenous risk placed on to the business. In an uncertain world, with many geopolitical and macroeconomic factors that are continuously dynamic and unpredictable, understanding whether there is value behind such practices is an important determinant in unravelling whether risk management can generate greater commercial certainty.

Risk remains an inherent factor of life and therefore as humans, we continuously aim to mitigate our exposure to risk which is detrimental to our welfare and serves no reward. Businesses and organisations represent nothing more or less than a collection of people. By default, businesses – like people – have principles as a means to avoid unnecessary risk to adapt and survive.

Corporate risk management's origin dates back to as far as the Egyptian times in the context of agricultural farming. Archives show how pharaohs predicted a poor yield of corn would purchase and store additional corn crops from better harvests to ensure they had sufficient supplies available upon harvest. Essentially, this way of balancing crop supplies stabilises the uncontrollable factors — in this case, poor weather leading to a suboptimal yield — factor and ensures that supplies are met (Froot et al, 1994).

Forward markets formed in the Middle Ages, whereby consumers set an agreement with farmers to no longer have to buy up stock in-advance, but in fact agree on a secured future price. It both benefitted the consumer, who can internalise the confirmed future cost, and the farmer through a more stable cash flow. Taking this history to the industrialised world of today and to the context of aviation, airlines that buy fuel in advance can benefit from the fact that they can plan ahead with a set future cost knowing it will not either increase or decrease. In addition, fuel providers, i.e. Air BP, Shell, Exxon Mobil etc., have the certainty of agreed future revenue too, therefore mitigating the cost exposure for both parties.

While the arguments have remained clear for consumers benefiting from hedging, understanding the benefits for large businesses is more complicated. Many investors own a large portfolio of shares in different companies and equities relative to that individual's personal aptitude to risk. As a result, the investor is in control of managing risk to suit an individual preference, rather than a corporation bearing that responsibility too. This view has often been why corporate risk management until the 1970s has been only briefly explored. After this period, a new wave of risk management solutions appeared in the form of mathematical financial modelling. Most famously, the work of Black and Scholes' (1994) option pricing models saw the birth of widely used financial derivatives and hedging instruments for non-financial corporations. This new method of risk management placed a greater emphasis on the mutually beneficial relationship for two parties securing more stable, medium-term futures by agreeing set prices via 'hedging'.

Chapter III

Literature Review

In this body of literature of corporate finance, many studies have assessed the impact of hedging behaviour on firms in the financial sector - often arguing that firm value can be increased through hedging. The research into the hedging activity of a non-financial firm, specifically an airline, is relatively sparse. It serves as an interesting industry to examine such a question given its cost structure and the findings reported in the previous literature, particularly that of Carter et al 2004.

Early literature on hedging being used as a tool to reduce financial distress and thus positively influence firm value included an article published by Smith et al (1985). They construed that hedging may significantly decrease the likelihood of bankruptcy through generating a more stable cashflow, and therefore enable the business to better *buffer* against the repercussions of cost volatility placed onto the firm. See graph in Appendix, Figure I, for the theoretical decrease in bankruptcy costs. Further on, Stulz (1996) studied the value hedging may have for firms that are already financially constrained, highlighting that such firms typically underinvest capital in worthy projects due to the burdensome cost of debt.

Furthermore, Froot et al (1993) extended the aforementioned literature by investigating the issue of underinvestment, and how firms that engage in effective hedging activity can remedy the under-capitalization problem and the financial repercussions that follow. They argue that firms facing financial constraints are heavily reliant on leveraging from outside sources due to low cashflow and facing increased financial distress costs. Hedging can serve as a way of generating cashflow stability by reducing the dependency of a firm taking excessive debt and therefore being plagued with the underinvestment problem. An interesting element of their research highlights that firms who were able to hedge effectively were better positioned to manage cashflows, therefore stimulating investment, thus driving an increase in firm's value. In addition, the theory states that if firms practice hedging during a downturn or commodity shock it can not only better manage its own cashflow and invest internally but can also take advantage of a struggling competitor's assets who failed to effectively hedge, or hedge at all.

Thus, those participating in hedging could acquire assets at below-market rates and generate an increase in firm value. Froot et al (1993) highlights two key dimensions of hedging: (1) the business alleviates the underinvestment and deadweight cost of debt, and (2) during a shock, the firm that exercises hedging can acquire further assets due to its more stable, positive cashflow it enjoys. However, Tufano (1998) argued that hedging could cause an agency cost issue and inevitably harm firm value. Managers may behave in self-interested ways that could conflict the long-term financial health of the firm through taking higher risk strategies, with high payoffs for financial success. And, during times of failure, he argues that blame is quickly shifted on the 'uncontrollable' market forces which coincides with financial distress rather than the acumen of the firm's management. In summary, Tufano critiques that there might be other costs that are omitted from the model presented by Foot et al (1993).

In this field of research there is sparse empirical evidence identifying that hedging can be used as a tool to increase firm value. Given this shortcoming, only few empirical papers that are published have tried to overcome this. Allayannis et al (2001), studied the relationship between hedging activity and firm value for non-financial firms in the United States. They identify a positive causal relationship between hedging and firm value (*Tobin's Q*), therefore drawing the relationship that an increase in firm value may be attributed to hedging, ceteris paribus. One potential pitfall of their study, recognised by Carter et al (2004), is that they fail to examine the different levels of hedging by firms and the period in which the hedging was valid. Further on, Jin et al (2004) critiqued the work of Allayannis further by saying that the causal relationship interpreted was due to the failure to remedy potential endogeneity concerns.

Carter et al (2004) subscribed to the similar methodology of Allayannis et al (2001) in examining the relationship between jet fuel hedging by airlines in the US airline industry and the *Tobin's Q* (firm value) of each airline. Their interpretations and findings support the previous study of Allayannis et al (2001) and highlight a stronger relationship between fuel hedging and firm value.

Chapter IV

Theoretical Framework

Since the inception of the literature, this region of corporate finance is primarily based on the assumptions of a frictionless Franco Modigliani and Merton Miller (1958) world. Their guiding premise, often referred to as the *capital structure irrelevance theorem*, is argued that the value of the firm – in our case proxied by *Tobin's Q* – is not affected by the capital structure of the firm. These assumptions being: zero taxes and transaction costs; no bankruptcy costs, and; no information asymmetry. Given that these assumptions are based on no market frictions and imperfections, firms are therefore not required to mitigate risk and investors can attain a desirable level of risk through the diversification of their own asset holding portfolio. For instance, shareholders of an airline can counter the risk of high kerosene price by holding shares in petroleum companies, therefore the purpose of hedging is unnecessary in a frictionless, Modigliani and Miller world. Since the work of Modigliani and Miller, other studies have aimed to rationalise the hedging behaviour of firms through the optimisation of both tax shields and tax volatility. Thence, mitigating endogenous firm-level risk (i.e. minimising financial distress placed onto the business), and through minimising agency costs and agent risk-aversion which therefore remedies the potential underinvestment problem (Smith and Stulz, 1985).

The academic literature which has been interested in gauging empirical insight into these theoretical arguments by analysing the direct effect between the hedging and firm value—in particular, for non-financial firms such as Airlines—is relatively embryonic. The previous literature of Allayannis et al (2001) and Carter et al (2004) put pause to these assumptions set out by Modigliani and Miller, arguing that they are not entirely consistent due to there being frictions present in the market, and thus, firm value is in turn impacted by the hedging position of firm. To examine the question deeply, we recognise that the firm is exposed to market risk, frictions and indeed the imperfections previously outlined by the literature.

In this paper, we aim to revisit the research question by examining the impact of hedging activity by a total of thirty airlines which hedge to smooth the volatility of sudden and unpredictable increases in fuel prices for the years 2008-2018. The rationale of hedging activity influencing the value of the firm is driven by two principles: (1) hedging provides airlines with the ability to '*smooth*' the volatility in cost-exposure to its single biggest input cost, oil and in turn profitability; (2) the positive and more stable cashflow associated with hedging allows firms to plan ahead, price ahead, and therefore mitigates the underinvestment problem. In particular, a more stable cashflow allows the firm to reduce the likelihood of financial distress and, acquire assets therefore furthering increasing its firm value.

Therefore, reducing the exposure to sharp and sudden increases in oil prices through hedging is attributed to an increase the firm's stock value. The majority of major airlines practice hedging their fuel requirements as a means to mitigate these volatilities, even though there lays a risk of over-paying the market price with a hedging contract. Froot et al (1993) further consolidates this proposition by arguing that hedging allows firms to deal with the underinvestment problem and therefore have sufficient cash to acquire assets in times of financial distress, i.e. given a market shock, weaker firms may collapse and under-price their assets upon liquidation, therefore allowing a more financially stable incumbent airline that benefited from hedging to acquire their assets at a discounted rate. Hedging therefore presents firms with the advantage of financial stability over a non-hedged firm.

Classic investment theory has argued that investors minimise risk by holding a large and sufficient portfolio of many firms to effectively diversify idiosyncratic risk and are therefore more naturally positioned to be able to effectively reduce risk than an airline. Further on, hedging is still thought to be an effective means of risk management for firms as it allows for enhanced cashflow stability and a longer horizon for managers to take more effective and judicious pricing decisions, which in turn promotes a more stable cash flow. In addition, given the theory argues that hedging in times of high commodity prices allows firms to reduce financial distress costs. It would be unreasonable to assume that every investment decision to buy stocks in airlines is based on the hedging level of the firm. However, hedging serves more of a means to mitigate the cost exposure for airlines and therefore through increasing the financial agility for the airline in times whereby a higher oil price would have negative repercussions on other financials. Hedging activity can therefore be viewed as an indirect variable that generates more stable financials which investors would otherwise base their decisions on.

Chapter V

Hypothesis

In line with the previous literature of hedging and firm value, the dependent variable used to proxy firm value is the natural logarithm of *Tobin's Q*. The metric is a measure for the changes in the size of the firm (through its assets) and, the market pricing of the firm through its capitalization and the perceived value of shares (see formula for *Tobin's Q* in Appendix G).

As expected, in terms of hedging activity being related to the share price of airlines, Carter et al (2004) found no real effect between these. Airlines report their hedging strategies in their annual report outlining the risk mitigation strategies undertaken by the senior executive board; therefore, while this data is obtainable for investors it may not necessarily be the direct motivator for holding shares. However, as previously mentioned in Chapter IV, hedging is more of an indirect variable that supports stronger financials i.e. through a more positive cashflow. Indeed, these are precisely the findings in the work of Carter et al (2004); evidencing that airlines that engage in hedging activity have a stronger positive cash flow on average, both increasing the ability of the firm to acquire further assets and alleviate the underinvestment problem. However, Allayannis et al (2001) found evidence that hedging activity does increase the median firm value for non-financial firms more generally. Our hypothesis endorses that of the previous literature, being that hedging may increase firm value through providing increased business certainty, more measured and insightful planning (particularly of that regarding future pricing decisions), and thus more stable cashflow.

Therefore, the assumption being that the majority of investors tend to be more risk-averse in their decision making by purchasing and holding shares that offer greater financial stability and consistent returns, particularly given the volatility in today's world. This is consistent with the previous literature identified in Chapter IV, where the hedging position tends to increase financial stability of the firm.

Furthermore, the work of Allayannis et al (2001) estimates that firms tend to increase their hedging premiums in periods of volatility and prolonged uncertainty. For instance, they capture the effect that firms tend to hedge more of the foreign exchange in a period of an appreciation of the US dollar and tend to reduce their hedging in times of depreciation. Airlines on the other hand, tend to take a more judicious approach to hedging with respect to the market conditions and more broadly use hedging not just as a means to reduce the cost of oil but moreover to smooth the volatility that is argued to be highly detrimental to their cashflow.

An additional part to consider is that oil prices and kerosene are indeed linked and follow the same relationship. And that the work of Allayannis et al (2001) and Carter et al (2004) was conducted using a sample of fifteen airlines from 1990 to 2000. During their sample, the global crude oil prices were more stable compared with the more recent sample this paper uses data from 2008 to 2018.

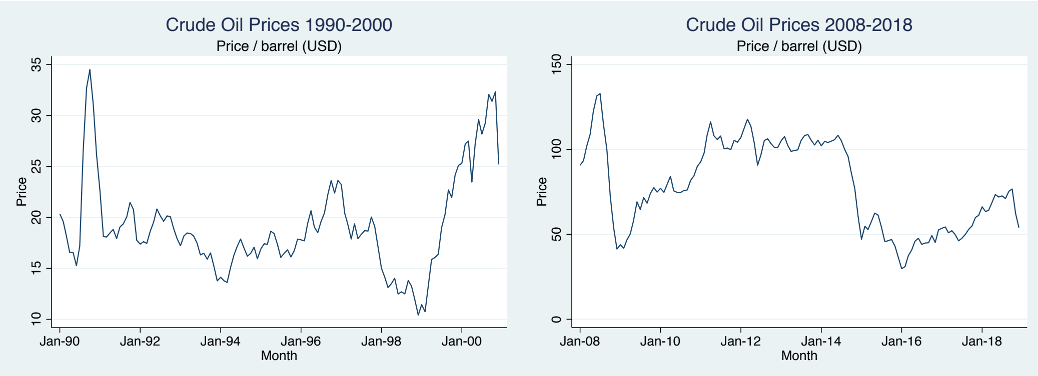

Figure III. – Crude Oil Prices 1990-2000 (L) and, 2008-2018 (R); World Bank (2018)

From the above, it can be seen that during the more recent sample we use there is significantly more increased volatility in the global oil prices between 2008-2018. The maximum price being $132.83/barrel in July 2008 and the lowest being $29.78/barrel in January 2016, with a standard deviation of 25.58. In contrast, the study by Carter et al (2004) sampled data between 1990-2000 where oil prices were relatively more stable. The maximum price being $34.5/barrel in October 1991 and lowest price being $10.41/barrel in December 1998, with a standard deviation of 4.74 (Appendix F).

This therefore allows us to revisit the research question and outcomes of Carter et al (2004) and apply them to a more recent, and volatile setting.

Our hypothesis for the main research question is:

Null hypothesis: hedging does not increase the *Tobin's Q* of an airline;
Alternative hypothesis: hedging does increase the *Tobin's Q* of an airline.

Following the analysis of the world's fifteen largest *legacy* airlines that engage in hedging activity, a further sub-research question will apply to the world's fifteen largest low-cost carriers (LCCs). Therefore, forming the second hypothesis which is:

Null hypothesis: hedging does not increase the *Tobin's Q* of LCC airlines;
Alternative hypothesis: hedging does increase the *Tobin's Q* of LCC airlines.

Chapter VI

Methodology

In this chapter, we outline the methodological approach used in this thesis. The scope of this thesis is based on deductive methodology, whereby the hypotheses — in this case, the work of Allayannis et al (2001) and Carter et al (2004) — are based on previous literature (Wilson, 2010). Given that the literature in this field is quantitative and statistically based, it therefore prompts the thesis' research strategy to be geared toward the same quantitate format.

These quantitative approaches place a focus on the measurement and analysis of the causal channels between variables to examine the research question with more depth and perspective. The paper will therefore use several research approaches, in the style of Carter et al (2004) to help remedy the potential endogeneity concerns a question such as ours poses. These approaches include, a balanced panelled dataset of regressions formed by four frameworks: OLS as a 'naïve comparison' to base on, then a fixed effects model to control for uncaptured time-invariant effects that could plague our estimates, then, go on to run the sample through a FGLS (*Feasible Generalised Least Squares*) to control for potential heteroskedasticity.

In reality there are many determinants both observed and unobserved in determining the true causal relationship between a variable of interest. Therefore, it is important to recognise that with this particular research question, we are faced with the challenge of endogeneity and causality. The theoretical framework chapter is supplemented with previous authors' empirical findings. This, we believe to be crucial in building our argument, for two reasons. First, as this thesis revisits the theory and empiricism of the work of previous authors, and for us to reach an objective conclusion based on theory and data it is important to compare and contrast our findings with that of their study and sample. Second, the findings in this field of hedging study are inconclusive and it therefore only seems appropriate to include the relevant discussions and findings of others into our analysis.

The econometric specification is based on that of Carter et al (2004), examining fifteen airlines over a ten-year span. The specification includes two separate samples: but with a distinction of the world's fifteen largest legacy/traditional airlines, and a separate sample of the world's fifteen largest low-cost carriers. As previously identified, the aviation market has remained relatively homogenous in terms of business models, until the more recent post-2000s proliferation of low-cost carriers that have rapidly grown at the expense of the traditional, more mature airlines. It is important, in our view, that a distinction is made between these two samples as it not only addresses the potential for endogeneity issues that could be present in more recent times, but it also allows for us to deal with the fact that the market dynamics are no longer as homogenous as they may have been. These factors could all, in turn, influence the causal effect, and indeed, allow us to reveal the efficacy of hedging activity for airlines that face lower margins, such as low-cost carriers.

To maximise the sample size, we use quarterly panel data of each airline collected from reliable financial sources such as the 10-K annual reports of each airline, consolidated financial accounts, and for the ratios, we obtain data from a trusted database, YCharts. For an airline to be in the sample it had to be meet several requirements as per the prerequisites to be included in the work of previous literature. This includes, having consistent and obtainable data, have published and trusted audited accounts, and, to report their financials in adjusted constant currency of USD. These are crucial in ensuring the risk of measurement error as a source of endogeneity concerns are minimised and practically eliminated. Furthermore, airlines that fitted the requirements of the sample were selected in order of size. Again, size of an airline is important to ensure that the dataset reflects a sample that is relatively more homogenous.

As airlines hedge to reduce the exposure to sharp and sudden increases of jet fuel to mitigate cost exposure, the larger airlines in this sample all declare hedging as a means of managing risk exposure and enabling the business to plan ahead and internalise future costs. Rather, some smaller and medium sized airlines have been accused of using hedging as a way of gambling the fortunes of an airline and therefore jeopardising firm value, as a means to 'bet' on a price which in fact turns out to be much higher than the market price. Indeed, this concern could still apply in principle to larger airlines too, and it has done by shareholders and some academics in the past; however, each airline transparently publishes their hedging strategy and their motivations of such a strategy. Rather, selecting larger airlines, mitigates the potential risk that agents who run the airline are not using hedging as an arbitrary means to gamble and take risks on shorting as some investor behaviour illustrates, but moreover, it is argued in the *derivatives and instruments* section as a means to 'increase the predictability of cash flows and profitability' (IAG-British Airways, 2020).

Other examples remain consistent across the industry; showing little difference in the motivations of practicing jet fuel hedging between the legacy carriers and low-cost carriers. Each major airline investing in such a derivative strategy to mitigate the effects of oil exposure – regardless of the oil price.

"easyJet operates under a clear set of treasury policies agreed by the Board. The aim of easyJet's hedging policy is to reduce short term earnings volatility and therefore the Company hedges forward, on a rolling basis, between 50% and 80% of the next 12 months anticipated requirements and between 20% and 50% of the following 12 months anticipated requirements."

easyJet plc Annual Report (2016)

It is also argued by other academics that airlines which are larger in size are better positioned to use a range of derivative instruments due to the financial costs, expertise and proficiencies required to form a strategy and ultimately execute it (Carter et al, 2004). Typically, larger firms are more endowed with skills, infrastructure and the experience that is needed to form such strategies as an oppose to smaller regional airlines that either lack a robust hedging strategy or do not have the bargaining power to secure lucrative options. This therefore builds the argument for including the airlines in our sample – like that of Carter et al (2004).

Chapter VII

Research Design

Econometric Specification

A longitudinal panel data set is used with quarterly data, allowing data to be observed cross sectionally with airlines, and in time-series (quarters, years). The use of quarters, instead of years, is used to increase the overall sample size and number of observations. Quarterly data was more readily available for us, so hence we use it. The specification is given as:

(1) OLS and FGLS models:

$$TobinsQ_{it} = \alpha + \beta 1 lnAssets_{it} + \beta 2 Dividend_{it} + \beta 3 DebttoAssets_{it} + \beta 4 CashflowtoSales_{it} + \beta 5 CapextoSales_{it} + \beta 6 ZScore_{it} + \beta 7 CreditRating_{it} + \beta 8 AdvertisingtoSales_{it} + \beta 9 Hedging\%_{it} + \varepsilon_{it}$$

(2) Within (Fixed Effects) model:

$$TobinsQ_{it} = \alpha + \beta 1 lnAssets_{it} + \beta 2 Dividend_{it} + \beta 3 DebttoAssets_{it} + \beta 4 CashflowtoSales_{it} + \beta 5 CapextoSales_{it} + \beta 6 ZScore_{it} + \beta 7 CreditRating_{it} + \beta 8 AdvertisingtoSales_{it} + \beta 9 Hedging\%_{it} + \chi_t + \varepsilon_{it}$$

Where:

i = airline, t = quarter (based on Carter et al 2004), ε_{it} *= error term*

Variable	Definition
Tobin's Q**$_{it}$,**	Airline's *Tobin Q* statistic;
lnAssets**$_{it}$,**	The natural log of *total assets* for each individual airline;
Dividend dummy**$_{it}$,**	1, if the *i* issues dividends in *t*;
Debt to Assets**$_{it}$,**	ratio of Debt to Assets for firm;
Cashflow to Sales**$_{it}$,**	ratio of Cashflow to Sales for firm;
Capex to Sales**$_{it}$,**	ratio of Capital Expenditure (Capex) to Sales ratio;
Z Score**$_{it}$,**	Altman's Z Score (0 – 4), (close to zero being distress, 1.8-3 being moderate, and 3.1-4 being regarded safe);

Credit Rating$_{it}$	Credit Rating 0-100 of airline, issued by S&P or Moodys;
Advertising to sales$_{it}$,	share of Marketing Expenses to revenue ratio;
Hedging$_{it}$,	the amount of future (next year's) annual fuel requirements are hedged as a total of all fuel (%) consumed by the airline

Variables

To build an econometric specification that is both robust and deals with potential endogeneity concerns, the specification identifies and controls for the variables which previous authors have used. As part of the identification strategy, we control for a range of independent variables in our models to estimate the causal channel hedging has on our dependent variable, Tobin's Q.

Dependent Variable: lnTobin's Q

Natural log of Tobin's Q is a proxy for firm value and the level of investment (Carter et al, 2004). *Equation* 1.0, *Chapter* VII, outlines the components of the equation. Authors in the field of hedging literature typically proxy firm value using Tobin's Q which was formed by Chung and Pruitt. The formula being outlined in Appendix G.

The *Tobin's Q* statistic reflects the valuation of the firm. A Q value < 1 indicates an undervaluation of the firm value relative to the true asset value. Conversely, a Q value > 1, indicates that the market valuation of the firm (relative to its netbook value of its assets) is overvalued. The theory behind proxying firm value using *Tobin's Q* is driven by the reasons outlined in the literature of Allayannis et al (2001), noting, that *'profitable firm's tend to trade at a premium on average, (...) thus if hedgers are more profitable then will have a larger Tobin's Q metric'.*

Independent Variables:

Ln(TotalAssets) is used to control for the size of the firm. Previous hedging literature and studies show that firms that have higher total assets are more likely to engage in hedging activities (Nance and Mian, 1993). This is due to the high costs associated with procuring a comprehensive strategy, compared to smaller firms that are relatively less endowed. The natural log of total assets can behave as an inverse measure of bankruptcy costs, therefore being negatively related to firm value (Carter et al, 2004). Allayannis et al (2001) and Carter et al (2004) and this paper identifies a negative relationship between *total assets* and *Tobin's Q*.

Profitability measures, such as *revenue* and *net income*, control for the drivers that may influence an increase in the *Tobin's Q* metric. For example, increases in revenue and net income may signal to investors that the financial health of the airline is increasing, and thus we have a higher firm valuation. Naturally, we expect that net income and revenue to usually increase hand in hand, this may give us the concern for some heteroskedasticity in the model, so we measure the robustness of our results through the Feasible Generalised Least Square (FGLS) regression.

Indeed, there is scope for some endogeneity concern controlling for such a concern, such as a potential multicollinearity issue in this variable as we may expect hedging and total assets to increase hand in hand, this is why we use the Feasible Generalised Least Square (FGLS) regression to deal with the potential for heteroskedasticity. Additionally, post-estimation variance inflation tests are carried out in Appendix C to satisfy such concerns.

The *Altman's Z-Score* and *Credit rating* explanatory variables are used to capture the credit quality of airlines. Investors use credit quality and bankruptcy indicators set independently by Moody's and S&P corporate debt tiers as an indicator of the bankruptcy probability of a business. These measures range from 5-100, and the highest indicating the most financially agile 'AAA' and thus the minimum credit risk, with the conversely weakest at the lowest of the range '5', CAA/D (Moody's/S&P respectively). These are important to capture as they indicate a reflection of corporate strategy, and proxy for risk which in turn is positively related to the way the market views the firm. The ratings are not to be directly attributed to the hedging position of the firm, but moreover, the overall financial health of the firm, this therefore may be indirectly linked to hedging position through the financial benefits of hedging. In our sample the range was between 35-80 (Appendix D).

As a control for liquidity, *free cash flow to sales* is used to capture how the cash liquidity of the airline could affect the firm value and therefore the exposure to financial distress and bankruptcy.

Further on, we control for *Return on Assets*, which essentially is the Net Income of the airline per quarter/Total Assets. This is used in line with the previous literature as a proxy for profitability as profit margins are notoriously low for airlines in the industry. Carter et al (2004) did not include such variable in their final model as they believed given the low profit margins for the industry it would not have an effect on firm value. However, Jin and Jorion (2006) included these variables as a check, but in line with their findings we noted no significance of such variable. Similarly, in our specification we control such variables as the industry dynamics have changed in a way whereby investors may be more motivated by direct profitability indicators, such as ROA and Net Income.

Dividends are used to control for the fact that in some years, and quarters the firm issues ordinary shares or special dividends that could influence firm value.
And finally, our variable of interest is the annual *Fuel Hedging % requirement* for each airline in our sample. The data for this variable was obtained from the annual reports and accounts of each airline. Usually, each airline explicitly reports the percentage of fuel requirements that are hedged and publishes its hedging strategy under its principle risk management strategy. In some cases, airlines were not explicit in publishing this figure, however the data was still obtainable as the airline publishes its aggregate annual fuel consumption and the amount (in gallons) of fuel is hedged. To deal with this, we therefore calculated the fuel hedging requirement by dividing these values.

The panel dataset enables us to view the data in two aspects: cross sectionally (i.e. airlines), and with the time series (i.e. quarters and years). The purpose of dealing with the data in such a way enables greater sample variability and, while enabling both improved variability in the sample and greater degrees of freedom. In essence, this generates results with increased reliability when inferring our estimates given the model parameters.

The next chapter goes on to discuss the potential endogeneity concerns that may be associated with such a specification. We embed the same specification similar to that of Carter et al (2004), while highlighting the concerns and the necessary robustness steps to remedy such concerns.

Chapter VIII

Discussion

Before we run our empirical specification, it is important to discuss and acknowledge the potential limitations thus far in the thesis and indeed the literature. Firstly, the aviation industry has become increasingly more consolidated. This therefore limits the sample size to the same estimation of Carter et al (2004) of only 15 airlines per sample. While we managed to scrape data for 15 of the largest airlines that are low-cost, the overall sample size is 30. This is considered low; however, this remains a limitation of the airline industry in empirical studies more broadly. Given this low number, it makes it difficult to effectively exploit random assignment, control for potential selection bias and indeed, to have a sufficient counterfactual that enables us to effectively estimate the 'true' causal channel that hedging has on firm value.

Indeed, in the reality of the aviation industry the overall ideal experiment is difficult to design; as have the previous authors struggled to effectively unravel. Randomising all global airlines and assigning a 'coin-toss' for fuel hedging (Heads, do not hedge, and Tails, hedge 50% of fuel) over a long period capturing volatile and less volatile times could present an effective solution to uncovering the true causal effect. In particular, those idiosyncratic firm-level characteristics, which in fairness could be biasing our Beta.1 (Fuel Hedging) coefficient and that of the previous authors, may be balanced out over a longer time period and through a large-scale random assignment. However, we are yet to convince the shareholders and management teams of all the major airlines to adopt such a precarious strategy—and indeed, we may observe some bankruptcies in such an experiment!

Given the costly impracticalities around operationalising such an ideal experiment, it is important that we make full use of the inexpensive data that is available to us today. We therefore use the same framework as Carter et al (2004) but use quarterly data to increase the number of observations. In addition, some airlines have been omitted from the sample due to inconsistent reporting of information related to our specification.

Using global airlines that reflect similar structures, i.e. flag carriers versus low-cost carriers are important when examining the question. As Carter et al (2004) did not distinguish the two mainly due to the fact that low-cost aviation was rather sub-scale in its 1990-2000 sample, we included the distinction of such different carriers to mitigate the specific effects which are linked to carriers.

Similar to the previous literature in this field, I have focused my research efforts toward the specific field of jet-fuel hedging affecting firm value. This is because jet-fuel is the largest single commodity input to the running of an airline. The study does not focus on other forms of derivatives such as currency and interest rate hedging. In addition, due to the data not being complete and obtainable, we could not control for the specific form of derivative usage (i.e. future or forward contract, option etc.) again, this remains consistent with the previous literature.

A more relevant example to the 2020 Covid-19 pandemic (of which future studies may wish to include), is the amount of state-funding legacy carriers receive, or control for those that have access to state-funding, which could in turn influence the firm value. Lufthansa currently received 9 billion Euros (May 2020) from the German government as a means to prevent financial insolvency, KLM (Royal Dutch Airlines) received 2 billion Euros as well as constant payroll support from the Dutch government (Financial Times, 2020). However, this access to funds in times of financial distress could enable investors to view the airline as lower risk compared to other airlines such as American Airlines or British Airways (IAG) that do not receive any state support. Therefore, while this limitation is present only in legacy carriers globally receiving ‘state-aid’ in times of financial distress, low-cost airlines have not received such support. Therefore, in our sample we controlled for legacy and low-cost due to these unobserved factors; however, further research efforts could control for airline-specific factors that may enable further precision in estimating the true causal effect in relation to these.

In the interests of multicollinearity, some variables were omitted from the sample that Carter et al (2004) included due to some intercorrelations among the explanatory variables which is expected in some capacity given there being many controls. These variables were dropped once a Variance in Inflation (VIF) multicollinearity test was conducted (see Appendix C), and therefore satisfied the rule-of-thumb requirements of being less than five. Removing such variables did not adjust the coefficients and results, only in some cases relating to some variables there were negligible differences that did not compromise statistical significance at any point. VIF tests were conducted for each pooled OLS model and results for these are published in the appendix.

Chapter IX

Estimation of Results

Table 1: Estimation of Tobin's Q (Firm Value) and Hedging Activity

This table summarizes the regression output of the two presented models: (B.) 15 Legacy Airlines 'Legacy' that engage in hedging activity and (A.) 15 Low Cost Carriers ('LCC') that engage in hedging activity. The dependent variable is firm value which is proxied by the natural logarithm of Tobin's Q. Each model incorporates other determinants that may affect firm value (see specification). The Pooled OLS (Model 1) are estimated using the robust standard errors. Model 2 uses Fixed Effects and Model 3 uses Feasible Generalized Least Squares (FGLS) with heteroskedasticity consistent standard errors. Statistical significance reported at 10% (***), 5% (**) and 1% (*) levels.

	A. LCC			B. Legacy		
	Model 1a: Pooled OLS	**Model 2a: Fixed Effects**	**Model 3a: FGLS**	**Model 1b: Pooled OLS**	**Model 2b: Fixed Effects**	**Model 3b: FGLS**
Fuel-price-Hedging-(%)	0.0430***	0.1069***	0.0430***	0.0212**	0.1252***	0.0212**
	-0.00776	-0.0122	-0.00768	-0.0103	-0.0137	-0.0102
Debt-to-Equity-Ratio	-0.00586***	-0.00723***	-0.00586***	0.00111	0.000766	0.00111
	-0.00176	-0.0012	-0.00174	-0.000817	-0.000553	-0.000809
Return-on-Assets	0.537	0.855***	0.537	2.753***	1.888***	2.753***
	-0.339	-0.24	-0.336	-0.379	-0.272	-0.375
Capex-to-Rev-ratio	0.558***	0.178	0.558***	0.736**	1.305***	0.736**
	-0.153	-0.144	-0.151	-0.357	-0.306	-0.353
Dividend-Dummy	-0.0207	-0.130***	-0.0207	0.170***	0.111***	0.170***
	-0.0588	-0.0422	-0.0581	-0.0494	-0.0343	-0.0488
Total-Revenue	-5.13E-06	3.76E-06	-5.13E-06	-1.85e-05***	6.94e-06*	-1.85e-05***
	-4.98E-06	-3.54E-06	-4.93E-06	-4.44E-06	-3.60E-06	-4.39E-06
Net-Income	-3.72E-05	7.29E-05	-3.72E-05	-9.89e-05***	-1.34E-05	-9.89e-05***
	-5.82E-05	-4.66E-05	-5.75E-05	-3.56E-05	-2.48E-05	-3.52E-05
Cashflow-to-Sales-ratio	0.181***	0.189***	0.181***	-0.147***	-0.163***	-0.147***
	-0.0501	-0.0361	-0.0496	-0.0393	-0.0377	-0.0389
Z-Score	0.209***	0.159***	0.209***	-0.0254	0.0521**	-0.0254
	-0.0175	-0.0204	-0.0174		-0.0238	-0.0203
Credit-Rating	-0.00499***		-0.00499***	0.00625***		0.00625***
	-0.00126		-0.00125	-0.00164		-0.00163
Advertising-to-Sales	12.09***	-0.367	12.09***	0.00290**	0.0148***	0.00290**
	-1.233	-1.375	-1.22	-0.00137	-0.00251	-0.00136
ln-Total-Assets	-0.00246	0.012	-0.00246	0.00767	-0.0303**	0.00767
		-0.0158	-0.0229	-0.0156	-0.00852	-0.0125
Constant	-0.655***	-1.085***	-0.655***	-0.630***	-0.844***	-0.630***
	-0.232	-0.244	-0.23	-0.132	-0.164	-0.131
Observations (N)	660	660	660	660	660	660
R-squared	0.516	0.353		0.241	0.35	
Number of Airlines in Sample	15	15		15	15	
Wald "Chi", χ^2			706.56***			703.96***

Chapter X

Regression Analysis

Firm Value *&* Hedging

This chapter discusses and analyses the results of the empirical models (1) and (2). Namely, Model 1 and 2 are distinguished by their sampling of the 15 largest LCC airlines and 15 largest legacy carriers that practise hedging. Therefore, it is only fitting to analyse each model separately given the structural divergence in two distinct business models in the aviation industry: low-cost and conventional legacy carriers. The subsampling therefore adds a different dimension to this paper; as previous literature remains inconclusive on the effects on the causal channel of hedging to generating firm value, and that can vary by industry and within industry. Thence, it is important that when opting for a relatively homogenous industry such as the aviation industry, we lay clear the recent divergences which may affect our interpretation of our estimates. I.e. our results could be plagued with selection bias should we have just sampled any of the fifteen largest airlines, and not have investigated the differences in findings between legacy and LCCs.

Summary Statistics: LCC and Legacy Samples

Below, we set out the summary statistics for the regression models. From the table we can see the observations, means, std. deviations and range of each variable as part of the specification used. Our model shows that for the low-cost sample we have a R-Squared statistic of .5540 indicating that our sample for low-cost airlines has some strong explanatory power. This is in line with the ranges of previous authors, however for our legacy carrier sample we noted a lower R-squared. This was neither improved by increasing or reducing the number of explanatory variables, but more of a reflection of the sample we used. Indeed, in this field of literature R-squared tends to be <60, this is of course expected to some degree given that the statistically significant variables (particularly, *Hedging*) is not capturing most of the mean of the *Tobin's Q*.

Summary Statistics

Variable	Obs.	Mean	Std. Deviation	Min	Max
Airline	0				
Year	660	2013	3.164676	2008	20182.519
Quarter	660	2.519697	1.118708	1	4
Log of Tobin's Q	660	.8703669	.5408412	.1431	3.315
Fuel Price Hedging (%)	660	.4461667	.2602876	.02	.95
Debt to Equity Ratio	660	.3365279	9.71778	-110.76	16.48
Return on Assets	660	.046613	.0808508	-.4282	.462
Capex to Revenue Ratio	660	.1466715	.1247082	.0089	.9214
Dividend Dummy	660	.8272727	.378298	0	1
Total Revenue	660	1993.612	4382.5	126.0025	93860
Net Income	660	125.5761	389.0173	-775.25	2812
Cashflow to Sales Ratio	660	.016616	.3676767	-2.722117	2.188966
Z Score	660	2.027438	1.515446	-1.101	8.232
Credit Rating	660	51	16.15742	20	75
Advertising to Sales Ratio	660	.0279363	.0173238	.00701	.2094
Log of Total Assets	660	8.241017	1.575089	4.838878	11.16365
Airline Number	660	8	4.323771	1	15

Low-Cost Carrier Sample

Source	SS	df	MS
Model	106.790524	14	7.62789457
Residual	85.9730754	645	.13329159
Total	192.763599	659	.292509256

Number of obs	660
F(14, 645)	57.23
Prob > F	0.0000
R-Squared	0.5540
Adj. R-Squared	0.5443
Root MSE	.36509

Legacy Sample

Source	SS	df	MS
Model	44.8462345	12	3.44971035
Residual	141.162441	646	.218517711
Total	186.008675	659	.282258992

Number of obs	660
F(14, 645)	15.79
Prob > F	0.0000
R-Squared	0.2411
Adj. R-Squared	0.2258
Root MSE	.46746

To contextualise the difference in statistics, the legacy carrier sample has a smaller R-squared mainly due to the fact the average fuel hedging percentage over our time period was smaller for all airlines (around 45.6% for the legacy carrier sample). Whereas, in the LCC sample, airlines hedged more of their fuel consumption on average (around 53% for the low-cost carrier sample). In particular, the more growth-focused LCCs that saw the largest increases in Tobin's Q (firm value) over the sample, consistently hedged a much higher proportion of fuel on average (>90%) — irrespective of the market conditions. This could explain the increase in the R-squared, as low-cost airlines tend to hedge a higher proportion of their fuel requirements on average and tend to adopt a more continuous hedging strategy. Furthering this, the fact that the samples reflect different financials given the structural differences present in the industry outlined in Chapters II *and* IV; this again can influence the differing outcomes.

Low-Cost Carrier Sample

Results here suggest that firms which hedge fuel requirements can be positively related to *Tobin's Q* (firm value) in all three models. The magnitude of our coefficient, 0.43 is alike with that of Allayannis et al (2001) and Carter et al (2004). Interestingly, in the samples they used they comprised of legacy carriers as the low-cost phenomena was still in its embryonic form. Our results suggest increases statistical significance at 1-percentage level, whereas Carter et al (2004) observed significance at the 10-percentage level. When accounting for fixed effects in Model 2 be viewed as statistically significant at the 1-percentage confidence level.

We re-ran Model 1 in the Appendix A with a binary *Hedging Activity* variable (i.e. indicating in which period the airline hedged through a discrete variable) and omitted the continuous Hedging % variable. This version of Model 1 is essentially to test the significance of whether hedging – to whatever degree that may be – can be significant in determining firm value. Our results show no significance of this, similar to that of Carter et al (2004). This therefore infers that firms that merely engage in hedging, in spite of how much or little fuel they do hedge, face no statistical significance in contributing to firm value. However, when including the continuous *Fuel Price Hedging (%)* variable we observe in model 1 a 4.3 percent value premium from hedging activity at 1 percent significance level, ceteris paribus. This result is close to that of the finding of Allayannis et al (2001) of an estimated 5 percent currency-hedging premium. Furthermore, Model 2 and 3 use different econometric modelling to test the robustness against the *naïve* OLS Model 1 specification. The magnitude of the coefficients increases slightly to 10.69 percent under a fixed effects model; again, these results prove similar to that of Carter et al (2004). There sample metric increased to 15 percent under fixed effects but showing no significance. Interestingly, the continuous fuel hedging variable is significant at the 1% level under a fixed effects regression with a slight increase. The increase in coefficient may be due to the fact that the indirect benefits of hedging may be slightly underestimated in the OLS model, as now we control for the fixed effects. Further on, a final FGLS model is conducted indicating robust results when compared to Model 1 (Pooled OLS). The FGLS results show robust findings and confirms that our model has not violated the OLS assumptions; particularly no heteroskedasticity present.

Legacy Carrier Sample

We now compare these findings when we sample for legacy carrier airlines (Appendix B). As previously mentioned, low-cost airlines are a relatively new phenomenon and the approach towards hedging varies airline to airline. This, serves as an interesting sample as it allows us to measure if hedging—as a more consistent strategy—can serve to increase firm value; or, whether having a more judicious approach (as the legacy airlines typically have) of hedging *high* with the prospect and actuality of high oil prices, and hedging *low* in a low-oil price climate. Our results suggest a larger magnitude of the coefficients of almost double the effect and of slightly less significance. The legacy sample continuous Fuel Hedging variable has a coefficient of 0.0212 at the 1% confidence level in Model 1b. However, when we tested the specification through the fixed-effects model, we observed a higher magnitude of 0.1252 at the 1% confidence level. Indeed, this magnitude is larger, but in line with the previous literature the Fixed Effects model captured a higher magnitude of around 0.11 percent for the Carter et al (2004) paper.

Endogeneity and Causality Concerns

When addressing a research question like this, the natural concern of endogeneity raises questions regarding the causality argument of Hedging generating Firm Value. In particular, does the conditional independence assumptions hold? Does the model suffer from a selection bias? Omitted Variable Bias? These are important concerns and this paper makes an attempt to deal with these endogeneity problems.

Carter et al (2004) used a first-differenced regression model between *Tobin's Q* and hedging, evidencing that the driver in changes of the amount of fuel hedged drives the value premium in increasing *Tobin's Q*. The purpose of such model is to deal with the fact that *Tobin's Q* may be endogenous in the econometric specification. For example, our variable of interest being *fuel price hedging (%)* could be driven by decision-making agents at airlines being influenced by unobservable factors (for instance: corporate structure, expectations, experience, risk-aversion etc.). From their findings, they proved that hedging was a statistically significant driver (at 10% level) of influencing firm value under a first-differenced regression, thus proving that the endogeneity concern of a potential OVB issue is satisfied.

We also use separate samples of the LCC and Legacy carriers to capture the unobservable structural difference that may be present in both types of airlines. I.e. managerial skill and acumen may be different in low-cost carriers versus legacy carriers, as well as operating structure (e.g. the ability to make timely decisions). Therefore, separating the samples is important as the low-cost carrier sample (or legacy carriers) may carry a bias in our estimations given the distinct industry operating differences.

Chapter XI

Conclusion

The purpose of this paper was to contribute to the debate of whether hedging can contribute to firm value in the aviation industry. Given that aviation remains a good candidate to evaluate such a research question, particularly through the fact that the industry is relatively homogenous (apart from the LCC and Legacy distinction), fuel accounts for over a 1/3 of operating expense and, most of not all airlines are exposed to jet fuel volatilities.

The risk to cost exposure of oil price volatility and the highly competitive dimension of the industry means that only a partial amount of risk is passed onto consumers through prices. And further to this, the competitive pricing environment leads to a low-margin and high-cost business placing airlines often in a highly leveraged position and at risk of financial distress. Therefore, the analysis in our framework enables us to examine the benefits of hedging in an industry that could arguably enjoy the benefits of hedging to the fullest extent.

This area of literature in the field of corporate finance remains inconclusive. The findings from this paper contribute to the work in two important ways: firstly, it provides a more recent lens to revisit the question in a time of increased volatility in crude oil prices and thus firm exposure, therefore illustrating that if there were ever any benefits to hedging they would be felt in times of increased uncertainty, one could argue.

As identified, fuel presents a significant cost component in the operation of an airline, placing significant exposure for managers to manage such an external risk. Hedging may provide managers with enhanced commercial certainty through improved price planning and the prevention of underinvestment that can inevitably stultify growth opportunities for the business. Therefore, it is in our opinion that hedging serves as a tool to smooth the bumps of uncertainty, allowing for more medium-term planning (with is strategically crucial in balancing cash-flow and better harnessing investment opportunities). The causal interpretation is in line with Carter et al (2004) and that hedging contributes between a 2-5% increase in firm value between both samples. Low cost airlines may have other factors that directly indicate to the market of its financial health and agility as identified; whereby the indirect benefits of hedging may not be captured by such a specification that this paper, and others, have presented. Clearly there remains an identification challenge here given the many observables and unobservables in an imperfect world – far from that Modigliani Miller presents. However, with the use of data science, enhanced financial planning and improved rational decision making by firm managers and indeed investors, whereby increase information symmetry and forecasting is present, the use of derivatives can be used in a less visceral way and more of a targeted and highly measured way to enable the full benefit.

From our findings it can be said that we have found evidence to support the argument that hedging can provide firms in the aviation industry with enhanced financial stability through positively contributing to firm value. However, it is important to recognise that our results are not unique to the literature in the fact that there may be other unobserved drivers of financial risk mitigation strategies and instruments which this field of corporate finance has not addressed to truly recognise the causal channel between firm value and hedging.

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**Hedging Data was obtained from the Annual Reports (10-K) reports published annually by each airline.*

–Appendix–

Appendix A: Low-Cost Carrier Sample

Low-Cost Carrier Sample

Airline	**Number of Firm-quarter Observations**
AirAsia	44
Allegiant	44
Cebu Pacific	44
easyJet plc	44
Eurowings	44
GOL Intelligent Airlines	44
Jet2.com	44
JetBlue	44
Norwegian Air Shuttle	44
Ryanair	44
Southwest Airlines	44
Spirit	44
Virgin Australia	44
WestJet	44
WizzAir	44
Total	**660**

Appendix B: Legacy Carrier Sample

Legacy Carrier Sample

Airline	**Number of Firm-quarter Observations**
Aeromexico	44
Air Canada	44
Air France	44
Alaskan Inc.	44
American Airlines Inc.	44
ANA (All Nippon Airways)	44
China Eastern Airlines	44
Delta Airlines Inc.	44
Deutsche Lufthansa AG	44
IAG British Airways plc	44
JAL (Japan Airlines)	44
LATAM (Latin America) Airlines	44

Qantas Airways Ltd	44
Turkish Airlines	44
United Airlines Inc.	44
Total	**660**

Appendix C: Multicollinearity Check

(Using Stata *Variance Inflation* tests, with a rule-of-thumb <5 in VIF to ensure no multicollinearity that could bias our results).

Low-Cost Carrier Sample VIF (OLS Regression)

Variable	Variance in Inflation (VIF)	1/VIF
Total Revenue	7.8	0.128253
Log of Total Assets	6.45	0.154963
Net Income	3.17	0.315309
Z Score	2.35	0.425498
Return on Assets	2.22	0.451386
Capex to Revenue Ratio	1.79	0.557443
Fuel Price Hedging	1.58	0.631662
Credit Rating	1.43	0.700111
Advertising to Sales Ratio	1.39	0.717534
Debt to Equity Ratio	1.30	0.770110
Cash flow to Sales Ratio	1.17	0.852537
Fuel Price Hedging (%)	1.17	0.854962
Mean VIF	**2.65**	

Legacy Carrier Sample VIF (OLS Regression)

Variable	Variance in Inflation (VIF)	1/VIF
Total Revenue	2.57	0.128253
Log of Total Assets	1.35	0.154963
Net Income	1.81	0.315309
Z Score	2.08	0.425498
Return on Assets	1.91	0.451386
Capex to Revenue Ratio	1.72	0.557443
Fuel Price Hedging	1.81	0.631662
Credit Rating	2.02	0.700111
Advertising to Sales Ratio	1.18	0.717534
Debt to Equity Ratio	1.04	0.770110
Cash flow to Sales Ratio	2.18	0.852537
Fuel Price Hedging (%)	1.57	0.854962
Mean VIF	**1.71**	

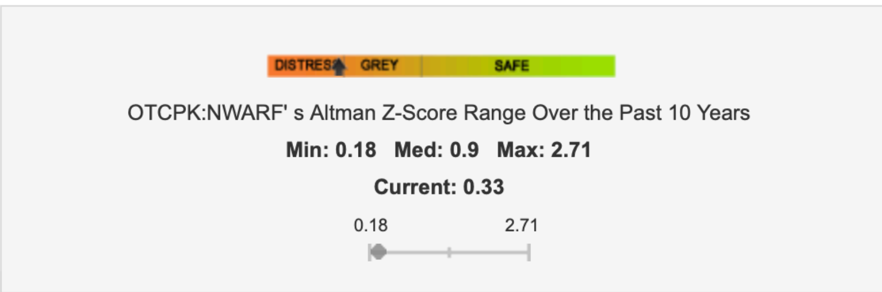
Appendix D: Credit Rating

Credit Rating

Moody's	S&P	Numeric Equivalent
Aaa	AAA	100
Aa1	AA+	95
Aa2	AA	90
Aa3	AA-	85
A1	A+	80
A2	A	75
A3	A-	70
Baa1	BBB+	65
Baa2	BBB	60
Baa3	BBB-	55
Ba1	BB+	50
Ba2	BB	45
Ba3	BB-	40
B1	B+	35
B2	B	30
B3	B-	25
Caa1	From CCC+ to CCC-	20
Caa2	CC	15
Caa3	C	10
Caa	D	5

Appendix E: Altman's Z Score

When Altman Z-Score is less than 1.81, it is in Distress Zones.
When Altman Z-Score is greater than 2.99, it is in Safe Zones.
When Altman Z-Score is between 1.81 and 2.99, it is in Grey Zones.



Appendix F: Fuel Price Data Results

Variable	Obs	Mean	Std. Deviation.	Min.	Max.
Month	132	19525.36	1164.181	17532	21519
Price	132	78.34924	25.57949	29.78	132.83

Variable	Obs	Mean	Std. Deviation.	Min.	Max.
Month	132	12950.82	1164.239	10958	14945
Price	132	19.10356	4.737658	10.41	34.

Appendix G: *Tobin's Q* Formula

$$\boldsymbol{Tobin's\ Q = \frac{Equity\ Market\ Value + Liability\ Market\ Value}{Total\ Asset\ Replacement\ Value}}$$

Appendix H: Fuel as a % of Operating Expense

(Data for *Figure II* – Graph of Fuel as a Percentage of Operating Expense for the World's 15 Largest Airlines)

	Fuel as % of Operating expenses															
	American A	Delta	Southwest	United Airl	Ryanair	China Sou	China East	easyJet	Turkish Ai	Air China	Lufthansa	Emirates	IndiGo	ANA	LATAM A	Brent Year
2007	27.20%	31.00%	29.70%	31.00%	39.30%	37.12%	35.00%	26.49%	37.20%	34.21%	17.30%	31.00%	42.86%	20.19%	32.90%	71.11
2008	31.70%	38.00%	35.10%	32.00%	36.40%	34.46%	33.00%	31.64%	40.74%	36.06%	20.90%	36.20%	45.12%	21.75%	39.50%	97.00
2009	23.80%	29.00%	30.20%	26.00%	43.80%	40.13%	32.00%	30.70%	29.75%	31.52%	14.71%	35.20%	43.28%	24.77%	28.60%	61.75
2010	26.10%	30.00%	33.40%	31.00%	34.10%	32.63%	31.00%	26.30%	32.71%	33.67%	17.80%	29.90%	41.23%	21.80%	33.20%	79.04
2011	29.60%	36.00%	38.20%	36.00%	39.00%	37.53%	37.00%	30.70%	37.24%	37.66%	20.60%	34.40%	46.99%	22.14%	25.23%	104.01
2012	35.80%	36.00%	37.30%	37.00%	43.00%	39.01%	36.00%	34.58%	37.80%	38.47%	23.53%	40.00%	50.82%	22.41%	36.30%	105.01
2013	35.40%	33.30%	35.30%	34.00%	45.00%	48.68%	34.00%	33.32%	37.00%	35.85%	22.49%	39.60%	50.95%	24.91%	34.85%	104.07
2014	33.20%	35.40%	32.60%	32.00%	46.00%	47.16%	34.00%	33.77%	37.00%	35.20%	21.61%	39.20%	50.26%	27.53%	27.58%	96.24
2015	27.30%	23.00%	23.60%	23.00%	43.00%	39.21%	23.00%	32.00%	35.59%	25.44%	32.79%	35.00%	46.09%	26.21%	34.00%	50.75
2016	17.60%	18.30%	22.70%	18.00%	41.00%	46.25%	21.00%	33.76%	30.88%	22.52%	15.38%	26.00%	34.70%	19.59%	36.10%	42.81
2017	19.60%	19.20%	23.00%	20.00%	37.00%	41.08%	25.00%	25.80%	28.19%	25.30%	15.00%	25.00%	36.82%	19.10%	43.48%	52.80
2018	23.60%	23.00%	24.60%	24.00%	35.00%	45.31%	33.00%	23.96%	32.24%	30.40%	18.00%	28.00%	37.23%	20.18%	46.15%	68.34
Hedging A	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	
Average	33.09%	35.22%	36.57%	34.40%	48.26%	48.86%	37.40%	36.30%	41.63%	38.63%	24.01%	39.95%	52.63%	27.06%	38.50%	

Data Sourced: 10-K Annual Reports of each airline above, (2008-2018); Brent Crude Prices sourced from the World Bank (2019).

End *of* Thesis.