Master Thesis

MSc. in Economics and Business Administration
Applied Economics And Finance

Hedging In The Airline Industry

Copenhagen Business School
HANDELSHØJSKOLEN

Authors:
Andreas Pilgaard
Daniel Skov Jensen

Supervisor:
Robert Neumann

Number of pages:
120
Characters incl. spaces:
248.486

May 15, 2017

Abstract

This thesis analyzes jet fuel hedging of airlines with the purpose of explaining differences in hedging strategies. Through the analysis of financial and operational hedging the thesis attempts to explain hedging behavior, and how hedging is related to firm value and exposure.

Financial hedging is analyzed using the financial distress theory of Smith and Stulz (1985), and the investment coordination rationale of Froot et al. (1993) and Froot et al. (1994). The idea of the financial distress framework is, that airlines can lower their cost of debt through the use of hedging, that works to lower the probability of bankruptcy. The investment coordination framework states, that airlines should match internally generated cash flows and investment opportunities.

The empirical analysis of financial distress finds, that airlines with higher interest expenses use more hedging. When testing whether debt levels and credit ratings affect hedging behavior, the results are inconclusive.

The analysis of the investment coordination framework shows, that hedging increases more for airlines with high cost of external financing than for airlines with low cost of external financing, when investment opportunities increase. This is in line with the framework.

The theories of financial hedging are tested through other hypothesis as well, but the results are mixed and we are unable to clearly confirm or reject the theories.

Operational hedging is analyzed through leasing and the fleet diversity theory of Treanor (2012). The concept of these frameworks is that they provide flexibility for airlines. This flexibility should increase the airlines' ability to adjust operations during periods of high fuel prices. Leasing and fleet diversity should therefore increase firm value and decrease exposure.

In the empirical analysis of leasing, we find that smaller airlines increase firm performance, when increasing the amount of leasing, while larger airlines decrease exposure. For fleet diversity we find evidence that all airlines on average are able to decrease exposure by increasing the level of fleet diversity.

Contents

Abstract **i**

1 Introduction **1**

1.1 Problem . . . 1
1.1.1 Problem area . . . 1
1.1.2 Presentation Of Problem . . . 2
1.1.3 Problem Formulation . . . 2
1.1.4 Delimitation . . . 2
1.2 Industry Characteristics . . . 3
1.2.1 Margins . . . 3
1.2.2 Capital Structure . . . 5
1.2.3 Jet Fuel . . . 7
1.2.4 Hedging . . . 8

2 Theory **10**

2.1 Financial Distress . . . 10
2.1.1 Unlevered Firm . . . 10
2.1.2 Levered Firm, Unhedged . . . 11
2.1.3 Levered Firm Value, Hedged . . . 11
2.2 Investment Coordination . . . 13
2.3 Leasing . . . 15
2.3.1 Terminology . . . 15
2.3.2 Leasing and perfect capital markets . . . 16
2.3.3 Leasing And Flexibility . . . 16
2.4 Fleet Diversity . . . 17
2.4.1 Hedging Through Fleet Diversity . . . 17
2.4.2 Option Value . . . 18
2.4.3 Diversity Or Divisibility . . . 18

3 Methodology **20**

3.1 Selection Process And Time Frame . . . 20
3.2 Data And Variables . . . 21
3.2.1 Percentage Hedged Next Year . . . 21
3.2.2 Tobin's Q . . . 22
3.2.3 Exposure Coefficients . . . 23
3.2.4 Credit Ratings . . . 24
3.2.5 Lease To Total Fleet . . . 26
3.2.6 Aircraft Dispersion Index . . . 26
3.2.7 Operating Lease Adjustments . . . 27
3.3 Statistical Methods . . . 28
3.3.1 Descriptive And Statistical Analysis . . . 28
3.3.2 Regression Analysis . . . 28

4 Analysis **32**
4.1 Data Overview . . . 32
4.1.1 Percentage Hedged Next Year . . . 32
4.1.2 Tobins Q . . . 33
4.1.3 Exposure Coefficients . . . 35
4.1.4 Fuel Price Development . . . 37
4.1.5 Other Variables . . . 37
4.2 Financial Distress . . . 38
4.2.1 Example: JetBlue Airways . . . 38
4.2.2 Hypotheses . . . 46
4.2.3 Empirical Analysis Of Hypothesis 1 . . . 46
4.2.4 Empirical Analysis Of Hypothesis 2 . . . 49
4.2.5 Empirical Analysis Of Hypothesis 3 . . . 56
4.2.6 Discussion . . . 59
4.2.7 Summary . . . 61
4.3 Investment Coordination . . . 61
4.3.1 Example: JetBlue Airways . . . 62
4.3.2 Hypotheses . . . 67
4.3.3 Empirical Analysis Of Hypothesis 4 . . . 67
4.3.4 Empirical Analysis Of Hypothesis 5 . . . 71
4.3.5 Empirical Analysis Of Hypothesis 6 . . . 73
4.3.6 Discussion . . . 76
4.3.7 Summary . . . 80
4.4 Leasing . . . 81
4.4.1 Example: JetBlue Airways . . . 81
4.4.2 Hypothesis . . . 86
4.4.3 Empirical Analysis Of Hypothesis 7 . . . 86
4.4.4 Discussion . . . 94
4.4.5 Summary . . . 97
4.5 Fleet diversity . . . 97
4.5.1 Example: JetBlue Airways . . . 98
4.5.2 Hypothesis . . . 102
4.5.3 Empirical Analysis Of Hypothesis 8 . . . 102
4.5.4 Discussion . . . 112
4.5.5 Summary . . . 115

5 Conclusion **116**

References **118**

Appendix **124**

1 Introduction

Risk management is part of most people's everyday life. We buy insurance to safeguard unforeseen events such as theft, car crashes, loss, critical illness and death. Even though insurance is costly, it seems that there is a general agreement, that having an insurance is necessary. Often, we discuss what the cheapest insurance is, however, we rarely discuss whether is it necessary to have one.

This picture is contrary to corporate risk management in the airline industry. In the airline industry, most airlines face a volatile jet fuel price creating uncertainty about future cost and ultimately survival. Airlines can safeguard this risk by entering different financial arrangements such as forwards, futures and options.

During times of high jet fuel prices, these arrangements make it possible for the airlines to reduce uncertainty. Smith and Stulz (1985) suggest that in this way firms can avoid bankruptcy. The risk of bankruptcy has a range of unfavorable effects on an airline. For example when it is announced in the media that an airline is close to bankruptcy, customers will seek to find an alternative carrier. This is likely to negatively impact ticket sales at the airline threatened with bankruptcy. Further, suppliers of jet fuel, hubs etc. will be reluctant to give credits putting further restrictions and pressure on the airline. During times of high jet fuel prices the financial arrangements mitigate some of this problem. However, during times of low jet fuel prices the benefits become limited. In fact, the holder the financial arrangements realize losses during these periods. For example Delta Airlines lost 2.3 billion USD on their financial hedging activities during 2015 (CNN, 2016).

The level of engagement in hedging activities differs highly among the European and American airlines. At the end of 2015 SAS hedged 80% of the following years expected fuel consumption, Air Canada hedged 18% and WestJet hedged 0%.

1.1 Problem

1.1.1 Problem area

Airlines have narrow margins creating a need for a reliable cost base, and jet fuel cost constitute a large fraction of the cost base. This means that airlines profits are highly sensitive to a volatile jet fuel price. To reduce exposure to fluctuations in the jet fuel price some airlines have entered into large hedging positions, while others have done so to a lesser extend or not at all. This has led to different effects on the income statements of airlines and discussion regarding the right choice of hedging strategy in industry. Thus, the relation between hedging and firm value does not seem straight forward, and we will therefore attempt to understand the different rationales behind financial hedging.

Aside from financial hedging, operational hedging is another large topic. Also here, airlines have differing strategies. Some airlines argue that operating a single aircraft type allow them to specialize and thus lower their operating cost. Others argue that a diverse fleet provide them with an ability to operate profitably under many different market conditions.

1.1.2 Presentation Of Problem

Airlines hedging behaviors are not similar. We are interested in understanding why the behavior differs considering that all airlines are expected to maximize profit. Airlines do not seem to agree on an optimal level of hedging. Questions such as: "Which factors determine the choice of hedging strategy?" and, "Which hedging strategies maximize shareholder value?" leads to the following problem formulation:

1.1.3 Problem Formulation

Why do we observe different fuel hedging strategies in the airline industry?

1.1.4 Delimitation

The thesis covers two main topics: Financial and operational hedging in the airline industry. We limit the analysis to hedging behavior and do not go into technical details of the various financial instruments applied in the industry.

In the financial hedging area we analyze two motives for hedging. The first is the financial distress motive suggested by Smith and Stulz (1985). The second is the investment coordination motive put forward by Froot et al. (1993). We consider these to be among the most popular frameworks within the field of financial hedging rationales. We do not cover topics such as tax incentives to hedge, agency cost related to hedging etc.

Within the area of operational hedging, we limit the analysis to leasing and fleet diversity.

Further we do not analyze the competitive interactions in the airline industry, which is a relevant determinant of how airlines decide on their hedging strategy. Another relevant topic within hedging is hedging of foreign currency exposure. The variety of countries in which airlines operate and buy fuel make them exposed to fluctuations in exchange rates. We will not cover hedging of foreign currency exposure.

As we analyze the financial statements of airlines, the treatment of accounting data becomes relevant. In the analysis we do not reformulate financial statements but collect the numbers from Compustat (2017) as they are reported.

1.2 Industry Characteristics

In this section we introduce the main characteristics of the airline industry that are relevant to the thesis.

1.2.1 Margins

Operating margins in the airline industry are low. Figure 1.1 presents revenue, jet fuel cost, other operating cost, and the operating profit of the global airline industry from 2005 to 2017. We see that total revenue was approximately 400 billion USD in 2005 and 700-800 billion USD in 2017. The fuel cost made up a large part of the total operating cost. Fuel cost constituted 22.2% to 35.6% of the total operating expenses between 2005 and 2015 (IATA, 2016).

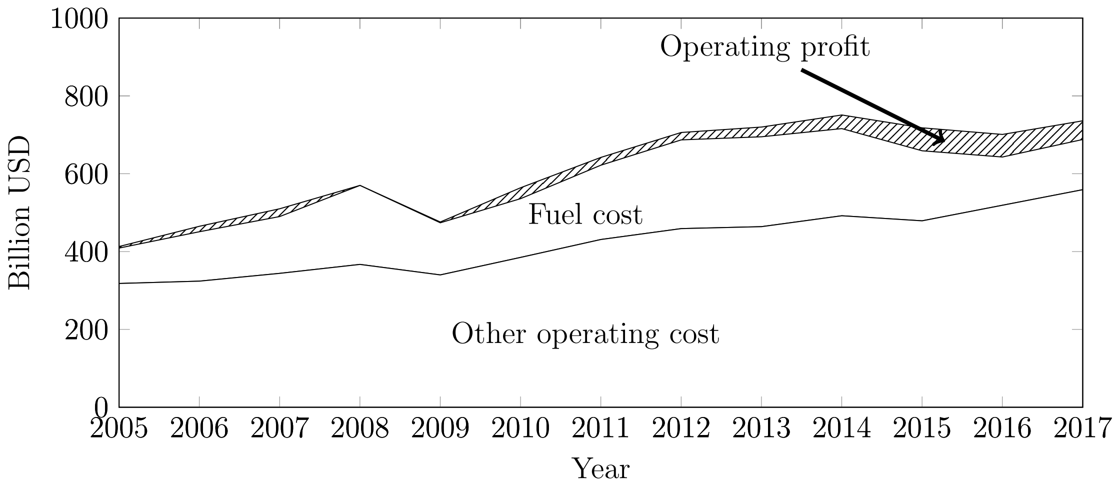

Figure 1.1: Revenue, fuel cost, other operating cost and operating profit of the airline industry in the period of 2005 to 2017. Values for 2016 and 2017 are estimates. The lines stacks fuel cost, other operating cost and operating profit so that the upper line describes the revenue. The sources is (IATA, 2016).

The jet fuel price increased from 90 USD per barrel in 2007 to 126.7 USD per barrel in 2008, where the airline industry profits turned negative. Figure 1.1 show that the overall industry operating margins were narrow in the subsequent years. More specifically the margins ranged from 0.4 to 4.9 in the years from 2009 to 2014. In 2015 the jet fuel price decreased to 66.7 USD per barrel and the operating margin increased to 8.3% (IATA, 2016).

Koopmans and Lieshout (2016, p. 8) find that the competitive environment in the airline industry can be characterized as concentrated. The reason being that airlines differentiate their products by offering a variety of flights schedules and differentiated services.

Differentiation usually implies higher operating margins but Koopmans and Lieshout (2016, p. 4) argue that the low profit margins in the airline industry is a result of several factors. One factor is that the threat of new entrants in industry is high, and another is that airlines have many empty seats during periods where customers buy fewer tickets. In addition P. Morrell and Swan (2006, p. 714) describe that airlines cannot decrease their cost sufficiently fast in such periods. This is because airlines own expensive aircraft that are not easily sold in periods of low economic growth. Another issue is that some airlines are old and therefore have entered into expensive contracts with employees a long time ago (Koopmans and Lieshout, 2016, p. 4).

Thus, because airlines operate with low operating margins, their profits quickly turn negative when the jet fuel price increases. Negative profits arise, because airlines ability to pass trough jet fuel cost increases is limited. Since the assets of airlines are inflexible they optimize the quantity supplied to the market instead of their prices. This implies that less than 100% of the jet fuel cost increases will be passed on to the customers immediately. The amount of pass-through depends on several factors. For example, if airlines follow a market leader when setting prices, they will be able to maintain operating margins. Other factors include the ability of new airlines to get slots in airports but also the fact that airlines prefer to sell cheap tickets rather than fly with empty seats (Koopmans and Lieshout, 2016, p. 4-8).

Airlines with a higher share of its revenue from cargo transportation are less exposed to changes in the jet fuel price. This is because they make use of surcharges, whereby they adjust the price of transporting goods when the jet fuel price changes (P. Morrell and Swan, 2006, p. 719). Figure 1.2 shows the industry share of revenue divided on cargo and passenger transportation.

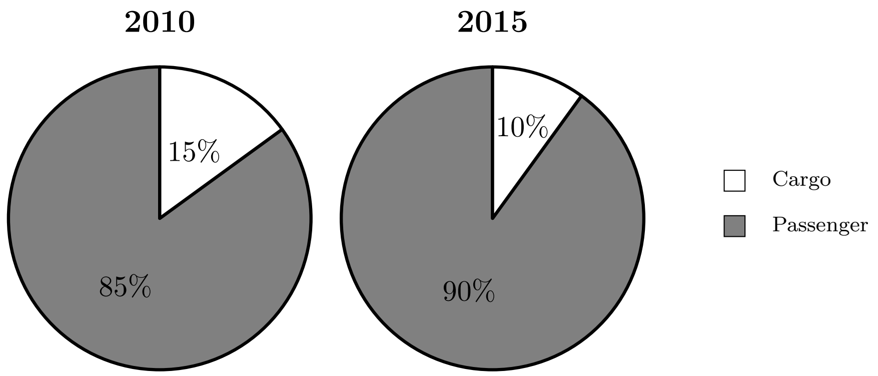

Figure 1.2: Total revenue of the aircraft industry in 2010 and 2015 divided on passenger transport and cargo transportation. In 2010 and 2015 the revenue of passenger transportation was 445 and 518 billion USD respectively and the revenue of cargo transportation was 66.1 and 52.8 billion USD. Source: IATA (2016)

According to Figure 1.2 cargo transportation revenues consisted of 15% and 10% in 2010 and 2015 of the total industry revenues while passenger transportation comprised 85% to 90% in 2010 and 2015, respectively. Passenger transportation make up the largest share of industry revenues. This means that the lack of ability to pass through jet fuel cost increases has the potential to impact industry profits.

1.2.2 Capital Structure

The Airline industry is a capital intensive industry, and many airlines borrow or lease to finance large parts of their aircraft. Figure 1.3 shows the distribution of the debt to equity ratios for 19 selected industries. The figure includes a "raw" and an operating lease adjusted debt to equity ratio for each industry. The airline industry has a lease adjusted debt to equity ratio of approximately 0.9 and is among the industries with the highest debt levels.

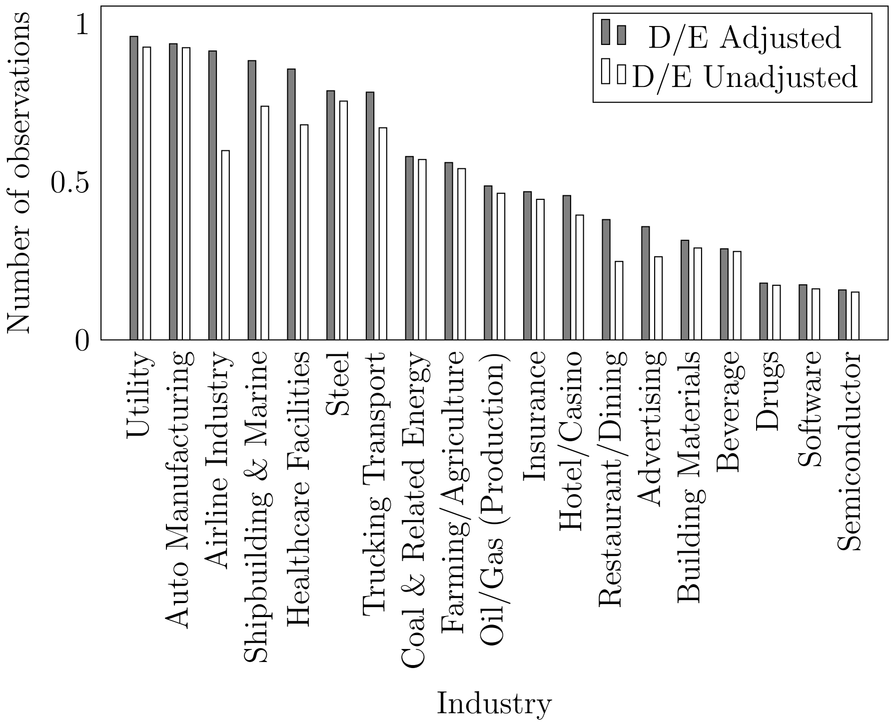

Figure 1.3: Market debt to equity (DE) ratios by industry. The histogram illustrates a global industry measure of the operating lease adjusted and unadjusted D/E ratios across 19 selected industries (Damodaran, 2017c)

The high debt to equity ratios characterizing the industry is likely to be a result of relatively low bankruptcy cost due to the tangible nature of airlines. I.e. if an airline defaults on its interest payments, the debt holders have a good chance to retrieve much of the loan not yet repaid through asset liquidation. In contrast drug and IT related industries have relatively low debt levels. This may be explained by the intangible nature of the assets in these industries (Berk and DeMarzo, 2013, p. 550).

Figure 1.3 also shows that the industry has a large engagement in operating lease agreements. In short when an airline enters an operating lease agreement the airline rents an asset, which become part of the airline's operations but not a part of the airline's balance sheet. Similar to debt, leasing generally implies a number of payments during the life of the lease agreement, and thus as with debt an airline can default on these lease payments. Adjusting the debt equity ratio of the global airline industry for operating leases causes a jump in ratio of approximately 30%-points.

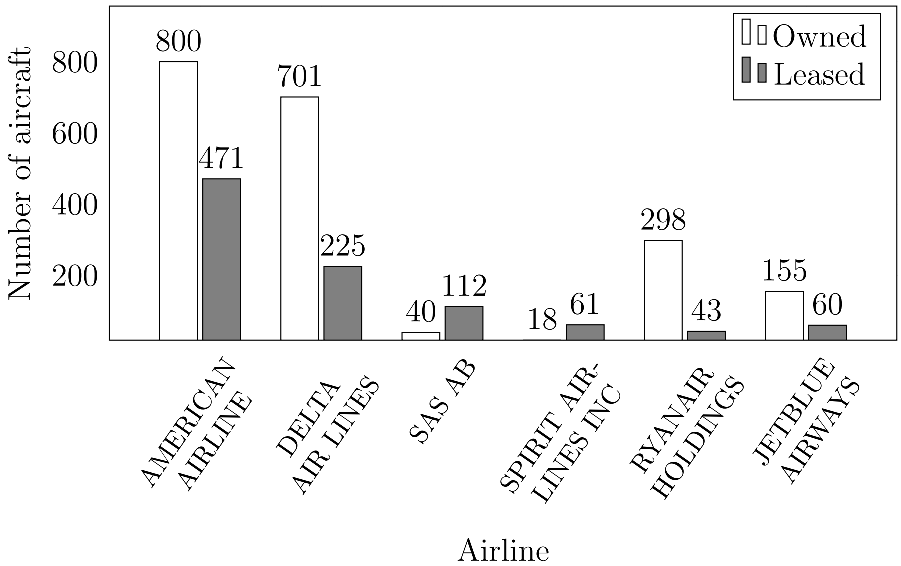

Figure 1.4: Leased and owned number of aircraft for American Airlines, Delta Airlines, SAS AB, Spirit Airlines, RyanAir Holdings, JetBlue Airways at the end of fiscal year 2015

Figure 1.4 gives a picture of the leased and owned aircraft of American Airlines, Delta Air Lines, SAS AB, Spirit Airlines, RyanAir Holding and JetBlue Airways during 2015. The six airlines had leased approximately 37%, 24%, 74%, 77% 13% and 28% of their fleets this year. This illustrates that the use of leasing is very different among airlines.

1.2.3 Jet Fuel

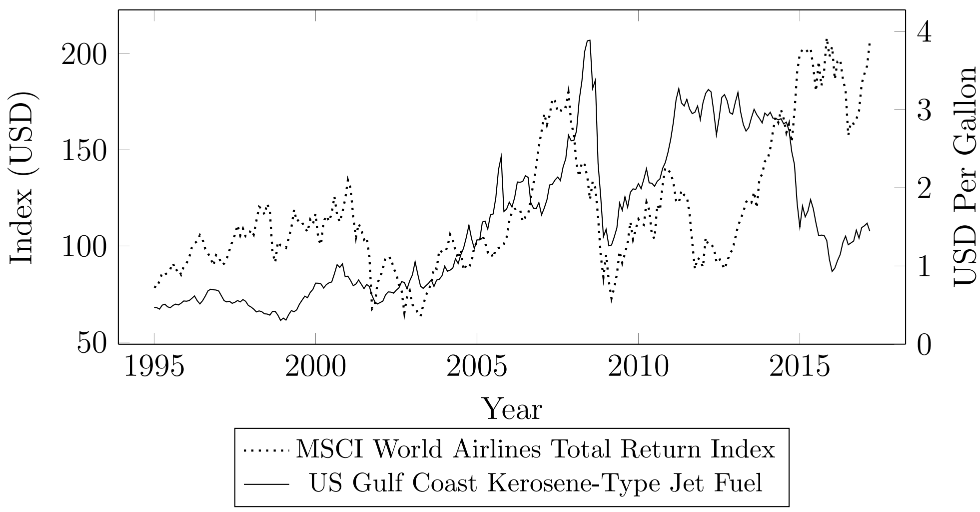

Figure 1.5: The monthly prices of U.S. Gulf Coast kerosene-type jet fuel (Federal Reserve Bank of St. Louis, 2017a) from January 1995 to March 2017 and the MSCI World Airline Total Return Index (See Datastream, 2017, search key: M3DWAL)

Figure 1.5 presents the monthly jet fuel price along with the MSCI World Airline Total Return Index from January 1995 to April 2017. The index gives an overview of how the airline industry has developed over time and an idea of how the industry has been affected by the jet fuel price development. During some periods we see opposite movements between the MSCI airline index and the jet fuel price, whilst during other periods the two move together.

For example, from January 1995 to January 2000, the correlation coefficient between the airline index and the jet fuel price was -0.1109. From 2005 to 2010 this correlation was 0.4362 and from 2010 to 2015, -0.3596. Thus the world airline industry is relatively sensitive to jet fuel price movements.

As a result, airlines try to control their exposure to the jet fuel price.

1.2.4 Hedging

Airlines use financial and operational hedging to control their jet fuel price exposure. They implement financial hedging using financial contracts such as forwards, futures and options. Operational hedging is performed by undertaking measures which optimizes the operations (P. Morrell and Swan, 2006, p. 715-717).

A practical problem is that the liquidity of jet fuel derivatives is low. This means that the hedging abilities are limited. More liquid alternative commodities that can be used for hedging are heating oil and crude oil, as these are closely related to jet fuel. (Vasigh et al., 2015, see ch. 11). Deutsche Lufthansa AG for example mainly hedge using financial instruments on crude oil (Lufthansa Group, 2011–2016, see annual report 2015, p. 171). The usual objective of jet fuel hedging is to stabilize the profits and cash flows generated by the airlines operations. Air Canada mentions this in their annual report:

> *"In order to manage its exposure to jet fuel prices and to help mitigate volatility in operating cash flows, Air Canada enters into derivative contracts with financial intermediaries" - (Air Canada, 2011–2016, see annual report 2015, p. 58)*

We find slight variations in the objective of hedging. For example, Norwegian explains in the quote below that they use financial instruments to stabilize cash flows but also to lower fuel cost.

> *"The objective of the jet-fuel price risk management policy is to safeguard against significant and sudden increases in jet-fuel prices whilst retaining*

access to price reductions" - (Norwegien Air Shuttle, 2011–2016, see annual report 2015, p. 18)

An example of an operational hedging strategy is to decrease the average age of the fleet through investments. Such a strategy works because new aircraft use less fuel than older aircraft (P. Morrell and Swan, 2006, p. 717). Other examples concern the use of leasing and fleet diversity to decrease exposure, because these strategies increase the flexibility of the airline to adjust operations to the current environment. Fleet diversity is determined by the number of different aircraft types that the airlines employ. The average fleet age and number of aircraft types is displayed in Figure 1.6 for selected airlines.

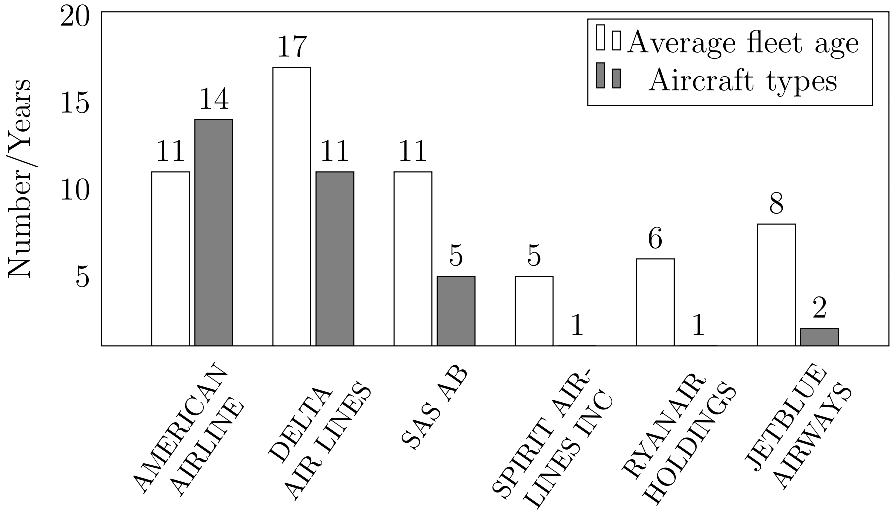

Figure 1.6: Aircraft types and average fleet age for selected airlines in 2015. The average fleet age has been rounded to nearest integer.

The average fleet age vary in Figure 1.6 from 17 years for Delta Airlines to 5 years for Spirit Airlines. The number of aircraft types range from 14 for American Airlines to one aircraft type for Spirit Airlines Inc. and Ryanair Holdings. We will further investigate these factors from the perspective of operational hedging in the analysis section.

2 Theory

This section describe the four theoretical frameworks used in the analysis of the airline industry. First we will go through financial distress and investment coordination which are theories within the subject of financial hedging. Subsequently we will describe operational hedging from the perspective of leasing and fleet diversity.

2.1 Financial Distress

Smith and Stulz (1985) put forward a framework in which a firm benefits from hedging. To illustrate the framework we set up three scenarios: A baseline scenario where the firm is unlevered, a second scenario where the firm is levered and unhedged, and a third scenario where the firm is levered and hedged.

2.1.1 Unlevered Firm

Smith and Stulz (1985, p. 396) build their framework upon the work of Kraus and Litzenberger (1973). In their model the firm can end up in a number of different states associated with different firm values. We use Kraus and Litzenberger (1973) to get from the Smith and Stulz (1985) notation to a notation, that we can apply in a later section.

$$\begin{aligned} V^U &= \underbrace{\sum_{i=1}^{S} P_i V_i}_{\substack{\text{Pre-tax} \\ \text{unlevered} \\ \text{firm value}}} - \underbrace{\sum_{i=1}^{S} P_i T V_i}_{\text{Tax}} = \underbrace{\sum_{i=1}^{S} \text{EBIT}_i \cdot P_i}_{\substack{\text{Pre-tax} \\ \text{unlevered} \\ \text{firm value}}} - \underbrace{\sum_{i=1}^{S} T \cdot \text{EBIT}_i \cdot P_i}_{\text{Tax}} \\ &= \sum_{i=1}^{S} (1-T) \cdot \text{EBIT}_i \cdot P_i \end{aligned} \tag{2.1}$$

Where S denotes the total number of states.

Implicitly Smith and Stulz (1985) define next years EBIT as the variable of interest when calculating the value of the firm. The model is a one period model and ignores subsequent periods. Therefore we also assume that EBIT at t=1 is equal to the cash flow received by the share and and debt holders of the firm.

2.1.2 Levered Firm, Unhedged

Next the value of the levered firm, V^L, is found by Smith and Stulz (1985) and Kraus and Litzenberger (1973):

$$\begin{aligned} V^L &= V_U + \underbrace{\sum_{i=1}^{j} P_i T V_i}_{\substack{\text{Tax shield,}\\ \text{down states}}} + \underbrace{\sum_{k=1}^{S} P_i T F}_{\substack{\text{Tax shield}\\ \text{up states}}} - \underbrace{\sum_{i=1}^{j} P_i C}_{\substack{\text{Bankruptcy}\\ \text{cost}}} \\ &= V_U + \underbrace{\sum_{i=1}^{j} P_i T \cdot \text{EBIT}_i}_{\substack{\text{Tax shield,}\\ \text{down states}}} + \underbrace{\sum_{k=1}^{S} P_i T \cdot \text{Debt Payment}}_{\substack{\text{Tax shield}\\ \text{up states}}} - \underbrace{\sum_{i=1}^{j} P_i C}_{\substack{\text{Bankruptcy}\\ \text{cost}}} \end{aligned} \tag{2.2}$$

where P_i denotes the state price in a given state i, V_i^U the unlevered firm value in a given state i, T the tax rate, F the face value of debt and C the cost of bankruptcy. An examples of bankruptcy cost is the cost of lawyers (Berk and DeMarzo, 2013, p. 543). We assume C to be fixed in the states where firm value is lower than F. The number of states in which firm value is below the face value of debt are denoted by j. We denote these the down states. k denotes the first state in which firm value is above the face value of debt. These states are denoted the up states.

From equation 2.2 we see that the value of the levered firm is equal to the present value of the unlevered firm added the present value of the tax shield, subtracted the present value of bankruptcy cost.

Note that if the levered firm value ends up in the down states the firm will go bankrupt. Bankruptcy entails that debt holders take legal ownership of the firms assets and liquidate these to get their repayment (Berk and DeMarzo, 2013, p. 541). Therefore the tax shield generated in the down states is equal to total firm value multiplied by the tax rate. In the up states the firm will be able to generate the maximum tax shield of the face value of debt multiplied by the tax rate. Combined these make up the present value of the firms tax shield.

2.1.3 Levered Firm Value, Hedged

Consider a firm that employs a forward hedge such that cash is generated in the down states and lost in the up states. If the firm can lock its value above the face value of debt hedging will be beneficial. Put formally it is required that $H_i + V_i > F$, where H_i denote the cash flow from the hedge in a given state. Equation 2.3 presents the value of a firm:

$$\begin{aligned}
V^{LH} &= \underbrace{\sum_{i=1}^{S} P_i(V_i + H_i)}_{\substack{\text{Pretax}\\ \text{unlevered}\\ \text{firm value}}} - \underbrace{\sum_{i=1}^{S} P_i(V_i + H_i)T}_{\text{Tax}} + \underbrace{\sum_{i=1}^{S} P_i T F}_{\text{Tax shield}} \\
&= \underbrace{\sum_{i=1}^{S} (\text{EBIT}_i + H_i) \cdot P_i}_{\substack{\text{Pre-tax}\\ \text{unlevered}\\ \text{firm value}}} - \underbrace{\sum_{i=1}^{S} T \cdot (\text{EBIT}_i + H_i) \cdot P_i}_{\text{Tax}} + \underbrace{\sum_{i=1}^{S} P_i T \cdot \text{Debt payment}}_{\text{Tax shield}}
\end{aligned} \tag{2.3}$$

For hedging to make sense at all, the point at which after tax firm value is locked, $H_i + V_i$, has to be larger than the face value of debt. These firms will increase firm value through a reduction in expected bankruptcy cost and an increase in the expected value of the tax shield (Smith and Stulz, 1985, p. 396-397).

To find the present value of hedging we need to subtract V^L from V^{LH}:

$$\begin{aligned}
\text{NPV(Hedge)} &= V^{LH} - V^{L} \\
&= \underbrace{\sum_{i=1}^{j} P_i T \cdot \text{Debt Payment}}_{\substack{\text{Tax shield,}\\ \text{from hedged}\\ \text{down state}}} - \underbrace{\sum_{i=1}^{j} P_i T \cdot \text{EBIT}_i}_{\substack{\text{Tax shield}\\ \text{in unhedged}\\ \text{down state}}} + \underbrace{\sum_{i=1}^{j} P_i C}_{\substack{\text{Savings on}\\ \text{reduction in}\\ \text{bankruptcy cost}}}
\end{aligned} \tag{2.4}$$

From equation 2.4 we see,that the value of hedging comes from an elimination of bankruptcy cost, and a higher tax shield. Therefore the model of Smith and Stulz (1985) relies on the assumption of the existence of taxes and bankruptcy cost. I.e. in a perfect capital market setting the NPV(Hedge) would be zero. In this setting the taxes are only introduced to create an incentive for the firm to hedge (Smith and Stulz, 1985, p. 396).

Smith and Stulz (1985, p. 398) argue that hedging will only reduce bankruptcy cost if the firm can credibly signal that it will hedge. The reason why credibility is important, is that shareholders have an incentive to stop hedging due to an unfavourable distribution of wealth between bondholders and shareholders. To illustrate: Consider a firm, that wants to obtain a loan of 4. The firm promise debt holders that it hedges and locks firm value at 5. This causes wealth of the bond holders to be 4 while the wealth of the equity holders is 1. Assume that if the firm does not stick to its promise, the value of the firm will either be 8 or 0. If firm value is 8 bond holders get 4 and equity holders get 4. If firm value is 0 both get nothing.

Consequently the expected value of debt is 2 while the expected value of equity is 2. Thus equity holders will have an incentive not to keep their promise. Therefore this may lead to covenants that stops the firm from making this decision which destroys firm value

We will further elaborate on the above in an example in section 4.2.

2.2 Investment Coordination

Froot et al. describes a view a financial risk management that connects hedging and corporate strategy. The objective is to enable optimal investments through hedging decisions in times of changing fuel prices. I.e. to make sure that the supply of cash generated from operations is sufficient when investment opportunities arise (Froot et al., 1994).

The framework of Froot et al. (1993) analyses how hedging can effect the investment policy of firms. An assumption behind the model is that investors prefer internally generated capital. Financial markets are not frictionless. Raising capital from external investors through equity or debt issuance comes at a cost. This cost is caused by asymmetric information between managers in possession of insider knowledge and outside investors with only publicly available information. Issuing equity capital is associated with an adverse selection problem as managers are expected to act on the behalf of current shareholders and will therefore only issue equity when the stock is overvalued. As outside investors are aware of this fact they are only willing to buy the stock at a discount causing the stock price to drop (Berk and DeMarzo, 2013, p. 565-568).

Debt issuance is not affected by adverse selection to the same extend. This is because bond prices are a result of interest rates (Berk and DeMarzo, 2013, p. 570). However issuing debt has the cost of financial distress and bankruptcy, which for example arise due to loss of customers and suppliers (Berk and DeMarzo, 2013, p. 544-547). This cause managers to rely on retained earnings, and this do under some circumstances move investment away from the optimal level.

Froot et al. (1993, p. 1638-1641) shows, that in the context of hedging using forward contracts, the optimal level of hedging depends on the relation between internally generated cash flows and investment opportunities. This relation can be measured using the correlation between the two. Table 2.1 describes the optimal hedging strategies for different correlations.

Correlation	Optimal percentage to be hedged
Negative	More than expected fuel consumption
Zero	Equal to expected fuel consumption
Positive	Less than expected fuel consumption

Table 2.1

If the correlation between internally generated cash flows and investment opportunities are negative, then airlines should hedge more than the expected future fuel consumption. If there is no or positive correlation, the hedged percentage should be equal to or less than the expected future fuel consumption respectively. For high positive correlations, the optimal hedge strategy is to hedge a negative percentage of the future expected consumption (Froot et al., 1993, p. 1640).

Therefore the table implies that the optimal hedge percentage of future expected fuel consumption is decreasing in the correlation between investment opportunities and internally generated cash flows. Other parameters also affect the relation between the correlation and the optimal hedge ratio in the Froot et al. (1993) model. An example is the production function and its parameters, but to keep the focus of the analysis on the airline industry we will not go further into the mathematical details of the model.

The objective is to match internally generated cash flows with investment opportunities, so that cash is available when profitable investments possibilities arise. Empirical evidence has suggested, that the airline industry is characterized by an investment environment where investment opportunities are high when the jet fuel price is high. This is a result of more airlines going bankrupt during these periods and therefore sell aircraft at lower prices (Fire sale of assets) (Carter et al., 2006, p. 63; Pulvino, 1998, p. 972). In this case cash flows and investment opportunities will negatively correlated.

Another relation between cash flows and investment opportunities could also be suggested. It could be that an oil price decrease would affect the macroeconomic output positively, and therefore increase consumption. Higher consumption would increase demand for flights. Consequently airlines could have higher investment opportunities due to an oil price decrease. At the same time airlines fuel cost decreases due to a lower jet fuel price. Such a relation would make cash flows and investment opportunities positively correlated.

Therefore the benefits achieved through hedging depends on the correlation between internally generated cash flows and investment opportunities. In order for airlines to make optimal hedging decisions, they must understand the sign and size of the correlation (Froot et al., 1993). Therefore we will analyze the relation between internally generated cash flows and investment opportunities further in the analysis.

2.3 Leasing

In this section we cover the basic terminology of leasing, and how leasing can be used as an operational hedge to create value. Leasing in itself is a large topic in the airline industry, and we only cover the fraction related to operational hedging. Hence there are other incentives to lease such as tax incentives, that we will not be covering.

This and the next section about fleet diversity have a common assumption. The assumption is that airlines will keep operating on a route when profits turn negative as a result of fuel price increases. The reason is that sufficiently high reentry cost makes leaving less profitable than staying (Treanor, 2012, p. 465). A potential cause of the high reentry cost is, that the customer loyalty is high. Consequently, the motive of the operational hedging strategies, leasing and fleet diversity, are to reduce losses until the jet fuel price starts to decrease again or revenues have adjusted the new fuel price level.

2.3.1 Terminology

A lease is an agreement between two parties. One party, the lessor, owns the asset and receives a series of rent payments for lending the asset. The second party, the lessee, rents the asset and makes the rent payments (Berk and DeMarzo, 2013, p. 860)

Two general types of lease arrangements exist. These are operating and capital leases. Capital leases are also called finance leases. Generally speaking operating leases remain on the balance sheet of the lessor and are therefore not reported on the balance sheet of the lessee. The lessee only reports the lease payments as operating expenses. Finance leases are reported on the balance of the lessee and depreciation expenses are reported on the income statement (Berk and DeMarzo, 2013, p. 866)

The duration of operating leases is typically between 1 and 7 years, while finance leases typically have duration of 10 to 12 years. Operating lease are possible to cancel, contrary to finance leases, which are only cancelable at a large cost (P. S. Morrell, 2007, p. 197-201).

2.3.2 Leasing and perfect capital markets

In a perfect capital market setting the size of the lease payments has two determinants. These are the market value of the asset today, the purchase price and the market value of the asset at the end of the lease (Residual value). The present value of the lease payments are (Berk and DeMarzo, 2013, p. 860-863):

$$\text{PV(Lease Payments)} = \text{Purchase Price} - \text{PV(Residual Value)}$$

Secondly, if we decide to finance the purchase using debt and acquire the asset, this is equivalent to buying the asset from the lessor at the end of the lease term.

$$\text{PV(Lease Payments)} + \text{PV(Residual Value)} = \text{PV(Purchase Price)} \tag{2.5}$$

$$= \text{PV(Loan Payments)} \tag{2.6}$$

Therefore there is no difference between leasing an asset or purchasing the asset in a perfect capital market. Leasing in itself does not have any value and only market frictions can create preference for leasing.

2.3.3 Leasing And Flexibility

The option to cancel operating leases gives the lessee of an aircraft flexibility to adjust its fleet size according to market conditions.

For finance and operating leases flexibility also arise from how an airline structure the life of its lease agreements. I.e. if an airline continuously has lease agreements on parts of its aircraft expiring, the airline can renew or leave the leasing contracts depending on market conditions. This allows the airline to get rid of some aircraft during economic downturns. For example in the annual report of 2015 SAS states:

> *"We have high flexibility in our aircraft fleet since several leases will continuously mature in the next few years, which will enable us to reduce the aircraft fleet in the event of a sudden decline in demand, but also allows the option of extending lease periods in certain cases."* - (SAS Group, 2011–2017, see annual report 2015, p. 29)

The option to adjust fleet size provides an operational hedge. The operational hedge can help to preserve internal cash during times of changing economic conditions (Treanor, 2008, p. 26-28).

2.4 Fleet Diversity

This section will go through the fleet diversity framework. As mentioned in section 2.3, the framework rests on the assumption that airlines will keep operating in periods of negative profits.

2.4.1 Hedging Through Fleet Diversity

Aircraft have many sizes. The airbus A380 has a standard seat configuration of 544 seats, while a A320 carries 150 passengers. Similarly, the A320 has a flight range of 6850 km, whereas the A380 has a range of 15200 km (Airbus S.A.S, 2017). This implies that small aircraft are unable to operate flight routes of the same distance as large aircraft. For flight routes of shorter length the large and small aircraft are substitutes.

In the analysis we will consider fleet diversity using the theory of Treanor (2012). The theory distinguish between a uniform fleet and a diverse fleet. A uniform fleet consists of one large aircraft, whereas a diverse fleet has one medium sized and one small aircraft. The large aircraft has the same revenue and cost as the medium and small aircraft combined.

If the same amount of fleet capacity is used, the uniform and diverse fleet compositions will result in a revenue, cost and profit of equal size. If the utilized amounts of fleet capacity differ from one fleet to another, then these will obtain revenue, cost and profit of unequal size.

During times of low fuel prices and positive profits, the airlines are interested in using the full amount of available fleet capacity. Conversely, when fuel cost increases to the amount, where total cost exceeds the revenue, airlines are interested in limiting the operations and capacity usage to a minimum. But the airlines cannot exit the market due to high future cost, that must be incurred to reenter the marked, when the fuel price returns to a lower level again. Instead the firms will attempt to operate using a smaller part of its fleet to limit the fuel consumption and the negative profits (Treanor et al., 2014, p. 152). Thus, hedging through fleet diversity exist, because airlines can use a diverse fleet to adjust operations.

If the fleets capacity can be divided into many small parts using aircraft of smaller sizes, then the airlines will be able to reach a level of activity that is closer to the minimum level of activity required by the reentry assumption. In practice this means that an airline with a medium sized and a small aircraft will be able to stop operating the medium sized aircraft and still be represented on the flight route using the small aircraft. If instead the airline has just one large aircraft, it will have to operate the fleet at full capacity to comply with the reentry assumption, and therefore incur larger negative profits.

2.4.2 Option Value

The arguments stated so far of the fleet diversity theory means that the uniform fleet is more risky than diverse fleet and less profitable. Treanor (2012, p. 468) shows that the value of the option to scale down operations depend on the fuel price. Since airlines prefer to decrease activities when fuel prices are high, the option value is positively related to the fuel price.

Treanor et al. (2014, p. 155) also mentions that the option has a disadvantage due to increased cost. The disadvantage occurs because small aircraft might be less fuel efficient than large aircraft or because a diverse fleet requires the employees to have a wide knowledge about aircraft. Human capital, in the form of knowledge about many different aircraft type, limits specialization and can be costly to obtain. Hence the disadvantage can be understood as the price of the option. In terms of firm performance such cost lowers the operating margin in good times.

Therefore the payoff of the option to scale down depends to a large extend on the fuel price. However it also depends on the ability of the operations to adjust closely to the minimum required level of activity. This ability increases as the fleets aircraft is divided into further smaller aircraft sizes.

2.4.3 Diversity Or Divisibility

Considering the above argument, it seems as if the optimal fleet consists of many small aircraft of the same type. Such a fleet would be able to operate within a close reach of the minimum required activity level while still keeping cost low due to specialization of the employee capabilities. A counterargument is that some airlines fly long routes, which require them to have large aircraft. This is because the flight range of the aircraft vary, as mentioned initially. Hence some airlines are unable to operate with a fleet of only small aircraft.

This means that the theory of Treanor (2012) can be interpreted in two ways. One interpretation is, that a fleet of many small aircraft is a good composition, while another interpretation of the theory is, that a mix of large and small aircraft is optimal. The need to utilize large aircraft due to their range cause the latter interpretation to be assumed in the analysis.

3 Methodology

In this section we first present the collection process, and how we have adjusted and calculated the different variables. Finally we outline the statistical methods, that we use.

Included in Appendix A.1 on page 124 is a link to a database file, that contains the data used in the analysis.

3.1 Selection Process And Time Frame

We have collected information on 30 airlines from Europe and North America. We used the International Air Transport Association (IATA) list of members (IATA, 2017) as our starting point and selected the airlines. We set three main criteria in the selection process. Firstly, the airlines had to be publicly traded. Secondly, data availability, such as good access to annual reports, was an important factor. Thirdly, the airlines had to be either North American or European. Consequently, these factors restrict our final results to apply only to a limited number of airlines. These are generally speaking publicly traded, relatively large, European, and North American airlines. This led to the sample of the 30 airlines. Only one out of the 30 airlines did not report its level of hedging for all years included in the sample.

The 30 airlines satisfying the selection criteria are listed in Appendix A.2 on page 124.

Our sampling period is from 2010 to 2015. Some airlines do not end their financial year on the 31st of December and we therefore have 7 observations instead of 6 to cover the period. More specifically we include data from 2010.03.31 to 2016.10.31. These dates refer to the end dates of the fiscal years. To structure the data we assign each observation a fiscal year. E.g. observations from an airline with its fiscal year ending during the first 6 six months of 2013 has been assigned the fiscal year 2012.

During our sample period one airline drops out and one enters. During 2015 Aer Lingus Group Plc was acquired by International Airlines Group which causes the airline to drop out of the sample (IAG, 2015). Spirit Airlines enters in 2011 as they were not registered on the stock exchange before (Spirit Airlines, 2012–2016, see annual report from 2011 p. 5).

FedEx is the only carrier in our sample, that has its core business area in cargo transport. The remainder have their business area mixed between cargo and passenger transport, however, generally with the largest weight in passenger transport.

3.2 Data And Variables

We collected all data points at the end of the fiscal years for each airline. E.g. if an airline had its fiscal year ending 31.12.2010 we obtained all data points for this date. Balance sheet and income statement data were obtained from Compustat (2017). Examples of these are: Total revenue, cash flow from operations, Earnings before interest and taxes (EBIT), capital expenditures (CAPEX) etc.

For airlines with stock price and financial statement data in different currencies we translated the stock price to the local currency using exchange rates from Datastream (2017). The translation allowed us to compute financial ratios such as leverage ratios and profitability ratios.

The variables load factor, fleet age, and fleet size were obtained from the performance statistics sections of the airlines annual reports. Some airlines did not report the load factor. Instead some reported total occupied seat miles (Occupied seats · Flight distance) and total seat miles (Total seats · Total flight distance). For these airlines we divided the numbers to obtain the load factor ourselves ($\text{Load Factor} = \frac{\text{Occupied seat miles}}{\text{Total seat miles}}$) (Vasigh et al., 2015, Ch. 7). We found the airlines' ages through their websites.

We obtained the jet fuel prices from Federal Reserve Bank of St. Louis (2017a, Search key: WJFUELUSGULF). These prices are monthly and are calculated as averages of the prices in the prior month. A problem with this approach is that the actual fuel price could have been different in the first 11 month of the financial year and thus have had an affect on the cost of fuel and thereby the income statement.

3.2.1 Percentage Hedged Next Year

Percentage hedged next year (HPCTNXY) denotes the ratio between the amount of jet fuel hedged next year and next year's expected jet fuel consumption:

$$\text{HPCTNXY} = \frac{\text{Amount hedged in gallon}}{\text{Amount of next years expected fuel consumption in gallon}}$$

We collected the ratios for each airline manually using mainly annual reports and quarterly performance presentations as our sources. In some cases where HPCTNXY was unreported, we tried to identify the input to compute the ratio ourselves. If only the amount of fuel hedged next year was reported we used the actual consumption in the following year as a proxy for the expected fuel consumption. For this variable 15 of the 183 observations in the data set are missing. We therefore end up with a total number of observations of 168. Croatia airlines did not report its HPCTNXY values for any of the six years during the sampling period. We were not able to locate the HPCTNXY values for Aeroflot in the two first years. Similarly, we were unable to find HPCTNXY for International Airlines Group (IAG), Turkish Airlines and Delta Airlines in some years.

3.2.2 Tobin's Q

Tobin's Q is a measure of whether the market value of the firm is above the market value of the firms assets. The market value of the firms assets is referred to as the replacement value in the context of Tobin's Q. The variable can be used to describe whether the firm is generating a sufficient return on its assets (Damodaran, 2012, see ch. 19). Tobin's Q is a difficult variable to calculate but Chung and Pruitt (1994, p. 70-71) provides a formula that approximates the calculation in a simple way:

$$\text{Tobin's Q} = \frac{\text{Market value of equity} + \text{Preference shares} + \text{Debt}}{\text{Total assets}}$$

We obtained the market value of equity on the ending date of the financial statements of each airline to match the date of market and balance sheet values. The market data was obtained from Compustat (2017). Chung and Pruitt (1994, p. 71) explain that debt in the above formula should be calculated as:

$$\text{Debt} = \text{Current liabilities} - \text{Current assets} + \text{Long-term debt}$$

Finally the numerator also contains preference shares, which have been included for SAS AB. The denominator consists of the value of the total assets, which in this way serves as a proxy for the replacement value of the firms assets. The true replacement value of the assets, the market value of the firms asset, can be problematic to estimate. When the book value of the total assets is used as a proxy for the replacement value, it means that the denominator is not adjusted for inflation and technological changes. Thus the denominator includes the cost value of the assets adjusted for depreciation recorded by the firm.

If inflation is high it means that total assets can underestimate the value of the replacement cost. Technological changes affects the value of the replacement cost in a similar way but technological improvements decrease the replacement cost, because aircraft become cheaper to produce (Damodaran, 2012, see ch. 19). Airlines own aircraft for many years. Therefore the balance sheet of airlines contain assets, that have been recorded at cost incurred many years ago. Thus, due to inflation and technological change the replacement value of the assets and the value of the total assets could potentially deviate. A counterargument to technological change is, that aircraft producers sell the same models for many years. For example the Boeing 747 started flying in 1969 (The Boeing Company, 2017), which indicate that the technological development in the aircraft producer industry moves relatively slow. Therefore total assets as a proxy for the replacement cost of the assets seems reasonable.

3.2.3 Exposure Coefficients

To get a general picture of how each airline is exposed to jet fuel price changes we follow a methodology similar to the one of Berghöfer and Lucey (2014, p. 129). Therefore, we set up the regression model below to obtain a measure of each airlines average monthly exposure.

$$R_{i,m} = \beta_{0,i} + \beta_{1,i} R_{mkt,m} + \beta_{2,i} R_{JF,m} + \beta_{3,i} R_{EX,m} + \epsilon_{i,m} \tag{3.1}$$

Where $R_{i,m}$ denotes airline i's stock return, $R_{mkt,m}$ the market return, $R_{JF,m}$ the jet fuel price return and $R_{EX,m}$ the exchange rate return. All returns are monthly log returns.

The coefficients of interest are the $\beta_{2,i}$ estimates, which tell by how many percent a stock price has been affected as a result of a 1% increase in the jet fuel price.

We used a time horizon of only one year leading to a $\beta_{2,i}$ estimate sensitive to current information. The advantage of a short time horizon is, that current information is reflected in the data. The disadvantage is, that our estimates will be unrepresentative of a given airline in case of an unusual year. Finally the choice of a short time horizon also allowed us to increase the number of exposure coefficients. The reason is that some airlines have not been listed long enough to allow for a longer horizon. A longer time horizon may give more representative estimates of a given airlines actual exposure. However, the loss of observations is likely to cause a bias, as the younger airlines will be less represented in the sample (Berk and DeMarzo, 2013, p. 433).

We obtain the exposure estimates at the point where the financial year ended. I.e. if an airline finished the financial year on 31.12.2010, we obtain the beta estimate at this date. An alternative approach would have been to obtain the estimate on the release date of the financial report. However because this point in time usually occurs several month after the financial year has ended, the stock price could contain newer information than that of the financial report.

In estimating the the betas we used monthly data. The reason for this choice is due to liquidity concerns of the smaller airlines, for which trading volume is rather low (Berk and DeMarzo, 2013, p. 433). This means that each estimate is based on a sample of 12 observations.

We obtained stock data for the 30 airlines in the sample from Compustat (2017) and used the MSCI World Total Return index as a proxy for the market return (Datastream, 2017, search key: MSWRLD). The monthly return of jet fuel price was obtained from Federal Reserve Bank of St. Louis (2017a, search key: WJFUELUS-GULF). We found the monthly data for the trade weighted US dollar index through Federal Reserve Bank of St. Louis (2017b, search key: TWEXBMTH). This index is a broad index meaning that it contains data from many currencies, and thus it includes the currencies of countries such as Sweden and Russia. SAS and Aeroflot's financial statement and stock values are in these currencies, which is why we find the index appropriate.

3.2.4 Credit Ratings

We have obtained two measures for evaluating the credit worthiness of the airlines. These are S&P/Fitch ratings and the distances to default. We calculate distances to default because credit ratings from S&P and Fitch is not available for all airlines.

S&P and Fitch ratings

We have collected S&P's long term issuer ratings, both domestic and foreign. Long-term means that debt has a longer maturity than 1 year (S&P, 2016, p. 4). However S&P ratings only exist for some of the airlines in our sample. Therefore we also use Fitch ratings if these are available. Subsequently the Fitch ratings are translated into S&P ratings using the translation table of BIS (2017). Ratings of North American companies were extracted from Compustat (2017), while the remainder were found on Thomson ONE Banker (2017). In total we obtained 91 ratings and the largest part were from S&P. These 91 observation describe the ratings of 19 of the 30 airlines. Thus we lack ratings for 11 airlines. The number of ratings obtained for each airline variate from 1 to 7 depending on whether the debt of the airlines were rated in all or only some of the sampling period years.

Distance To Default

To get another measure of our sample credit rating we implemented the KMW Corporation procedure described by Crosbie and Bohn (2003, p. 10-14). The model used by KMW to estimate distance to default is a Black Scholes based model. The underlying assumptions of the model is beyond the scope of this thesis, however, in the below we give an overview of the different components of the model.

Firstly, we consider a firms equity as a European call option on the firms assets with a strike price equal to the face value of debt. The value of the call option, according to the Black-Scholes model, is given by:

$$V_E = V_A N(d_1) - e^{-r_f T} D N(d_2)$$

where:

- $d_1 = \frac{ln(V_A/X) + \left(r_f + \frac{\sigma_A^2}{2}\right)T}{\sigma_A \sqrt{T}}$
- $d_2 = d_1 - \sigma_A \sqrt{T}$

V_E is the market value of equity, r_f the risk free rate, σ_A the asset volatility, X is firm's default point at time T, N($\cdot$) denotes the standard normal cumulative distribution function. Further one can show that the relationship between the firm's asset volatility and equity volatility is given by (Crosbie and Bohn, 2003, p. 15):

$$\sigma_E = \frac{V_A}{V_E} N(d_1) \sigma_A$$

We therefore have two equations with two unknowns. Solving for σ_A and V_A we can compute a measure of the distance to default using the equation below:

$$DD = \frac{V_A - X}{V_A \sigma_A}$$

To find an estimate of the firms default point, X, Crosbie and Bohn (2003, p. 3) suggest using a level that lies somewhere between short term liabilities and long term liabilities. Hence we use the short term debt plus half the long-term debt to proxy for this point. The basic idea is, that as the short term liabilities mature, the firm also has to amortize on the long-term debt to avoid default. Using Excel's solver function we arrived at our final estimates for asset value and volatility. Subsequently we calculated the distance to default.

3.2.5 Lease To Total Fleet

The lease to total fleet ratio (LeaseToFleet) was collected manually from annual reports and investor presentations. We calculated the ratio as the number of leased aircraft divided by the total fleet size. A typical airline's fleet consist of owned, financially and operationally leased aircraft. We have merged the operationally and financially leased aircraft into one category and the owned aircraft into a second. As operating leases are characterized by shorter time frames than finance leases this merging is likely cause some problems with regards to measuring the value and effect of the flexibility of leasing in the analysis.

3.2.6 Aircraft Dispersion Index

We use the aircraft dispersion index (ADIndex) variable as a proxy for fleet diversity in the analysis. The variable was calculated for 28 of the 30 airlines in the data set. The ADIndex for Dart Group Plc and Transat A.T. Inc. was not calculated because the airlines did not report fleet information. We used data from annual reports and investor presentations to calculate the ADIndex with below (Treanor et al., 2014, p. 157):

$$\text{ADIndex}_i = 1 - \sum_{j=1}^{N} \frac{(\text{Number of aircraft in category}_j)^2}{(\text{Total number of aircraft}_i)^2}$$

Where N is the number of aircraft types that the airline has. The numerator contains the squared number of aircraft that the airline operates of a specific type. The denominator contains the squared number of total aircraft that the airline operate.

The ADIndex will be one if the airline has one aircraft of each type and zero if it has only one aircraft type. The index increases in the number of different aircraft types.

Airlines define aircraft types differently. SAS AB for example report the aircraft types A330, A340 and A350 in the same category while other airlines report them separately (SAS Group, 2011–2017, see annual report 2015, p. 30). This complicates the calculation of the ADIndex variable. We gathered the aircraft types in 49 categories based on size, manufacturer and data availability. An example of a group of aircraft types is the A318/A319/A320/A321 group. These are referred to as the A320 family. Airbus produces all four aircraft and their size is fairly similar with standard capacity of 107, 124, 150 and 185 passengers, respectively (Airbus S.A.S, 2017). It is however a weakness of the ADIndex that we are not able to group the airlines more precisely. Class configuration differences also affect the capacity of the aircraft, and such details are not accounted for in the calculation of the ADIndex (Berghöfer and Lucey, 2014, p. 128).

Another example of a problem, arises with the reporting of aircraft types of smaller aircraft. Small Boeing aircraft are reported more precisely than small airbus aircraft. Therefore two airlines with the same number of different aircraft types can have a different ADIndex.

Appendix A.3 on page 124 shows the categorization of the 49 aircraft types used, when we calculated the ADIndex variable. In comparison Treanor et al. (2014, p. 157) find 57 aircraft types.

3.2.7 Operating Lease Adjustments

Operating leases are off-balance sheet. This means that the true leverage of the airlines are higher than the leverage ratio calculated using the amount of debt stated in the financial statements (Damodaran, 1999). We therefore adjusted the debt for operating leases.

For each year from 2010 to 2015, data on future lease commitments was obtained for the airlines through Compustat (2017), Thomson ONE Banker (2017) and financial statements of the airlines. Subsequently, the future lease commitments were discounted back to the time at which the financial statements had their ending date. We discounted the commitments following the method recommended by Damodaran (1999, p. 11), who also states that the discounting rate should be the before taxes rate. To simplify the calculations all airlines future lease commitments were discounted using a rate of 4.05%. This is the cost of debt before taxes for the US airline industry. (Damodaran, 2017b).

The CAPEX variable was adjusted for operating leases by following the approach of Carter et al. (2006, p. 68). The adjustment consisted of the current year's present value of future lease commitments subtracted the previous year's present value of future lease commitments. This difference was added to the unadjusted CAPEX. Therefore the adjusted CAPEX is higher when airlines invest in aircraft using operating leases compared to the unadjusted CAPEX.

We also adjusted the net debt to market value of equity variable (NetDMVE). The adjusted variable is the net debt operating lease adjusted to market value of equity ratio (NetDOPLAdjMVE). We adjusted the ratio by adding the present value of the future lease commitments to the debt part of the ratio.

Tobin's Q (TobinQ) was also adjusted and denoted Tobin's Q operating lease adjusted (TobinQOPLAdj). The calculation added the present value of the future lease commitments to the numerator through the debt variable and the denominator through total assets. The approach is consistent with the procedure applied to adjust Tobin's Q for operating leases in Carter et al. (2006, p. 68)

3.3 Statistical Methods

3.3.1 Descriptive And Statistical Analysis

Along with different simple descriptive statistical tools such as time series graphs, box-plots, histograms etc. we analyze the relationship between variables by splitting the variable of interest into two groups according to the obtained median of each airline. Thus we get a low median group and a high median group. This approach makes it possible two test for simple relations between the groups across different variables by conducting t-tests of differences between two group means. This methodology is inspired by Treanor et al. (2014, p. 166). When we test for differences between means we use t-tests which build on three assumptions. The first assumption is normality in the underlying population distributions, the second is unknown population variances in the two groups, and the third is, that the population variances of the groups are unequal (Newbold et al., 2013, p. 396-397).

3.3.2 Regression Analysis

We further analyze the data using regression analysis by employing different regression models, which require several assumptions to be satisfied to give reliable estimates. The models and some of the relevant assumptions will be covered in this and the following sections. The motivation behind using more than just a single model is to perform a robustness test of our results and to give an idea of whether the choice of estimation procedure has an effect on the result.

Omitted variable in regression analysis arise from correlation between the independent variables and the error term of the regression (Wooldridge, 2014, p. 76).

Generally speaking such a bias implies that repeating the regression analysis over several samples would on average lead to coefficients different from the true coefficients (Wooldridge, 2014, p. 769).

An assumption that is common for all the regression models used in this thesis is, that they require the assumption of random sampling to be satisfied (Wooldridge, 2014, p. 74-497). We have not been able to obtain data for all years for each airline. An example is the hedging percentages of next years expected fuel consumption (HPCTNXY), where we have been unable to gather 15 observations. This can be problematic if the missing observations are not missing at random (Wooldridge, 2014, p. 293). The observations are missing in our data set because some airlines have not reported HPCTNXY in some or all years. For example, Croatia Airlines did not report HPCTNXY for any of the six years. This is problematic because Croatia Airlines is a small airline, which operated a fleet of 12 aircraft in 2015 while the mean fleet size in our sample was 313 and the median 211.

The analysis thus lack information about the hedging behavior of a smaller airline and not just a number of random observations. On the other hand, only 15 observations out of 183 are missing, and hence the problem is limited. Another issue is that we only have airlines listed on the stock exchange in the sample. Larger airlines are potentially unrepresentative for smaller airlines and therefore the results of the analysis might only hold for listed airlines.

An additional problem that might arise in the data set is measurement error which, under certain assumptions, can lead to a downward bias in the estimated coefficients. An example of a measurement error is when we adjust the debt for operating leases. The reason is that we do not know each airlines pre-tax cost of debt and therefore apply an average rate for the industry as a whole. Using the operating lease adjusted debt as an independent variable biases the estimated beta coefficient on operating lease downward. The size of the bias increases with the variance of the measurement error (Wooldridge, 2014, p. 291).

Panel data models

The term panel data refer to data that has been sampled from the same entities over time Wooldridge (2014, p. 402-403). We have therefore obtained data on the same airlines over the period from 2010 to 2015. We analyze panel data using three models: The pooled OLS, the first difference (FD) and fixed effects model (FE).

We use pooled OLS by regressing pooled cross sections and including year dummy variables. It is a requirement of pooled OLS, that the independent variables are uncorrelated with the error term. This requirement is not satisfied if the error term contains unobserved factors, that are correlated with the independent variables (Wooldridge, 2014, p. 413). An approach to avoid this problem is to include control variables for each of the omitted factors. Unfortunately this is not always possible, because some factors are unobservable. An example of an unobservable factor is management skills, which influence firm performance but are difficult to measure.

To mitigate this problem, we use the first difference and fixed effects model to control for unobserved entity factors, that are constant across time (Wooldridge, 2014, p. 462-463).

In panel models the definition of the error term is expanded to consist of two terms, an idiosyncratic error and an unobserved effect term (Wooldridge, 2014, p. 413). The first difference and fixed effects models controls for the unobserved effect term of the error.

We do not consider serial correlation to be an issue in our panel data set up, because the number of time periods is small compared to the number of entities/airlines (Wooldridge, 2014, p. 440). To address the problem, however, we use cluster-robust standard errors in all of our regressions to allow for heteroscedasticity and serial correlation within each set of observations. Each set of observations are referred to as clusters.

The idea of the first-difference model is to regress changes from one period to the next for each entity in the sample (Wooldridge, 2014, p. 414). If we consider our sample of six years of observations for each airline, we get a total of 180 observations (Our number is 183 caused by differences in fiscal year ends). When we take the first difference of our data, we reduce the number of observations by 1 year for each entity assuming that we have a full set of observations for each airline. Thus we lose 30 observations. This is a cost of using this approach.

Fixed effect estimation works by finding the mean of each variable for each airline in the regression and demeaning the values by subtracting the mean from each observation. The fixed effects model uses the within R-squared, that only describes time variation. Time constant variation is not considered because fixed effects removes this type of variation (Wooldridge, 2014, p. 435-437).

Even though the first difference and fixed effects models mitigate some of the omitted variable bias, we still have problems. If the unobserved factors are not stable across time it will induce an omitted variable bias (Wooldridge, 2014, p. 414). On top of this problem simultaneity cannot be solved by panel data regressions.

Instrumental variable regression

Instrumental variable estimation can eliminate simultaneity, which arise when two variables are a function of each other. An example is the effect of hedging on firm value. Assuming that hedging causes higher firm value, airlines with low firm value might attempt to increase firm value by increasing the amount of hedging. In this case we have, that low firm value cause higher levels of hedging. Therefore simultaneity bias makes it difficult to find the true causal relation of hedging on firm value (Wooldridge, 2014, p. 501-502). In addition instrumental variable regression can also be used to mitigate omitted variable bias (Wooldridge, 2014, p. 462).

We conduct instrumental variable regression analysis using two stages. In the first stage the endogenous variable is regressed on the instrument. This generates predicted values of the endogenous variable. The second stage regression model is similar to the usual OLS regression model, however, the endogenous variable is switched with its predicted equivalent from the first stage. The coefficient on the predicted value from the second stage is unbiased given instrument relevance and instrument exogeneity (Wooldridge, 2014, p. 463-476).

Instrument relevance requires, that the instrument is able to explain some of the variation in the variable being instrumented (Wooldridge, 2014, p. 462-463). Instrument relevance is satisfied, if the instrument has a t-test value of approximately or above 3.2 in the first stage regression. If the assumption of instrument relevance is not satisfied, it indicates that the instrument is weak and the estimated coefficient can be biased (Wooldridge, 2014, p. 478). Instrument exogeneity means that the instrument and the error term of the second stage must not be related. It is difficult to test for instrument exogeneity and thus we will have to argue whether this assumption is satisfied (Wooldridge, 2014, p. 463).

4 Analysis

The analysis is based on the four frameworks described in the theory section above. To explain why firms hedge differently, we have to understand airlines hedging behavior, and how it is related to firm value and jet fuel price exposure.

We analyze hedging behavior of airlines to understand which factors affect the magnitude of hedging, and thus see if firms hedge according to the different theories of hedging. The hedging theories claim, that airlines can increase firm value by hedging according their prescribed procedure. We therefore also look at firm value, to understand whether this is the case empirically.

Further we investigate exposure for different reasons. Exposure provides the connection between financial hedging strategies and operational hedging strategies because hedging works through the effect on exposure. Thus, to evaluate whether these strategies work as substitutes we need exposure. In addition some of the models of financial hedging and operational hedging provides value through lowering exposure.

The structure of the analysis is as follows. Key variables that we use throughout the analysis are described first. Subsequently financial hedging theories are the focus of the first part of the analysis, while operational hedging frameworks are considered afterwards.

In the sections of Financial Distress, Investment Coordination, Leasing and Fleet Diversity the theories are first connected to the airline industry through the use of an example. Then one or more hypothesis are tested using statistical methods. Finally the results are discussed.

4.1 Data Overview

4.1.1 Percentage Hedged Next Year

For the percentage hedged of next years expected fuel consumption (HPCTNXY) we have been able to obtain 168 observations of a total of 183. An overview of the data is given in Appendix A.4 on page 125. The mean of all the 168 HPCTNXY observations is 41.58% and the standard deviation is 29.24%. The lowest observation had a value of zero, meaning that the airline hedged 0% of next years expected fuel consumption while the maximum HPCTNXY value was 100%. For example the average HPCTNXY of JetBlue Airways was 15.33% over the period, while SAS had an average HPCTNXY of 53%.

Figure 4.1 shows a histogram of the HPCTNXY observations. The distribution of HPCTNXY is evenly spread out between 0% and 100%, but that a large number of observations is below 10%.

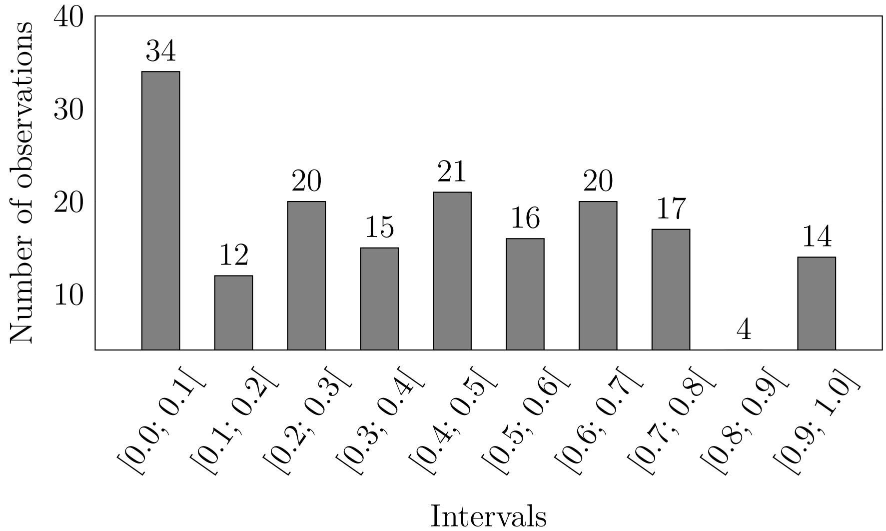

Figure 4.1: Percentage hedged of next years expected jet fuel consumption

As a comparison Berghöfer and Lucey (2014, p. 127-129) report a mean hedge percentage value of 24.31% and a standard deviation of 27.1% for the period 2002-2012. For the period 1992-2003 Carter et al. (2006, p. 67-69) find a hedge percentage of 10.9% and a standard deviation of 20%. Our sample mean HPCTNXY value of 41.58% is therefore higher than the mean of the prior findings but the standard deviation of 29.24% is reasonably close.

4.1.2 Tobins Q

We use Tobin's Q to explain and compare the performance of airlines. Appendix A.5 on page 126 contains the mean, standard deviation, minimum and maximum Tobin's Q values for each of the 30 airlines. The corresponding Tobin's Q values adjusted for operating lease commitments are tabulated in Appendix A.6 on page 127.

The overall mean of the unadjusted Tobin's Q is 0.7867 for the 30 airlines. Following the interpretation of Tobin's Q described in section 3.2.2, this value implies, that airlines on average generate a return below the required return on the assets. Appendix A.6 shows, that when the measure is adjusted for operating lease commitments, the overall mean is closer to one with a mean of 0.8389. The effect on Tobin's Q is limited, because both the numerator and the denominator is effected by the adjustment.

The above numbers are based on the assumption that the replacement value is correctly approximated using the total assets value of the airlines balance sheets. The overall standard deviation of Tobin's Q is 0.4738 and the standard deviation of the operating lease adjusted Tobin's Q is 0.3689. This means that unadjusted Tobin's Q is more dispersed than the adjusted.

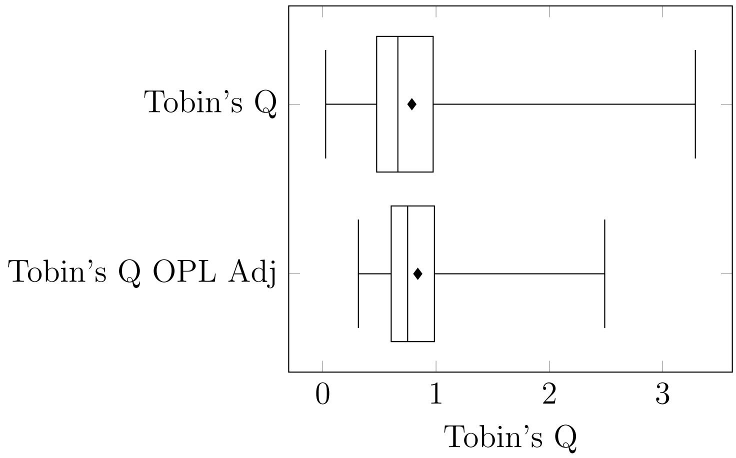

Figure 4.2: Box plot of Tobin's Q and Tobin's Q adjusted for the present value of future operating lease commitments. The diamond marks the mean.

The box plot in, figure 4.2 also shows, that the lower and upper quartiles are more dispersed for the unadjusted Tobin's Q compared to the operating lease adjusted Tobin's Q. The figure also illustrates that the mean and the median of the adjusted values are slighty closer to one than the unadjusted values. Airlines are thus closer to generating the required return of the assets when measured on the operating lease adjusted Tobin's Q.

Looking at airlines individually we find a Tobin's Q mean for Deutsche Lufthansa AG of 0.4432, whereas Ryanair Holding Plc, has a high mean of 1.2154. The Tobin's Q means adjusted for operating lease of these to firms are 0.4767 and 1.2103, respectively. Therefore both the adjusted and unadjusted measures of Tobin's Q indicate that Ryanair Holding Plc is better at managing its assets/aircraft than Deutsche Lufthansa AG.

Prior research reported a mean Tobin's Q value of the period between 1992 to 2003 of 95.5% and a mean Tobin's Q adjusted for operating lease value of 96.2% (Carter et al., 2006, p. 67-69).

4.1.3 Exposure Coefficients

In this section we present our estimated exposure coefficients obtained using the methodology introduced in section 3.2.3. We have been able to obtain 181 exposure coefficient estimates. The table in Appendix A.7 on page 128 gives an overview of the estimated coefficients across airlines.

From the table we see that the most negatively exposed airlines during our sampling period are American Airlines, JetBlue Airways, and United Continental Holdings. At the other end of the spectrum is SAS, Aeroflot, and Flybe Group Plc. with the highest positive exposures. For these airlines an increase in the jet fuel price has led to a stock price increase.

The overall mean exposure coefficient is -0.1861 and significantly different from 0 at the 5% level (p-value = 0.0027). The interpretation of this coefficient is, that a 1% increase in the jet fuel price has, on average, been associated with a decrease in the stock price return of -0.1861% in our sample.

Of the 181 coefficients 111 are negative (61%), while 70 are positive (39%). Further, we conduct a one-sided t-test of the negative coefficients, testing whether the coefficients are significantly less than 0. We find that 21, 36, and 49 are significant at the 5%, 10% and 15% level respectively. Similarly for the positive coefficients 9, 15, and 22 are significantly larger than 0 at the 5%, 10% and 15% level respectively.

These findings are similar to those of Berghöfer and Lucey (2014, p. 127-131) despite a difference in the data frequency. In our estimation we use monthly data, where they use weekly observations. Berghöfer and Lucey (2014) found that 68% of the airlines in their sample were negatively exposed. Of the negatively exposed airlines 28% had exposure coefficients significantly less than 0 at the 10% level. We found that $36/111 \approx 32\%$ were negatively and significantly exposed.Berghöfer and Lucey (2014) use data from 2002 to 2012. The overall mean exposure in their sample was -0.131, which is also rather close to our result of -0.1861.

A positive exposure coefficient means that an increasing jet fuel price should cause the stock price to increase. One would expect the opposite pattern as airlines are consumers of jet fuel and should be hit negatively by jet fuel price increases. Berghöfer and Lucey (2014) and Treanor et al. (2014) also obtain positive coefficients, however do not explain these findings.

The closest we get an explanation for these coefficients is, that the competitive environment may be an important determinant of exposure (Treanor, 2008). For example, if demand is very sensitive to price changes, airlines may find it harder to pass through a jet fuel price increase compared to airlines facing a less sensitive demand (Treanor, 2008, p. 19). This causes the latter to be less exposed to the jet fuel price than the former. However, this mostly explain why some airlines have no exposure, and not why they have positive exposure.

Actual Versus Absolute Exposure

Figure 4.3 presents box plots of the actual and absolute values of the estimated exposure coefficients. The actual exposure coefficients have a wide range of values, both positive and negative. Some airlines have experienced a negative impact on the stock price return in some years (the minimum observed exposure coefficient was -3.87) and a positive in other years (the maximum observed exposure coefficient was 2.44) during our sample period. Consequently, the mean exposure coefficient of -0.1861 is a measure constructed by both positive and negative values resulting in a cancel out effect between positive and negative values. To be able to analyze the exposure coefficients and get a measure of exposure that is unaffected by the cancel out effect we use the absolute values depicted in the upper box plot in Figure 4.3. Berghöfer and Lucey (2014, p. 129) and Treanor et al. (2014, p. 161-162) also use this procedure in their research.

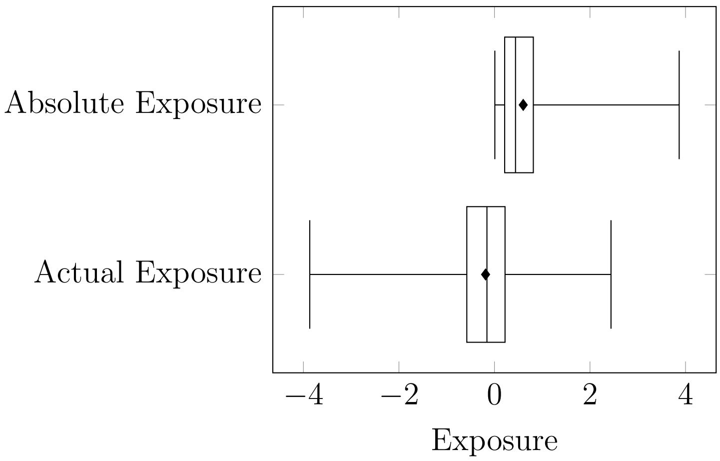

Figure 4.3: Box plot of actual and absolute values of the estimated exposure coefficients

The mean of the absolute exposure is 0.6019. Thus, a 1% increase in the jet fuel price return causes on average an absolute change in the stock return of 0.6019%.

The position of the box in the plot relating to the absolute exposure coefficients suggests, that the distribution is positively skewed. This implies that relatively few airlines experience the most extreme stock price movements caused by jet fuel price movements.

4.1.4 Fuel Price Development

Figure 4.4 plots the fuel price development on the vertical axis to the right hand side. HPCTNXY, Tobin's Q, and the Absolute Exposure coefficients are plotted on the vertical axis on the left hand side. The values plotted are mean values of all airlines obtained at the dates where the financial year ended.

The jet fuel price was at its highest level from 2010 to 2013 at a level of 2.9 and decreased during 2013 and 2014 to a level slightly above 1.1 USD pr. gallon. The reduction from 2.9 to 1.1 USD pr. gallon corresponds to a decrease of 62%.

For the other variables we first find a mean value of HPCTNXY for each year that is relatively stable around a level of 40%-50% for all years. Tobin's Q moves in the opposite direction of the jet fuel price, increasing from the lowest level of approximately 0.6 during 2010 and 2011 to a level slightly above 1 during 2014. Finally, the mean value of the exposure coefficients decreases over the sampling period from a level of 0.8 to a level of 0.4 in 2015.

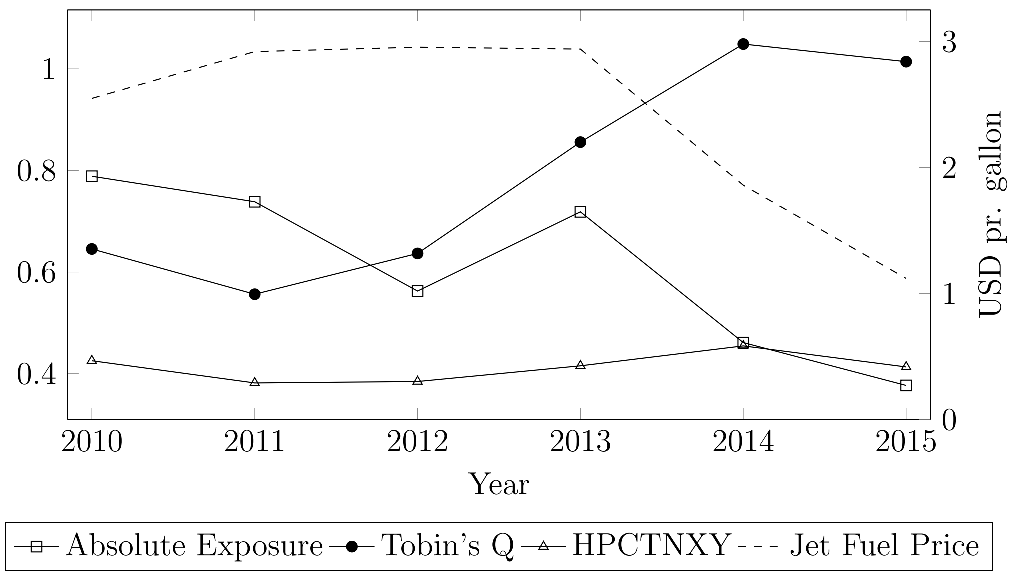

Figure 4.4: Fuel price, HPCTNXY, Tobin's Q and Exposure.

4.1.5 Other Variables

Appendix A.8 presents summary statistics of the above and the remaining variables used in the analysis. The table contains the mean, standard deviation, minimum, maximum values along with the number of observations, that we have obtained.

The debt to market value of equity (DMVE) jumps from a mean value of 1.6282 to 3.6031, when we adjust for operating leases. This illustrates the importance of adjusting variables for operational leasing as discussed in the methodology. We have adjusted the debt to equity ratio (DOPLAdjMVE), CAPEX to revenue (CAPEX-OPLAdjToRevenue), net debt to equity (NetDOPLAdjMVE), distance to default (DistanceToDefaultOPLAdj), and Tobin's Q (TobinQOPLAdj).

We translated the S&P and Fitch ratings into numerical values, found the mean, minimum and maximum values and translated these back into letters. We see that the mean rating during our sampling period is BB-, the minimum a D rating and the maximum a BBB+ rating.

4.2 Financial Distress

This section will analyze the airline industry using the framework of Smith and Stulz (1985). Initially an example of JetBlue Airways will be used to illustrate the framework. Subsequently an empirical test will investigate whether the airline industry hedges in accordance with the the model of Smith and Stulz (1985).

4.2.1 Example: JetBlue Airways

This example demonstrates, how the framework of Smith and Stulz, described in section 2.1, can be applied to the airline industry. JetBlue Airways has been chosen to illustrate the implications of the theory, as the company's financial statements are denoted in USD. This simplifies the examples, because fuel is also denoted in USD.

Below we first state assumptions and numbers used in the example. Secondly, we calculate three different firm values of JetBlue Airways to compare the effect of hedging in different fuel price scenarios.

Assumptions And Financial Statement Numbers

Data from the 2013 to 2015 financial statements of JetBlue Airways has been used in the calculations below (JetBlue Airways Corporation, 2011–2016). The financial statement of JetBlue Airways can be found in Table 4.1.

JetBlue Airways hedged 5% of next years expected fuel consumption at the end of 2015. The average hedged percentage between 2010 and 2015 was 15.33%. JetBlue Airways used a low level of fuel hedging at the end of 2015 compared to the previous years. We will assume, that JetBlue Airways hedges all of the expected fuel consumption or none in the calculations below.

When calculating the value of a firm the analysis would normally account for all future profits of the firm. A thorough approach would include a reformulation of the financial statements to find NOPAT (net operating profit after taxes) and FCFF (free cash flow to the firm). Instead of doing this we attempt to simplify the example by following the method outlined in section 2.1. Thus, the calculations use the estimated EBITs of two 2016 fuel price states as a measure of the future value of Jetblue Airways' equity and debt.

We define two states: Up and down. These depend on the fuel price development. The average fuel cost of JetBlue Airways' was $1348/700 = 1.9257$ USD per gallon in 2015 (JetBlue Airways Corporation, 2011–2016). The up state considers a drop in the fuel price of 1.4 USD per gallon to a price of $1.9257 - 1.4 = 0.5257$ USD and in the down state the cost increases symmetrically to $1.9257 + 1.4 = 3.3257$ USD. The symmetry of the future fuel price variation is important, because it establishes a situation with a linear hedge, which is consistent with the presentation of the framework in section 2.1. We assume, that the fuel price increases or decreases with a probability of 50%

	Actual			Future states	
	2013	2014	2015	2016	
				Down state	Up state
Analytical income statement:					
Revenues	5441	5817	6416	6416	6416
- Aircraft fuel cost	1899	1912	1348	2328	368
- Other operating expenses	2824	3070	3507	3507	3507
= EBITDA	718	835	1561	581	2541
- Depreciation and amortization	290	320	345	345	345
= EBIT	428	515	1216	236	2196

Table 4.1: Actual EBIT of JetBlue Airways in 2013, 2014, 2015. EBIT for 2016 are estimated based on the two fuel price scenarios. The up state is calculated with a fuel price of 3.3257 USD per gallon and the down state assumes a fuel price of 0.5257 USD per gallon. Source: (JetBlue Airways Corporation, 2011–2016).

Table 4.1 shows the EBIT calculation of the up and down states. JetBlue Airways consumed 700 million gallons of aircraft fuel in 2015 (JetBlue Airways Corporation, 2011–2016, see annual report 2015, p. 10). At an average fuel cost of 1.9257 USD per gallon, this resulted in a fuel cost of $1.9257 \cdot 700 = 1348$.

In the two future states we assume, that revenue and other operating cost are unchanged from 2015. However the fuel cost will be effected by the fuel price changes. The up state of Table 4.1 shows a fuel cost of $0.5257 \cdot 700 \approx 368$ and

$3.3257 \cdot 700 \approx 2328$. Large variations in the fuel price have been chosen to ensure that the value of the firm would fall below the face value of debt in the down state.

The face value of debt constitutes the debt payment in both up and down state, and we assume, that the full face value of debt will be paid back to the debt holders after one period. The debt payment is also assumed to be fully deductible (Kraus and Litzenberger, 1973, p. 913).

If JetBlue Airways is unable to pay the full face value of the debt in 2016, they will pay all of the EBIT generated to debt holders. Equity holders will not receive anything in this case. In the context of the Smith and Stulz (1985) the face value of debt serves as the default point. Hence bankruptcy cost will be incurred, if the firm's EBIT drops below the face value of the debt. Below we will see, that bankruptcy occurs in the down state when the firm uses leverage, because EBIT is low as a result of high fuel cost. JetBlue Airways can increase its value by avoiding bankruptcy cost through hedging, because hedging limits the minimum EBIT. This implies that the firm will not end up in the down state, even if the jet fuel price is high.

The 2015 balance sheet of JetBlue Airways showed a face value of debt of 1,827 million USD. JetBlue Airways published its 2015 financial report on the 17th of February 2016, and by the end of February the market value of the airline was 7,064 million USD (Compustat, 2017). Adding the market value of equity to the face value of debt results in a firm value of $7064 + 1827 = 8,891$ million USD. In this calculation we assume, that the face value of debt is equal to the market value of debt, which is an acceptable assumption according to Berk and DeMarzo (2013, p. 40). Figure 4.5 illustrates the development of the value of equity, debt and firm value between 2010 and 2015.

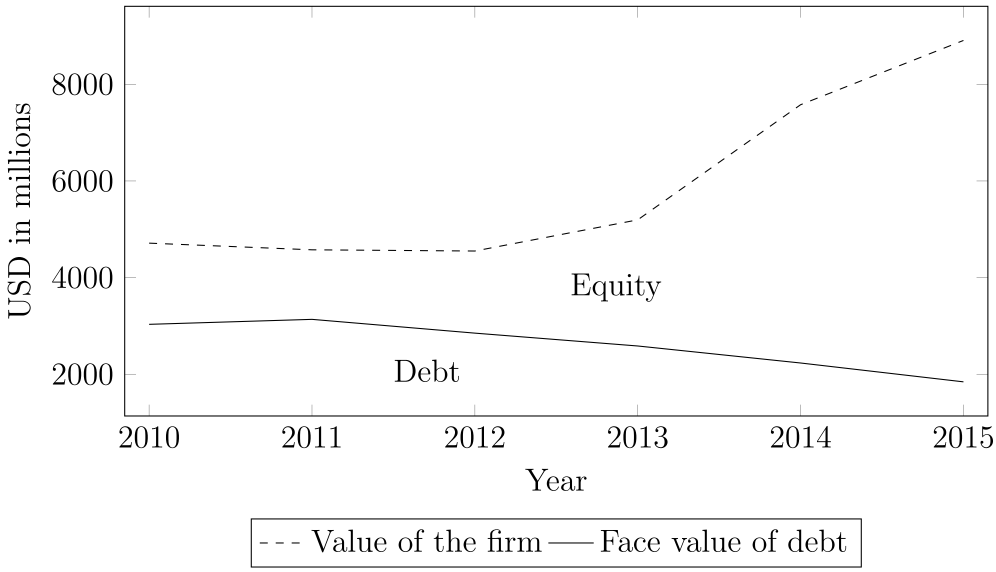

Figure 4.5: Jetblue Airways firm value and face value of debt. The source of data is (Compustat, 2017)

The difference between the value of the firm and the value of the debt in Figure 4.5 is the value of the equity. From Figure 4.5 we see, that the difference between the value of the firm and the value of the debt has varied substantially over the 6 year period. The value of the firm has been closer to the value of the debt and therefore the probability of bankruptcy have been higher. If the variation and thus the probability of incurring bankruptcy cost is affected by the fuel price, we would expect hedging to increase the value of the firm.

We assume the same tax rates in the up and down states. The effective tax rate of JetBlue was 38%, 36% and 40% in 2015, 2014 and 2013 respectively (JetBlue Airways Corporation, 2011–2016, see annual report 2015, p. 35-38). Based on these numbers a tax rate of 38% is assumed in the example.

In the calculations below we first find the value of JetBlue Airways in the 2016 up and down states separately. Subsequently, we probability adjust and discount these values backwards. For discounting the 2016 values to 2015 values we need the cost of capital of JetBlue Airways. We assume a cost of capital of 7%, and use this for discounting all cash flows. The number seems reasonable considering that the estimated cost of capital in the global airline industry is at this level (Damodaran, 2017a).

We assume a bankruptcy cost of 500 million USD, and that hedging has no transaction cost. Next we will go through each of the three scenarios no leverage and no hedging, leverage but no hedging, and leverage and hedging.

No leverage and no hedging

The value of the unlevered firm in the 2016 up and down states is:

$$V^U_{2016,\text{up}} = (1 - \text{T}) \cdot \text{EBIT}_{2016,\text{up}} = (1 - 0.38) \cdot 2196 = 1,361.52$$

$$V^U_{2016,\text{down}} = (1 - \text{T}) \cdot \text{EBIT}_{2016,\text{down}} = (1 - 0.38) \cdot 236 = 146.32$$

Subsequently the probability adjusted and discounted 2015 value is:

$$V^U_{2015} = \frac{V^U_{2016,\text{up}} \cdot P_{\text{up}} + V^U_{2016,\text{down}} \cdot P_{\text{down}}}{1 + r_U} = \frac{1,361.52 \cdot 0.5 + 146.32 \cdot 0.5}{1 + 7\%} = 704.5981$$

The 2015 unlevered and unhedged value of JetBlue Airways is therefore 705 million USD. Figure 4.6 illustrates firm value in the 2016 up and down states and the expected 2015 value.

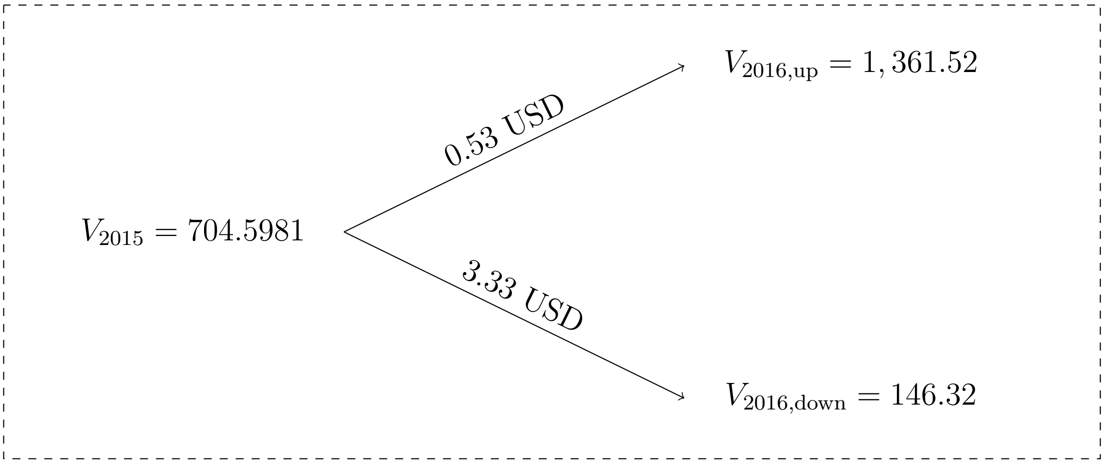

Figure 4.6: No leverage or hedging. Jet fuel prices per gallon are shown on the grid lines.

Leverage but no hedging

The leveraged 2016 value in the up state is calculated as the unlevered 2016 up state value from before added the full tax shield:

$$V^L_{2016,\text{up}} = V^U_{2016,\text{up}} + T \cdot \text{Debt Payment}_{2016,\text{up}} = 1,361.52 + 0.38 \cdot 1827 = 2,055.78$$

The levered 2016 down state value is calculated as the unlevered 2016 down state value, but now we also add the tax shield of the down state and subtract the bankruptcy cost. The down state tax shield is limited by the size of EBIT, because this decides what can be deducted. Bankruptcy cost exist in the down state because JetBlue is unable to pay the debt payment in full.

$$V^L_{2016,\text{down}} = V^U_{2016,\text{down}} + T \cdot \text{EBIT}_{2016,\text{down}} - C = 146.32 + 0.38 \cdot 236 - 500 = -264$$

The size of EBIT in the down state is 236 million USD and therefore JetBlue Airways can deduct this amount in taxes. Using the 2016 up and down state firm values we find the 2015 expected value of JetBlue Airways:

$$V^L_{2015} = \frac{V^L_{2016,\text{up}} \cdot P_{\text{up}} + V^L_{2016,\text{down}} \cdot P_{\text{down}}}{1 + r_U} = \frac{2,055.78 \cdot 0.5 + (-264) \cdot 0.5}{1 + 7\%} = 837.2804$$

Thus the expected 2015 leverage unhedged value of JetBlue Airways is 837 million USD. This is $837 - 705 = 132$ million USD higher than the unlevered and unhedged firm value. Figure 4.7 illustrates the value in 2015 and 2016 with leverage but no hedging. From the figure we find that the value in the down state is negative, but the value in the up state increases sufficiently to offset the loss in the down state. Therefore the value of the levered firm is even higher than the comparable unlevered firm value.

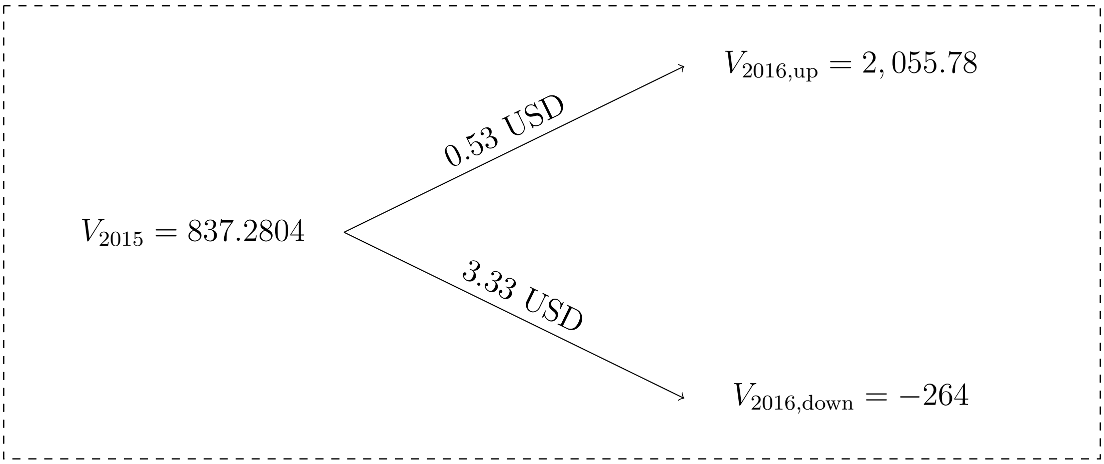

Figure 4.7: Leverage but no hedging. Jet fuel prices per gallon are shown on the grid lines.

Leverage and hedging

If JetBlue Airways decides to hedge they will enter a long forward contract on 700 gallons of fuel, which is the expected 2016 consumption with a forward price of 1.9257 USD per gallon. Thus if the fuel price increases in value, then JetBlue

Airways will receive an additional $3.3257 \cdot 700 - 1.9257 \cdot 700 \approx 2328 - 1348 \approx 980$. A fuel price decrease will similarly lead to a negative payoff from the hedge of $0.5257 \cdot 700 - 1.9257 \cdot 700 \approx 368 - 1348 \approx -980$

The total profit before debt payments and taxes of JetBlue Airways now consists of EBIT (2196) and the payoff from hedging (-980). Therefore, the total profit is $2,196 - 980 = 1,216$ million USD in the 2016 up state. In the 2016 down state EBIT was 236 million USD while the payoff from the hedge was positive 980 million USD. Hence, the total profit in the 2016 downstate was $236 + 980 = 1216$.

Using this information we calculate the firm value in 2016 up state:

$$\begin{aligned} V^{LH}_{2016,\text{up}} &= (1-T) \cdot (\text{EBIT}_{2016,\text{up}} + H_{up}) + T \cdot \text{Debt Payment}_{2016,\text{up}} \\ &= (1-0.38) \cdot (236 + 980) + 0.38 \cdot 1827 = 1,448.18 \end{aligned}$$

The up state consist of the EBIT and hedging payoff plus the full tax shield. Next the firm value in the 2016 down state is calculated:

$$\begin{aligned} V^{LH}_{2016,\text{down}} &= (1-T) \cdot (\text{EBIT}_{2016,\text{down}} + H_{down}) + T \cdot \text{Debt Payment}_{2016,\text{down}} \\ &= (1-0.38) \cdot (2196 - 980) + 0.38 \cdot 1827 = 1,448.18 \end{aligned}$$

As with the up state, the down state also contain the EBIT and the hedging payoff plus the full tax shield. These two value are now used to find the 2015 expected value of the firm.

$$\begin{aligned} V^{LH}_{2015} &= \frac{V^{LH}_{2016,\text{up}} \cdot P_{\text{up}} + V^{LH}_{2016,\text{down}} \cdot P_{\text{down}}}{1 + r_U} \\ &= \frac{1,448.18 \cdot 0.5 + 1,448.18 \cdot 0.5}{1 + 7\%} = 1,353.4393 \end{aligned}$$

The 2015 expected value of JetBlue Airways with leverage and hedging is 1353 million USD. Compared to the firm value with leverage but without hedging this is $1353 - 837 = 516$ million USD higher. Figure 4.8 shows the 2015 expected firm value and the 2016 up and down state firm values.

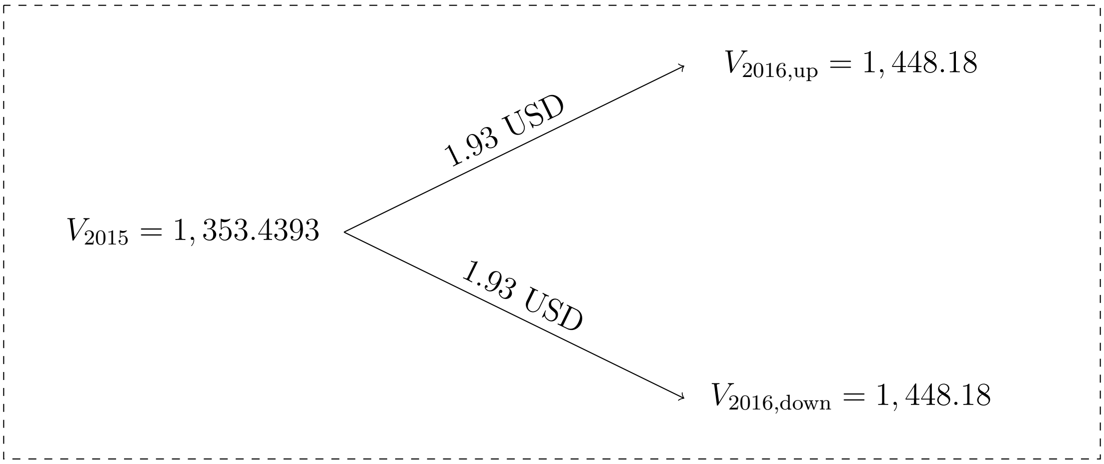

Figure 4.8: Leverage and hedging. Jet fuel prices per gallon are shown on the grid lines.

We see from the figure that the value in both states are equal because JetBlue Airways now uses jet fuel hedging. We can also calculate the difference between the firm value leveraged without hedging and the firm value leveraged with hedging using the following equation:

$$
\begin{aligned}
\text{NPV(Hedge)} &= V^{LH} - V^{L} \\
&= \underbrace{P_{2016,\text{down}} \cdot T \cdot \text{Debt Payment}}_{\substack{\text{Tax shield,}\\ \text{from hedged}\\ \text{down state}}} - \underbrace{P_{2016,\text{down}} \cdot T \cdot \text{EBIT}_{2016,\text{down}}}_{\substack{\text{Tax shield}\\ \text{in unhedged}\\ \text{down state}}} \\
&+ \underbrace{P_{2016,\text{down}} \cdot C}_{\substack{\text{Savings on}\\ \text{reduction in}\\ \text{bankruptcy cost}}} \\
&= \frac{0.5 \cdot 0.38 \cdot 1827 - 0.5 \cdot 0.38 \cdot 236 + 0.5 \cdot 500}{(1 + 7\%)} = 516
\end{aligned}
$$

From the equation above we find that the difference between the leveraged firm value with and with hedging is 516, which is consistent with the value found with the first method. The new equation also display from where the value increase derives.

With hedging JetBlue Airways receive the full tax shield in the down state, but this also means that they will not get the partial tax shield from the down state anymore, which is why this value is subtracted from the state. Lastly hedging entails that the firm will not incur bankruptcy cost and therefore this amount is added in the down state.

4.2.2 Hypotheses

According to our example and the Smith and Stulz (1985) framework we should expect hedging to increase firm value as a result of a reduced probability of bankruptcy and an improved tax shield. Therefore a simple expectation is that firms with higher leverage hedge more, because these have higher probability of bankruptcy. Consequently the first hypothesis becomes:

Hypothesis 1: *Airlines with higher leverage hedge more.*

Another way to describe the probability of bankruptcy is to look at credit ratings of airlines. Credit ratings increase when the probability of bankruptcy decrease. This leads to hypothesis 2:

Hypothesis 2: *Airlines with low credit ratings use more hedging.*

Smith and Stulz (1985) argue that airlines should hedge to reduce the probability of bankruptcy, and thereby obtain lower cost of debt. The financial statement term for cost of debt is interest expenses. Therefore, we test if firms with high interest expenses hedge more. This is stated in Hypothesis 3:

Hypothesis 3: *Airlines with high interest expenses use more hedging*

4.2.3 Empirical Analysis Of Hypothesis 1

Grouping According To Leverage

To set up an initial analysis of Hypothesis 1, we divide our sample into two groups according to the median leverage ratios. We denote the two groups: The low leverage group and the high leverage group. As a measure of leverage, we use the operating lease adjusted debt value subtracted cash. Finally we divide by the market value of equity (NetDOPLAdjMVE). We subtract cash to get a measure of the airlines' net debt level.

The distribution of the 30 airlines median leverage ratios are presented in Figure 4.9. The 15 airlines with the lowest leverage ratios are put in the low leverage group, while the remainder are put in high leverage group.

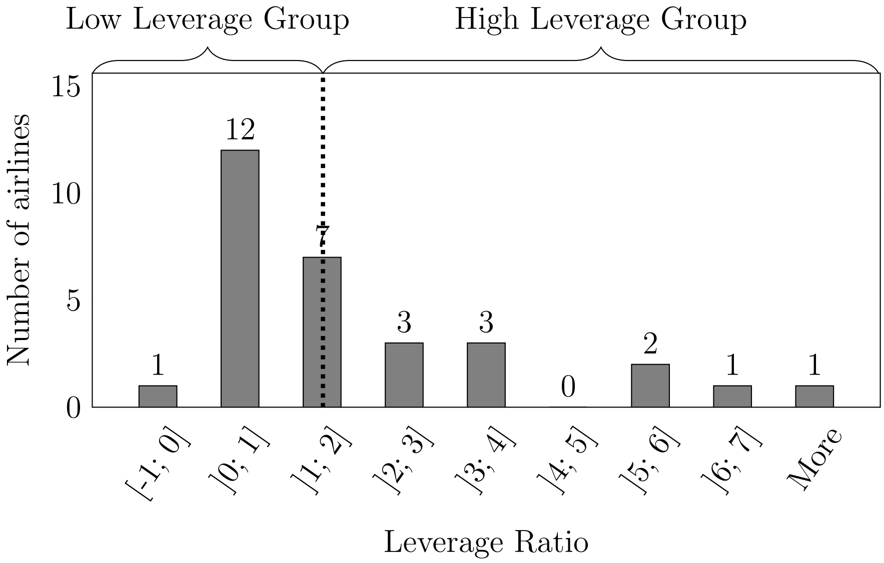

Figure 4.9

The histogram shows, that most airlines have leverage ratios between 0 and 4. Outside this range are only 5 airlines. The airlines with lowest median leverage ratios are Dart Group and EasyJet while the airlines with highest ratios are AirBerlin and American Airlines.

Differences Between Groups

The grouping of airlines makes it possibility to observe some differences or tendencies across the two groups.

Table 4.2 presents the means of HPCTNXY, total fleet, fleet age, and EBIT to revenue. Further the table also presents the difference between the means of the two groups along with the standard error of the difference, and the total number of observations.

Table 4.2: The table presents the mean values across the high and low leverage groups followed by the difference between the means, and the standard error of the difference. The difference and standard error are used to conduct a two-sided t-test of the difference.

	LowLeverage Mean	HighLeverage Mean	Difference Diff.	Std. Error	Obs.
HPCTNXY	0.3919	0.4392	-0.0473	0.0453	168
TotalFleet	291.9872	274.2653	17.7219	44.0848	176
FleetAge	9.9872	9.1320	0.8552	0.8006	150
EBITToRevenue	0.0903	0.0386	0.0517***	0.0094	183

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The high leverage group has a slightly higher mean HPCTNXY than the low leverage group. The difference between the means is 0.0473%-points, which is insignificant at the 10% level. Thus, the t-test does not suggest a difference.

A natural extension of the above is to investigate whether the relationship between hedging and leverage exist, when we control for other factors in a panel data regression analysis. We therefore consider other variables that are relevant determinants of hedging.

We use total fleet to control for firm size. The means of the low and high leverage groups presented in Table 4.2 are 292 and 274 respectively. The difference of 18 aircraft is insignificant at the 10% level and also small in magnitude. We suggest that larger airlines may operate in a higher number of different markets, and thus be more resistant to jet fuel price movements compared to smaller airlines. This gives the larger airlines a diversification of risk, which may reduce the need for hedging.

We use fleet age as a proxy for an operational hedging. An airline's need for financial hedging of jet fuel is likely to depend on the age of the fleet. I.e. newer aircraft is more fuel efficient, and therefore able to reduce losses during periods of high jet fuel prices.

EBITToRevenue proxy for the airlines' ability to generate cash. A higher ratio indicates better ability to generate cash and therefore reduce need for financial hedging to avoid bankruptcy. From Table 4.2 we see that the difference between the low and high leverage group is 5.17% points which is significant at the 1%. This indicates a better ability among the low leverage airlines to generate cash.

Regression Analysis

Equation 4.1 presents the model that we will estimate to see if we can find evidence of Hypothesis 1. We use the pooled OLS model, a first difference model and a fixed effects model to investigate the hypothesis. Equation 4.1 presents the pooled OLS model, which gives an overview of the variables included in the regression. The first difference and fixed effects models have similar equations.

$$\begin{aligned}\text{HPCTNXY} =&\beta_0 + \beta_1\text{NetDOPLAdjMVE}\\ &+ \beta_2\text{TotalFleet} + \beta_3\text{FleetAge} + \beta_4\text{EBITToRevenue}\\ &+ \text{Controls For Time Fixed Effects} + \epsilon\end{aligned} \tag{4.1}$$

When we estimate the model we get the results presented in Table 4.3. The results are mixed across the three models. Model 1 and 2 suggest that airlines with higher debt levels hedge less, while Model 3 suggest a positive relation.

Ind. Variabels	(1) Pooled OLS	(2) FD	(3) FE
NetDOPLAdjMVE	-0.00254	-0.000392	0.000235
	(0.00212)	(0.000626)	(0.00118)
TotalFleet	0.0000647	-0.000204	-0.000582**
	(0.000160)	(0.000267)	(0.000210)
FleetAge	-0.0185	0.0313*	0.0198
	(0.0117)	(0.0180)	(0.0217)
EBITToRevenue	-1.060	-0.0661	-0.0265
	(0.869)	(0.490)	(0.579)
Constant	0.633***	-0.0478	0.427*
	(0.120)	(0.0313)	(0.228)
R-squared	0.170	0.0865	0.120
N	136	109	136

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.3: Dependent variable: HPCTNXY. All models have been regressed using untabulated year dummy variables.

Although the sign of the coefficient on the debt ratio of Model 3 is in line with Hypothesis 1 the magnitude is small. E.g. if an airline increases its debt ratio by 1%-point the hedged percentage is expected to increase by 0.00023%.

All parameter estimates on the net debt adjusted for operating leases to market value of equity ratio are insignificant at the 10% level and therefore we do not find any empirical evidence of Hypothesis 1.

4.2.4 Empirical Analysis Of Hypothesis 2

Hypothesis 2 states that firms with lower credit ratings hedge more, as these will get the greater benefit from hedging through a reduction in bankruptcy cost. Since not all firms have credit ratings from S&P or Fitch, we proxy for this measure using the variable DistanceToDefaultOPLAdj. This variable is the operating lease adjusted distance to default. We split data into two groups based on the median DistanceToDefaultOPLAdj. The split is illustrated in figure 4.10.

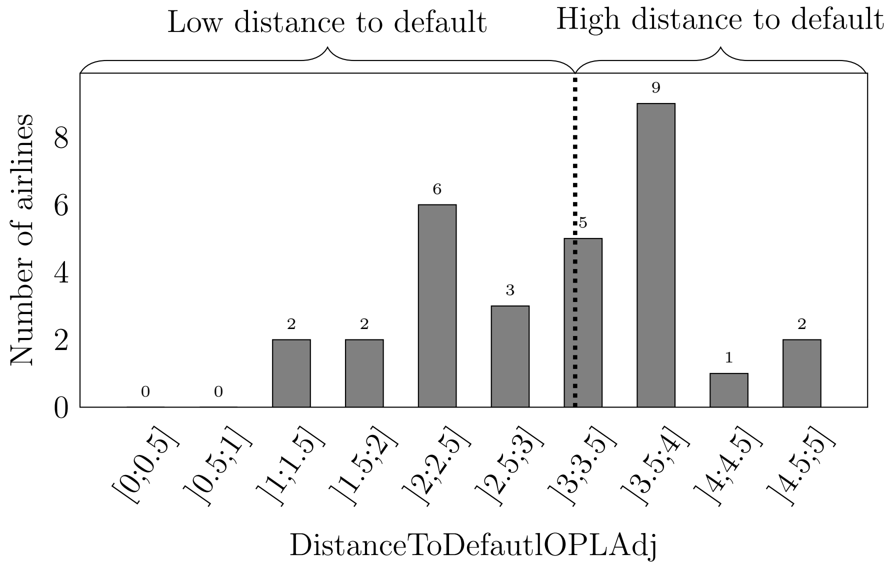

Figure 4.10: The historgram illustrate how we divided the 30 airlines based on each airlines median DistanceToDefautlOPLAdj values. The vertical dotted line marks the median of the medians of 3.16, which separates the low distance to default from the high distance to default group

Table 4.4 shows the mean HPCTNXY for the low and high distance to default firms. We find that airlines with low distance to default use more hedging. The average HPCTNXY for low distance to default airlines is 42.88% and the average value for high distance to default airlines is 40.40%. Even though the difference between the means is insignificant this evidence is in favor of Hypothesis 2.

	DTDOPLAdjLow	DTDOPLAdjHigh	Difference		
	Mean	Mean	Diff	Std. Error	Obs
HPCTNXY	0.4288	0.4040	0.0249	0.0450	168
TobinQ	0.6387	0.9363	-0.2976***	0.0669	183
TobinQOPLAdj	0.7261	0.9529	-0.2268***	0.0522	183

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.4: Statistical test of high and low distances to default. The test contain all 30 airline, but 15 observations have been excluded because the HPCTNXY variable are unavailable for these oberservations.

To test the robustness of the results from Table 4.4, we use the same procedure to calculate the difference in hedging behavior based on the SPFitchRating variable in Table 4.5. The SPFitchRatings in the table have been calculated from 19 out of the 30 airlines in the sample. The average credit rating of the 9 airlines with the lowest credit ratings are BBB- while the 10 airlines with the highest credit rating have a B rating on average.

	SPFitchRatingLow	SPFitchRatingHigh	Difference		
	Mean	Mean	Diff	Std. Error	Obs
HPCTNXY	0.2477	0.4374	0.1896***	0.0584	86
TobinQ	0.8393	0.8821	0.0429	0.0929	91
TobinQOPLAdj	0.8958	0.9051	0.0093	0.0819	91
SPFitchRating	B	BBB-	-	-	91

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.5: Statistical test of high and low credit ratings. The credit ratings are from S&P and Fitch and has data for 19 of the 30 airlines in the data set. 5 observations have been excluded because the HPCTNXY variable are unavailable for these observations. The low credit rating group consist of 9 airlines, while the high group consist of 10.

The average HPCTNXY of low credit rating airlines is 24.77%, and the average HPCTNXY of airlines with the high credit ratings is 43.74%. These results are contrary to the predictions of Hypothesis 2, which predicts that airlines with low credit ratings would hedge more than airlines with high credit ratings. The test of Table 4.5 shows, that the relationship between credit rating and HPCTNXY is significant.

To put this into perspective, 2.39% of companies with S&P ratings of B defaulted in 2015. 0.16% and 0.00% of the companies with BB and BBB ratings respectively defaulted on their payments in the same year (S&P Global Fixed Income Research, 2016, p. 10-48).

To summarize, the evidence of Hypothesis 2 is mixed and we are unable to conclude that the theory of Smith and Stulz (1985) hold.

A problem with the approach of this section is that the results might reflect the division of data into groups. If we divided the data into a larger number of groups, more complex relationships would appear. For example, companies close to bankruptcy may have limited ability to hedge. Spirit Airlines describes such circumstances:

> *"In the past, we have not had and in the future we may not have sufficient creditworthiness or liquidity to post the collateral necessary to hedge our fuel requirements..." - (Spirit Airlines, 2012–2016, see annual report 2015, p. 19)*

Regression Analysis

In the previous section we tested the framework of Smith and Stulz (1985) using credit ratings and statistical methods such as means and medians. In the next section we will use regression analysis to answer Hypothesis 2.

We will choose a different approach than before and test if hedging in accordance with Smith and Stulz (1985) improves firm value. We proxy for firm value by using Tobin's Q. The idea is, that airlines hedging according to the framework have higher Tobin's Q. We test this by interacting HPCTNXY and DistanceToDefaultOPLAdj. Firms with lower distance to default are expected to experience a larger increase in Tobin's Q, when they increase HPCTNXY than firms with a higher distance to default. We expect the interaction term between HPCTNXY and DistanceToDefaultOPLAdj to be negative. We include the control variables discussed previously. This leads to Equation 4.2:

$$\begin{aligned}\text{Tobin's Q} =&\beta_0 + \beta_1\text{HPCTNXY} + \beta_2\text{DistanceToDefaultOPLAdj}\\&+ \beta_3\text{HPCTNXYDistanceToDefaultOPLAdj} + \beta_4\text{TotalFleet}\\&+ \beta_5\text{EBITToRevenue} + \beta_6\text{FleetAge}\\&+ \beta_7\text{NetDOPLAdjMVE}\\&+ \text{Controls For Time Fixed Effects} + \epsilon\end{aligned} \tag{4.2}$$

Ind. Variables	(1) Pooled OLS	(2) FD	(3) FE	(4) Pooled OLS	(5) FD	(6) FE
HPCTNXY	-0.129	0.201	0.117	-0.662*	0.212	0.103
	(0.178)	(0.387)	(0.251)	(0.370)	(0.409)	(0.334)
DistanceToDefautlOPLAdj	0.0486	0.0519**	0.0584**	-0.00582	0.0531*	0.0569
	(0.0339)	(0.0238)	(0.0278)	(0.0544)	(0.0295)	(0.0409)
HPCTNXYDistanceToDefautlOPLAdj				0.148	-0.00332	0.00419
				(0.102)	(0.0538)	(0.0595)
TotalFleet	-0.000304*	-0.000346**	0.000418	-0.000333*	-0.000344**	0.000418
	(0.000169)	(0.000161)	(0.000484)	(0.000174)	(0.000159)	(0.000488)
EBITToRevenue	4.531***	2.128**	3.150***	4.286***	2.127**	3.145***
	(1.015)	(0.968)	(1.070)	(1.007)	(0.973)	(1.083)
FleetAge	0.0171	0.00393	0.0119	0.0187	0.00382	0.0120
	(0.0193)	(0.0164)	(0.0207)	(0.0190)	(0.0167)	(0.0213)
NetDOPLAdjMVE	0.00860	0.00269*	0.00626*	0.00742	0.00270*	0.00624*
	(0.00511)	(0.00137)	(0.00310)	(0.00502)	(0.00135)	(0.00312)
Constant	0.244	-0.102***	0.0311	0.450	-0.102***	0.0352
	(0.236)	(0.0301)	(0.325)	(0.271)	(0.0312)	(0.324)
R-squared	0.608	0.268	0.563	0.618	0.268	0.563
N	136	109	136	136	109	136

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.6: Dependent variable: Tobin's Q. All models have been regressed using untabulated year dummy variables.

Model 1 through 3 excludes the interaction term. When we use the three estimation procedures we get the results presented in Table 4.6. Model 1 is a pooled OLS regression and suggests a negative relation between Tobin's Q and HPCTNXY.

I.e. increasing HPCTNXY by 1%-point is expected to lead to a $0.129/100 = 0.00129$ reduction in Tobin's Q. Model 2 and 3 suggest a positive relation, however, disagreeing on the magnitude, with which Tobin's Q is affected. Model 2 suggests an increase of 0.00201 while Model 3 identify a more moderate effect from a 1%-point increase of 0.00117. All coefficients however are insignificant at the 10% level. When we include the interaction term between HPCTNXY and DistanceToDefaultOPLAdj to implement the idea, that the value of hedging is likely to depend on an airlines distance to default. Model 4 through 6 do not find any significant evidence of such a relationship. Again the three models disagree on the direction of the relationship. E.g. according to Model 4 the partial effect on Tobin's Q from a 1%-point increase in HPCTNXY is positively related to distance to default. This indicate, that airlines with a higher distance to default benefit more from increasing hedging than airlines with lower distance to default. To see this, we take the derivative of equation 4.2 with respect to HPCTNXY:

$$\frac{\widehat{\partial \text{TobinQ}}}{\partial \text{HPCTNXY}} = -0.662 + 0.148 \text{Distance To Default}$$

If we consider consider a 1%-point increase in HPCTNXY this expression becomes:

$$\text{Effect on Tobin's Q} = -0.662 \cdot 1\% + 0.148 \cdot 1\% \cdot \text{Distance To Default}$$

We see that we cannot determine the effect on Tobin's without a level of distance to default however we can see that the effect on Tobin's is positively related to the size of distance to default. Therefore, we can conclude that according to the pooled OLS model the effect on Tobin's Q from a 1%-point increase in HPCTNXY increases in the distance to default. The negative constant term suggests, that the effect on Tobin's Q is negative for lower values of distance to default. The point at which the relationship becomes positive is:

$$\begin{aligned} 0 &= -0.662 \cdot 1\% + 0.148 \cdot 1\% \cdot \text{Distance To Default} \\ \text{Distance To Default} &= \frac{0.662}{0.148} = 4.4730 \end{aligned}$$

Thus the point at which the effect on Tobin's Q becomes positive is after a distance to default of 4.4730. These results are contrary to the expectation stated in Hypothesis 2. In our sample only two airlines had a median distance to default ratio above this level. Therefore, generally speaking, Model 4 suggest that most airlines dilute performance if they increase HPCTNXY and the closer to bankruptcy they are, the more negative the effect on performance.

The coefficient on the interaction term in Model 5 suggests, that the relation is the opposite of model 4, meaning that airlines closer to their default point can increase Tobin's Q by increasing HPCTNXY. Hence model 5 is consistent with Hypothesis 2. Model 6 has the same sign on the interaction term as model 4, but suggests that the relationship is positive for all values of distance to default. None of the estimated interaction term coefficients are significant.

The results of the regression analysis are mixed and cannot be considered evidence in favor of Hypothesis 2.

We extend the regression analysis a little further by replacing Tobin's Q in Equation 4.2 with the estimated absolute exposure coefficients. We argue that firms close to default will be more exposed to jet fuel price risk, because these are closer to incurring bankruptcy cost, than firms further away from bankruptcy. If we can show that an increase in HPCTNXY reduces exposure more for firms with low distance to default than for firms with high distance to default, then the idea is that bankruptcy cost must be of importance in determining hedging behavior. Thus, we expect that the coefficient on HPCTNXY will be negative, because hedging should reduce the absolute exposure. We also expect, that the interaction term between HPCTNXY and DistanceToDefaultOPLAdj will be positive because the effect of increasing DistanceToDefaultOPLAdj lowers the negative effect on absolute exposure from increasing hedging.

Ind. Variabels	(1) Pooled OLS	(2) FD	(3) FE	(4) Pooled OLS	(5) FD	(6) FE
HPCTNXY	-0.113	1.003**	0.696*	0.0462	1.668***	1.000
	(0.120)	(0.389)	(0.393)	(0.626)	(0.471)	(0.721)
DistanceToDefaultOPLAdj	-0.178***	-0.112*	-0.131**	-0.162*	-0.0363	-0.0973
	(0.0447)	(0.0570)	(0.0627)	(0.0902)	(0.0854)	(0.118)
HPCTNXYDistanceToDefaultOPLAdj				-0.0436	-0.195	-0.0910
				(0.151)	(0.121)	(0.198)
TotalFleet	0.000220	0.00574***	0.00238**	0.000228	0.00585***	0.00237**
	(0.000201)	(0.00138)	(0.00105)	(0.000202)	(0.00136)	(0.00107)
EBITToRevenue	0.638	-5.540*	-5.034**	0.703	-5.613*	-4.911**
	(0.733)	(2.955)	(1.806)	(0.776)	(2.949)	(1.865)
FleetAge	-0.000817	-0.0252	0.0270	-0.00121	-0.0336	0.0235
	(0.00949)	(0.0873)	(0.0567)	(0.00971)	(0.0855)	(0.0588)
NetDOPLAdjMVE	0.0140***	0.0168***	0.0124**	0.0144***	0.0178***	0.0129**
	(0.00415)	(0.00297)	(0.00538)	(0.00430)	(0.00302)	(0.00527)
Constant	1.347***	-0.266	0.299	1.286***	-0.264	0.214
	(0.279)	(0.166)	(0.698)	(0.411)	(0.168)	(0.692)
R-squared	0.383	0.397	0.377	0.384	0.406	0.379
N	134	107	134	134	107	134

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.7: Dependent variable: Absolute exposure. The models have been regressed using untabulated year dummy variables.

The results of the absolute exposure regressions are presented Table 4.7. The coefficient on HPCTNXY in Model 1 is negative and insignificant at the 10% level. However, Model 2 and 3 suggest a positive and significant relation at the 10% level between HPCTNXY and AbsoluteExposure. Therefore, the models suggest that an increase in HPCTNXY causes an increase in exposure. This is contrary to the expectations just stated. Finally when adding the interaction term to the model, the coefficient on this term is negative but insignificant across the three models (Model 4 through 6).

Therefore we do not find any evidence of a relation between distance to default, hedging, and exposure. Once again we are unable to prove Hypothesis 2.

To summarize the analysis of credit ratings and distance to default, we do not find evidence in favor of Hypothesis 2 and the theory of Smith and Stulz (1985). The next section will look further into the cost of debt capital through analysis of the interest expenses of airlines.

4.2.5 Empirical Analysis Of Hypothesis 3

A Look At Two Airlines

Smith and Stulz (1985) states that airlines can improve their value by increasing the level of debt to take advantage of the tax shield. On the other hand, increased leverage increases the probability of bankruptcy and thus also increases the cost of debt required by the debt holders. Smith and Stulz (1985) then argue that firms should use hedging to bring down these cost of debt. In this section we therefore test Hypothesis 3, which states that airlines with higher interest expenses use more hedging than firms with lower interest expenses.

Cost of debt is analyzed using the variable InterestExpenseToDebt, which is the ratio of interest expenses to total debt of the airlines. The interest expenses mainly contain interest rate payments on debt, but some financial statements does not make it possible to separate interest rate payments and other financial costs. The variable is therefore a rough estimate of the cost of debt. An example is the InterestExpenseToDebt variable of Ryanair that for 2015 was 1.67%, while the airline's actual average interest rate was 2.01% in 2015. Ryanair also issued bonds in 2015 with an interest rate of 1.125% (Ryanair Holdings Plc, 2011–2016, see annual report 2015, p. 111). In 2014 Air Berlin issued bonds with an interest rate of 6.75% and the InterestExpenseToDebt variable had a value of 9.08% (AirBerlin Group, 2011–2016, see annual report from 2015, p. 131). A deviation exist between InterestExpenseToDebt and the actual interest rate from the financial reports, but the variable still serves as a reasonable proxy.

	Air Berlin	Ryanair
InterestExpenseToDebt	7.71	2.41
NetDOPLAdjMVE	19.41	0.24
HPCTNXY	50.58	88.67

Table 4.8: Mean value for Air Berlin and Ryanair for the years 2010-2015. NetDOPLAdjMVE is the net debt adjusted for operating lease divided by the market value of equity.

Table 4.8 describe the average InterestExpenseToDebt, NetDOPLAdjMVE and HPCTNXY for Air Berlin and Ryanair for the years 2010 to 2015. Comparing Air Berlin and Ryanair we see, that Air Berlin has a higher leverage than Ryanair, and that Ryanair has the lowest interest expenses. Inconsistent with the theory of Smith and Stulz (1985) Air Berlin has the highest HPCTNXY. Interpreted in the framework of Smith and Stulz (1985) Air Berlin use more leverage than Ryanair, and should therefore hedge more to alleviate the increased probability of bankruptcy.

Statistical Test

Figure 4.11 illustrates the distribution of InterestExpenseToDebt medians, and divides the airlines into two groups. A low and a high InterestExpensesToDebt group. The figure illustrates that most of the airlines' medians lie between 0.02 and 0.08.

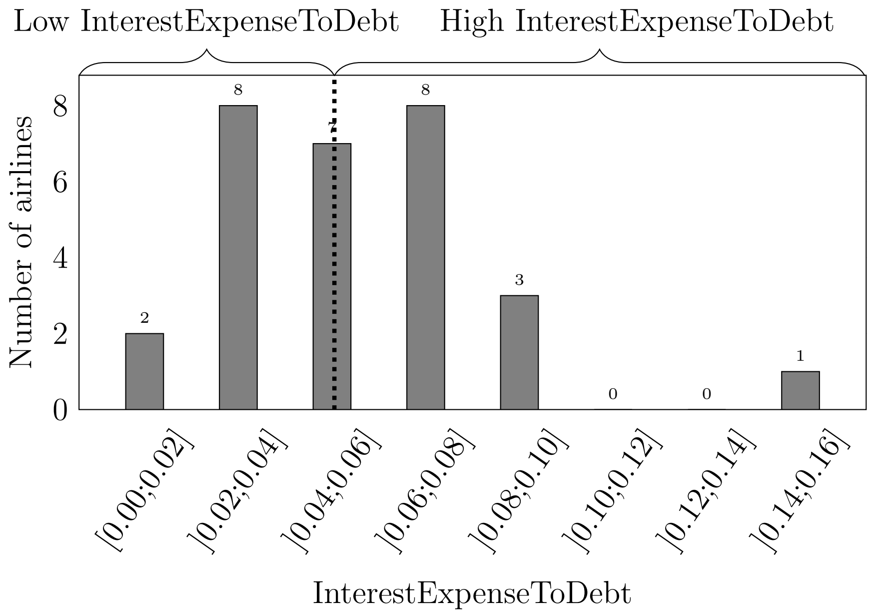

Figure 4.11: 29 of the 30 airlines divided into high and low InterestExpenseToDebt groups. The median of the airlines median is 5,0320%.

Next we will use the division of the histogram to analyze the two high and low InterestExpenseToDebt groups using a statistical test. Dart Group Plc. has been excluded from the test, because we were unable to obtain reasonable estimates of its interest expense.

	InterestExpenseToDebtLow	InterestExpenseToDebtHigh	Difference		
	Mean	Mean	Diff	Std. Error	Obs
HPCTNXY	0.4774	0.3010	0.1763***	0.0416	153
NetDOPLAdjMVE	1.8048	5.1513	-3.3465**	1.4359	168

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.9: High and low InterestExpenseToDebt. The test contain all 29 airline, but 15 observations have been excluded because the HPCTNXY variable are unavailable for these oberservations.

Table 4.9 shows the test. The low InterestExpenseToDebt group has an average HPCTNXY of 47.74% while the high InterestExpenseToDebt has an average HPCTNXY of 30.10%. The difference is significant on the 5% level and means that airlines with low interest expenses on average hedge 17.63% more than airlines with high interest expenses. The findings of Table 4.9 is contrary to the prediction of Hypothesis 3, which stated that high interest rates should lead to more heading.

Regression Analysis

Table 4.9 shows, that high InterestExpenseToDebt airlines have more leverage than low InterestExpenseToDebt. This is consistent with the theory of Smith and Stulz (1985). Airlines, that take greater advantage of the tax shield through increasing their leverage, will have larger cost of debt. Next, we will use regression analysis to control for the effect of leverage, in the relationship between InterestExpenseToDebt and HPCTNXY using the variable NetDOPLAdjMVE and other controls.

Table 4.10 shows the pooled OLS regression in Model 1. The coefficient on NetDOPLAdjMVE has a negative but significant parameter estimate. This is evidence that airlines with a high InterestExpenseToDebt ratio hedge less. Model 2 and 3 show positive but insignificant coefficients indicating that increasing InterestExpenseToDebt increases hedging. Model 2 and 3 confirms Hypothesis 3 because it seems that airlines with high interest expenses use more hedging.

Ind. Variables	(1) Pooled OLS	(2) FD	(3) FE
InterestExpenseToDebt	-3.624*	0.341	1.546
	(1.790)	(0.936)	(1.401)
NetDOPLAdjMVE	0.000171	-0.000476	-0.000396
	(0.00231)	(0.000675)	(0.00102)
TotalFleet	0.0000532	-0.000183	-0.000557**
	(0.000160)	(0.000297)	(0.000227)
FleetAge	-0.0122	0.0299	0.0132
	(0.0108)	(0.0183)	(0.0172)
EBITToRevenue	-0.928	-0.0922	-0.0948
	(0.802)	(0.534)	(0.514)
Constant	0.770***	-0.0470	0.402*
	(0.152)	(0.0328)	(0.227)
R-squared	0.234	0.0873	0.140
N	135	108	135

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.10: Dependent variable: HPCTNXY. The models have been regressed using untabulated year dummy variables.

To summarize we have been able to provide some evidence of Hypothesis 3 by controlling for unobserved effects in the regression in Table 4.10.

A reason that the coefficients in Model 2 and 3 of Table 4.10 are insignificant can be that in addition to hedging being a function of interest expenses, it might be that interest expenses also are a function of hedging.

4.2.6 Discussion

Prior Research

The empirical analysis of Hypothesis 1 did not find that leverage was related to HPCTNXY. Haushalter (2000, p. 118-131) investigate the oil and gas production industry and set up the expectation that financial leverage is positively related to the amount hedged. I.e. firms that have high financial leverage prefer to hedge more than firms with lower financial leverage. His finding is that leverage is significantly positively related to the hedged percentage.

On other hand, Nance et al. (1993, p. 276-279) conduct an analysis of 169 American firms from 1993 and find a negative relationship. Thus, the evidence of Hypothesis 1 is ambiguous and the results of our test are not able to confirm the Smith and Stulz (1985) framework.

In the empirical analysis of Hypothesis 2, the empirical evidence does not confirm the hypothesis, that airlines with low credit ratings or low distances to default hedge more. Haushalter (2000, p. 113-145) also test whether credit ratings influence hedging behavior and find that firms without a credit rating hedge more than firms with a credit rating. The interpretation is that firms with credit ratings have lower cost of external financing because information between managers and debt holders are better aligned.

The theory of Smith and Stulz (1985) has also been analyzed using other variables than those used in our analysis. Nance et al. (1993, p. 269) argue that according to the Smith and Stulz (1985) framework, small firms should have a higher return from hedging than large firms. The reason is that cost of bankruptcy increases at a diminishing rate, when firm size increases. Hence small firms have to pay a higher fraction of the firms value in bankruptcy cost compared to larger firms. Other factors do however also effect the relation between hedging a firm size. For example Nance et al. (1993, p. 269) also mention that larger firms will have a higher return of hedging because they can have a larger and more efficient department to control the firms hedging. Thus, they are unable to show whether firm size increase or decrease the amount of hedging (Nance et al., 1993, p. 273).

They use firm value to describe firm size and find that larger firms hedge more (Nance et al., 1993, p. 275).

In summary, prior research of the Smith and Stulz (1985) theory does not give any clear answer to whether the theory holds empirically.

Extension of the framework

The theory of Smith and Stulz (1985) can be put into perspective by considering the problem of asset substitution. The problem arise when the value of the firm decreases below the value of the firms debt, and shareholders decides to take advantage of the situation (Aretz et al., 2007, p. 437).

In the following example we assume that firm value of JetBlue Airways decrease below the value of debt. Before the debt holders are able to declare the airline bankrupt, the share holders can decide to take on a very risky investment project with negative NPV. Since the value of the equity already is zero, shareholders are willing to invest in negative NPV projects, if it entail the possibility of the value of equity increasing above zero. The investment however lowers firm value, which decreases the value of debt (Aretz et al., 2007, p. 437).

The asset substitution problem and the theory of Smith and Stulz (1985) combined makes hedging even more advantageous. The reason is, that the cost of debt financing will increase, if debt holders believe it is possible to end up in a situation, where firm value decrease below the value of debt (Aretz et al., 2007, p. 437). For JetBlue Airways and the airline industry this means that jet fuel hedging does not only reduce the probability of incurring bankruptcy cost, it also reduces the probability of shareholders taking advantage of the debt holders. The asset substitution problem therefore provides an additional incentive for hedging. That is, debt holders will require smaller returns on the debt if the probability of asset substitution is lower.

Practical Considerations

We critique our own analysis in this section and the coming sections on several grounds. Our sample consist of 30 airlines but many more exist. Thus using a larger sample could affect the conclusions. Also we have only used airlines listed on the stock exchange which means that the analysis is tilted towards larger airlines. When analyzing the framework of financial distress this means that we only look at airlines with a certain level of informational transparency. This affects the cost of external financing and in turn unlisted airlines may have different hedging strategies because their cost are higher.

Another cause of concern is the analysis period from 2010 to 2015. If the variation of the fuel price changes in the future, then our conclusions might not hold. We found that leverage was unrelated to HPCTNXY, when testing Hypothesis 1, but an increase in the jet fuel price variation could make this relationship more evident.

A third potential issue with the conclusions is that the regressions presented above might suffer from simultaneity. For example highly levered airlines may hedge to protect themselves from bankruptcy. From this point of view the level of debt determines the level of hedging. On the other hand banks may be more willing to make loans to airlines that hedge more. In this way the level of hedging determines the level of debt.

A way to address this issue is through instrumental variable regressions. However, the methodology use instruments that need to fulfill the requirements of instrument relevance and exogeneity, which make them hard to identify. We try to use this approach to some of our regression models in the following sections.

4.2.7 Summary

In our empirical analysis of the theory put forward by Smith and Stulz (1985) we investigated Hypothesis 1, 2, and 3.

In the analysis of Hypothesis 1 we analyzed the relation between airlines percentage hedged of next years fuel consumption (HPCTNXY) and its level of debt (NetDOPLAdjMVE). According to Hypothesis 1 airlines with higher debt levels should hedge more. We were unable to find evidence in favour of the hypothesis.

In the analysis of Hypothesis 2 we investigated whether firms with higher credit ratings hedge more. The results were inconclusive. In the regression setup we tested whether firms hedging in accordance with the Smith and Stulz (1985) framework can improve firm performance. We did not find any statistical evidence in favour of this either.

Finally we analyzed Hypothesis 3 to find evidence that firms with higher interest expenses (InterestExpenseToDebt) hedge more. We found that firms with higher InterestExpenseToDebt hedge more. Thus we were able to provide some evidence in favor of Hypothesis 3.

4.3 Investment Coordination

In this section we analyze the framework put forward by Froot et al. (1993). We first present an example to illustrate the theory in a practice. Next, we set up hypotheses and test these empirically. Finally we discuss our results and conclude.

4.3.1 Example: JetBlue Airways

Assumptions

We will now turn to a small example that illustrate some of the main points of the Froot et al. (1993) framework. Our approach is inspired by the article "A Framework For Risk Management" by Froot et al. (1994). In the following example we will again consider Jet Blue Airways as our case. An initial important assumption for the model is that managers at Jet Blue Airways have assessed financing of investment opportunities via share and debt issuance to be too costly. Therefore, in case of investment opportunities, that demand more cash, than the airline is able to generate internally, are lost. The result is, that in case of a low level of internally generated funds, managers will choose a lower investment level corresponding to the amount of cash the firm is able to generate. As a proxy for cash generated, we use Jet Blue Airways' EBIT.

We assume that JetBlue Airways face three jet fuel price states associated with different investment opportunities. The three states are characterised by a high jet fuel price level, an unchanged price level and a low price level. From this point we denote the high jet fuel price state as the down state, the unchanged price level as the unchanged state and the low price level as the up state. The state names relate to the amount of internal cash generated. In the down state JetBlue Airways incur a jet fuel cost of 2,328 million USD, in the unchanged state a cost of 1,348 million USD and in the up state a cost of 368 million USD. The EBIT and hence internal cash levels for the down, unchanged and up state are 236, 1,216 and 2,196 million USD respectively. We denote this the internal supply of cash.

Each state has its own investment environment, such that in case of a high jet fuel price level JetBlue Airways face a certain bucket of investment opportunities. These buckets differ across states. Among the investment opportunities in each of the 3 buckets, we refer to the investment level with the highest net present value as the optimal level of investment. We assume that in the down state the optimal level of investment is 1,316 million USD, in the unchanged state the optimal level of investment is 1,216 and in the up state the optimal level of investment is 1,116 million USD. This can be interpreted as the investment opportunities demand for cash. Figure 4.12 summarize these numbers.

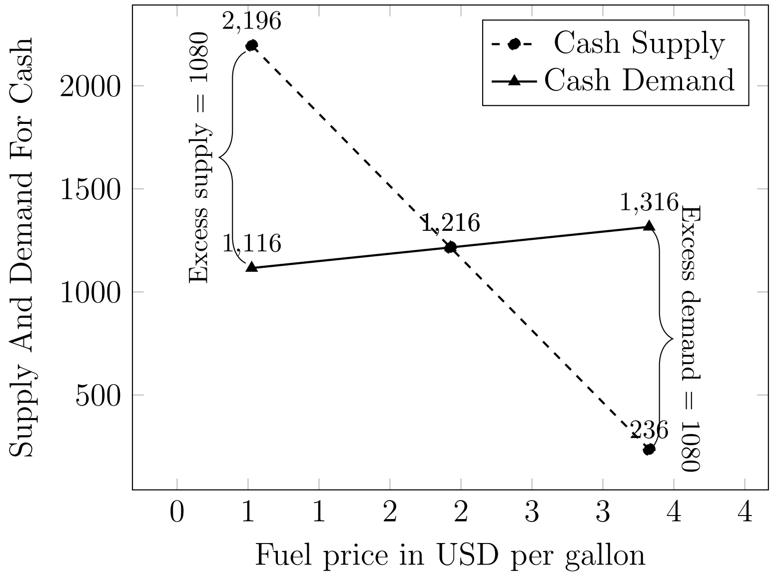

Figure 4.12

Note that the optimal level of investment is negatively related to the internal amount of cash generated. E.g. in situations where margins are high, and hence internally generated cash is high, investment opportunities require less cash and therefore the demand for cash is low. As written in section 2.2 empirical evidence suggests that the airline industry is characterized by a negative relation between internal cash generated and investment opportunities.

JetBlue Airways Unhedged

If JetBlue Airways decides to be unhedged, it would only invest 236 million USD in the down state even though the optimal level of investment is 1,316 million USD as shown in Figure 4.12. Table 4.11 shows that JetBlue Airways is able to choose the optimal level of investment in the unchanged and up state. In the unchanged state JetBlue Airways has no excess cash while in the up state the excess cash is 1,080 USD.

	No Hedging		
State	Down	Unchanged	Up
Jet fuel cost	2328	1348	368
Internal funds (EBIT)	236	1216	2196
Investment	236	1216	1116
Internal funds after investment	0	0	1080
PV(Future cash flows from investment)	450	1600	1350
Total value of the firm	450	1600	2430

Table 4.11: Unhedged position of JetBlue Airways: The table shows the jet fuel cost and the associated EBIT outcomes across the three states. These numbers are found in Table 4.1. Also the table shows the investment made, the internal funds after investment (EBIT less the investment) and the PV of the future cash flows. Total value of the firm comprises the internal funds after investment and the PV of future cash flows.

In the down state the discounted cash flows of the investment is 450, in the unchanged state 1,600, and in the up state 1,350 million USD. The total value of the firm after the invesment is calculated by adding up internal funds after the investment and the present value of the investment. The expected value of these totals is $1/3(450 + 1600 + 2430) = 1,493.33$ million USD and thus the expected value of the firm after the investment is 1,493.33 million USD.

JetBlue Airways Hedged

Assume that JetBlue Airways set up a hedging strategy to avoid the above illustrated deviation from the optimal level of investment in the down state. To overcome the problem, the hedging strategy has to deliver cash, such that the supply of cash equals the demand for cash.

In the down state the difference between supply and demand is $236 - 1,316 = -1,080$ million USD. The negative sign indicates a lack of cash. In the unchanged state, demand for cash equals supply. Finally, in the up state, the difference is $2196 - 1116 = 1080$ million USD. We illustrate the excess amount of cash graphically in Figure 4.13.

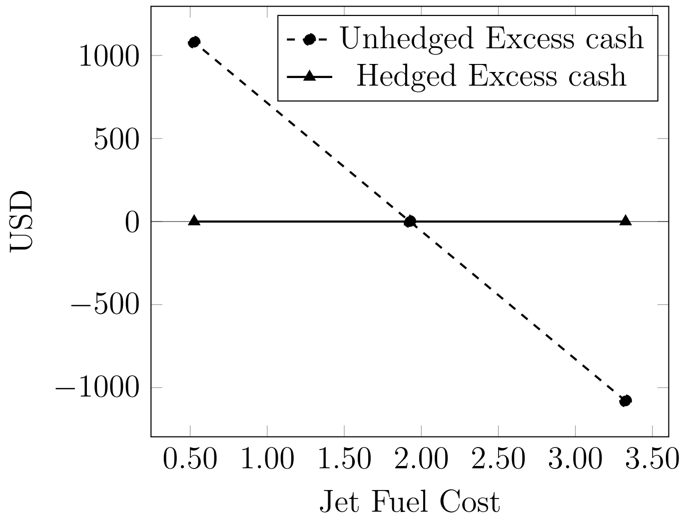

Figure 4.13: The graph shows Jetblue Airways amount of excess internally generated cash across the three states

The problem from here is to find a way for JetBlue Airways to change the distribution of internal cash, so that the excess amount of 1,080 million USD in the up state is redistributed to the down state. We only consider forward contracts.

To find the number of forward contracts to enter, we first analyze JetBlue Airways' excess amount of cash, and how it is affected by changes in the jet fuel price. I.e. we find the slope of the excess cash line from Figure 4.13.

$$\text{Slope of excess cash line} = \frac{0 - (-1,080)}{1.9257 - 3.3257} = -771.4285$$

The interpretation of the slope is, that for every 1 USD increase in the jet fuel price, the amount of internal cash decrease by 771.4285 USD. To avoid the lack of cash in the down state, JetBlue Airways should take a long position in a forward contract causing the forward payoff to be high, when the jet fuel price is high. We consider two strategies.

Buy one forward contract per gallon: First we assume a forward price of 1.9257 per gallon and that one forward contract comprise 1 gallon of jet fuel. To find the right number of contracts to enter, we first asses entering 1 forward contract for each gallon of jet fuel to be consumed. This generates 0 USD in the unchanged state. However in the down state the payoff from the forward position is $(3.3257 - 1.9257) \cdot 700 = 980$. The situation is the same in the up state but with a negative sign. This result is almost, what JetBlue Airways needs. However when the jet fuel price is high it still needs another $1080 - 980 = 100$ million USD to be able to take on the optimal level of investment.

Buy 1.1020 forward contracts per gallon: As one forward contract comprise one gallon of jet fuel, a one dollar increase in the fuel price leads to a payoff from a long position in one forward contract of 1 USD. Scaling this number to the amount consumed a dollar increase in the jet fuel price cause 700 contracts to generate 700 million USD. However as we saw from the slope of the excess cash line, we need a payoff of 771.4285 million USD for every 1 dollar increase in the jet fuel price to offset the drop in excess cash. Consequently JetBlue Airways need to generate cash of $771.4285/700 = 1.1020$ pr. gallon consumed, and thus have to enter 1.1020 contracts for each gallon consumed, i.e. 771.4285 contracts. This causes the excess hedged cash line illustrated in 4.13 to be 0 for any jet fuel price outcome.

The result of this strategy is that in the up state the forward contracts pay off $771.4285 \cdot (0.5257 - 1.9257) = -1080$ million USD, in the unchanged state 0 USD, and in the down state $771.4285 \cdot (3.3257 - 1.9257) = 1080$ million USD. The hedging strategy makes cash supply equals cash demand in all states. JetBlue Airways' hedged investment decisions are illustrated in Table 4.12 below.

	Hedging		
State	Down	Unchanged	Up
Jet fuel cost	2328	1348	368
Internal funds (EBIT), before hedging	236	1216	2196
Payoff from hedging	1080	0	-1080
Internal funds after, hedging	1316	1216	1116
Investment	1316	1216	1116
Internal funds after investment	0	0	0
PV(Future cash flows from investment)	2000	1600	1350
Total value of the firm	2000	1600	1350

Table 4.12: Hedged position of JetBlue Airways

Table 4.12 expands Table 4.11 to include the pay off from hedging. The important thing to see is that the internal funds after investment are 0 across all states. Therefore hedging in accordance with the Froot et al. (1993) and Froot et al. (1994) framework redistributes internal cash from the up state to the down state which ensures that JetBlue Airways' is able to invest optimally in any state. The total expected value of the firm under hedging is $1/3(2000 + 1600 + 1350) = 1,650$ million USD. This is $1,650 - 1,493.33 = 156.67$ million USD higher than the unhedged firm value. Therefore, the NPV of the hedging decision is 156.67.

4.3.2 Hypotheses

The example from the previous section and the Froot et al. (1993) theory formulate a hedging strategy, that matches cash flows and investment opportunities. This should improve firm value, and since we assume, that managers hedge to maximize shareholder value, we would expect them to hedge according to the framework.

Hypothesis 4: *Airlines hedge to match internally generated cash flows with investment opportunities.*

Airlines with higher external financing cost are likely to benefit more from hedging than airlines with lower external financing cost. Airlines with low external financing cost have better access to capital and thus do not need to generate cash through a hedging strategy given a rise in investment opportunities. The hypothesis we investigate therefore becomes:

Hypothesis 5: *A change in investment opportunities will induce airlines with higher external financing cost to hedge more, than airlines with lower external financing cost.*

After investigating whether airlines hedge according to the Froot et al. (1993) framework, we analyze if the hedging strategy improves the value of the firm as predicted by the example of the previous section. This leads to the following hypothesis:

Hypothesis 6: *Hedging to match internally generated cash flows with investment opportunities increase firm value.*

4.3.3 Empirical Analysis Of Hypothesis 4

This section test Hypothesis 4 which states that airlines should hedge to match cash flows and investment opportunities. The firms operations supply cash while the investments demand cash. Froot et al. (1993) measure the relation between internally generated cash flows and investment opportunities using the correlation coefficient. The idea is that by finding the correlation between internally generated cash flows and investment opportunities, firms can find the optimal hedge percentage. In the airline industry, internally generated cash flows and investment opportunities depend on the jet fuel price as mentioned in section 2.2. Therefore we will start the analysis with a graphical illustration of the development of internally generated cash flows, investment opportunities and jet fuel prices.

Graphical Analysis

The sensitivity of internally generated cash flows to the jet fuel price is high in the airline industry, because jet fuel represent a large part of the costs. For example, JetBlue's jet fuel cost amounted to 1348/6416 = 21% of annual revenues in 2015, where the airline consumed a total of 700 million gallons of jet fuel (JetBlue Airways Corporation, 2011–2016, see annual report 2015, p. 10). To compare, the larger airline United Continental Holdings, Inc. consumed a total of 3,886 million gallons of jet fuel in the same year (United Airlines, 2011–2016, see annual report 2015, p. 5).

EBITToRevenue and CashflowsToRevenue are used to proxy for internally generated cash flows. CashflowToRevenue are the cash flows from operations from the airlines' cash flow statements. Figure 4.14 plots the jet fuel price and internally generated cash flows between 2010 to 2015. The jet fuel spot price at the end of each year has fluctuated from 1 USD to 3 USD per gallon during the period, but had a decreasing trend over the period. This is contrary to internally generated cash flows, that increased. Figure 4.14 therefore shows a negative relationship between internally generated cash flows and the fuel price development. This relationship is visible for both EBITToRevenue and Cashflows variables. This indicate that fuel price changes have influence on internally generated cash flows, not only in theory but also in practice.

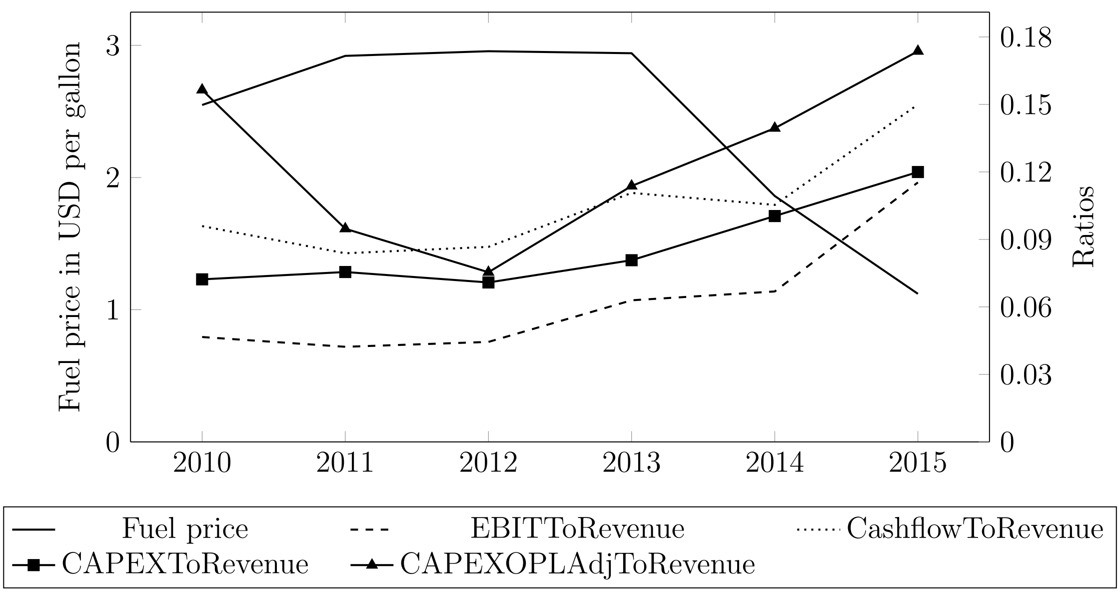

Figure 4.14: Annual jet fuel spot prices obtained from (eia.gov, 2017). The numbers are mean values of the airlines in the data set.

The results of Figure 4.14 are consistent with empirical investigations of jet fuel cost pass-through. (Koopmans and Lieshout, 2016, p. 2) describe that approximately all of the jet fuel cost increases are passed through, but that the effect is not immediate. Thus, from Figure 4.14 we see that the short-term effect of a change in the jet fuel price is to lower internally generated cash flows.

In the above example in section 4.3.1, we assumed that the relation between investment opportunities and jet fuel prices was positive. Thus, airlines had more investment opportunities in periods of high fuel prices. This section will investigate whether this assumption holds empirically. We follow the approach of Carter et al. (2006) and use CAPEXToRevenue as proxy for investment opportunities. Airlines often lease part of their fleet, and therefore the capital expenditures might not entirely reflect the investment level of the airlines (Carter et al., 2006, p. 68). Therefore, we use the operating lease adjusted CAPEX, CAPEXOPLAdjToRevenue.

Figure 4.14 illustrates a negative relationship between jet fuel prices and investment opportunities. Hence, from the graphical analysis we find the opposite relation between capital expenditures and jet fuel prices than the relation assumed in example. The reason that we do not observe a positive relation, could be that hedging behavior in the airline industry does not match cash flows and investment opportunities, and that the airlines hence are unable to take advantage of the opportunities that arise. An alternative explanation is that the fire sale idea described in section 2.2 is weaker than the other effects. Instead investment opportunities could arise in periods with high fuel prices, because these exist in periods of high macroeconomic activity as described in section 2.2.

Until now we have found that airline's internally generated cash flows and investment opportunities were negatively related to the fuel price. Next, we will see if internally generated cash flows and investment opportunities are positively or negatively related. The relation affects the optimal choice of hedging strategy according to the framework of Froot et al. (1993) as described in 2.2. The relationship between internally generated cash flows and investment opportunities are plotted in Figure 4.13 using the proxies described before. The plot shows all the airlines annual observations of the variables EBITToRevenue, CashflowToRevenue, CAPEXToRevenue and CAPEXOPLAdjToRevenue.

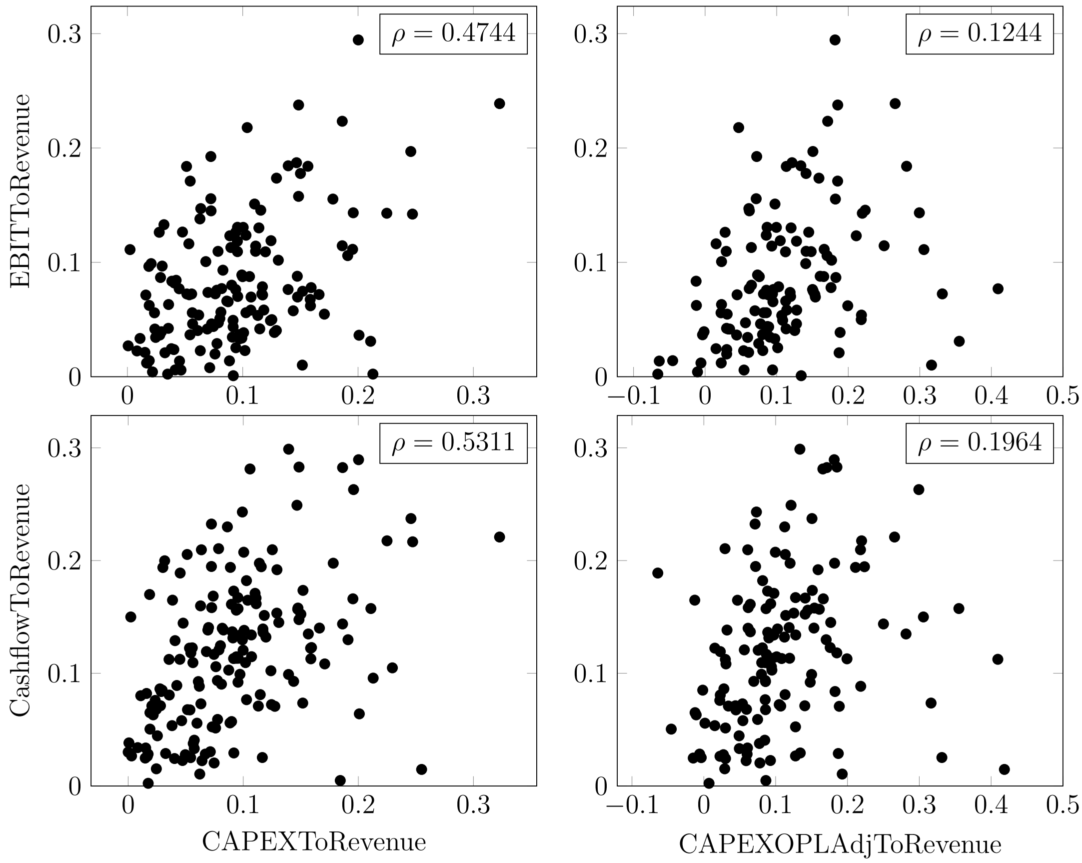

Table 4.13: Correlation between internally generated cash flows and investment opportunities. Few observations are not included in the the illustrations, because they are to large but they have been included in the calculation of correlation coefficients.

Figure 4.13 illustrates, that the internally generated cash flows and the investment opportunities are positively correlated. From the correlation coeffiecients shown in the figures, we see that the correlations are highest for the CAPEX numbers that are not adjusted for operating lease commitments. More specifically we find that the CAPEXToRevenue and EBITToRevenue numbers have a correlation of 0.4744, while the correlation between CAPEXOPLAdjToRevenue and EBITToRevenue are 0.1244. The corresponding correlations when measured with the CashflowToRevenue variable is 0.5311 and 0.1964, respectively.

Correlation And Hedging

To investigate the correlation and hedging behavior more in detail, Table 4.14 divide the 30 airlines based on their median HPCTNXY into a low and a high hedging group. The table presents the correlation coefficients within the two groups. This indicates that airlines with lower correlation between internally generated cash flows and investment opportunities hedge less.

HPCTNXY	Low	High
Corr(EBITToRevenue,CAPEXToRevenue)	0.3437	0.5536
Corr(EBITToRevenue,CAPEXOPLAdjToRevenue)	0.0081	0.2493
Corr(CashflowToRevenue,CAPEXToRevenue)	0.4692	0.5757
Corr(CashflowToRevenue,CAPEXOPLAdjToRevenue)	0.1356	0.2633

Table 4.14: Correlation and HPCTNXT. The airlines have been split into low and high HPCTNXY groups based on their median HPCTNXY value. Subsequently correlations for the two groups have been found. The number of observations used to calculate each correlation were between 76 and 92 depending on the specific variables included.

From section 2.2 we know that the optimal hedging strategy for positive correlations between internally generated cash flows and investment opportunities is to hedge less than the future expected fuel consumption. In addition section 2.2 stated that the optimal hedge ratio decreases when the correlation increases. We can use this prediction to interpret the data in two ways.

Firstly, since all 30 airlines hedge between 0% and 100%, this behavior is consistent with the Froot et al. (1993) framework. Secondly, when we in Figure 4.14 analyze the hedging behavior of the airlines we cannot provide evidence that confirms Hypothesis 4, which stated that firms hedge to match internally generated cash flows and investment opportunities. According to the framework of Froot et al. (1993) and Froot et al. (1994) we would expect the airlines with the lower correlations to hedge more. On the contrary, we find, that airlines with lower correlations hedge less.

4.3.4 Empirical Analysis Of Hypothesis 5

To test Hypothesis 5 we reintroduce the regression from the test of Hypothesis 1. In section 4.2.3 we argued that firms with higher leverage had higher probability of bankruptcy. The higher probability of bankruptcy is likely positively related to the cost of debt, and therefore we use NetDOPLAdjMVE to proxy for cost of external financing. In the analysis of Geczy et al. (1997, p. 1329) they include an interaction term between an external financing cost variable and an investment opportunity variable. The idea is to test whether airlines facing both high levels of investment opportunities and high external financing cost hedge more.

As a proxy for investment opportunities we use capital expenditures, both unadjusted and adjusted for leases. The regression equation we estimate is shown in

Equation 4.3 below.

$$\begin{aligned} \text{HPCTNXY} =& \beta_0 + \beta_1 \text{NetDOPLAdjMVE} \\ & + \beta_2 \text{NetDOPLAdjMVECAPToRev} + \beta_3 \text{CAPEXToRevenue} \\ & + \beta_4 \text{TotalFleet} + \beta_5 \text{EBITToRevenue} \\ & + \text{Controls For Time Fixed Effects} + \epsilon \end{aligned} \tag{4.3}$$

Table 4.15 shows two different specifications of Equation 4.3 estimated using the pooled OLS, first difference and fixed effects approaches as previously. Model 1 through 3 includes the unadjusted capital expenditures to revenue (CAPEXToRevenue) and the interaction between this ratio and NetDOPLAdjMVE (NetDOPLMVECAPToRev). In Model 4 through 6 we substitute the unadjusted capital expenditures with the adjusted (CAPEXOPLAdjToRevenue). The new interaction term is denoted NetDOPLMVECAPOPLToRev.

Ind. Variabels	(1) Pooled OLS	(2) FD	(3) FE	(4) Pooled OLS	(5) FD	(6) FE
NetDOPLAdjMVE	-0.00403	-0.00122	0.00114	-0.00340	-0.00172	0.000310
	(0.00510)	(0.00460)	(0.00409)	(0.00263)	(0.00276)	(0.00176)
NetDOPLMVECAPToRev	0.0169	0.0121	-0.0174			
	(0.0742)	(0.0748)	(0.0685)			
CAPEXToRevenue	-0.831	-0.378*	-0.486*			
	(0.657)	(0.204)	(0.258)			
NetDOPLMVECAPOPLToRev				0.0111	0.0268	0.000204
				(0.0289)	(0.0428)	(0.0154)
CAPEXOPLAdjToRevenue				-0.788**	0.209	0.201
				(0.372)	(0.244)	(0.257)
TotalFleet	-0.000168	-0.000241	-0.000591**	-0.000220	-0.000128	-0.000600*
	(0.000155)	(0.000282)	(0.000239)	(0.000154)	(0.000278)	(0.000295)
EBITToRevenue	-1.078	-0.276	-0.321	-1.243	-0.0979	0.0322
	(0.880)	(0.526)	(0.718)	(0.988)	(0.509)	(0.573)
Constant	0.628**	0.0213*	0.605***	0.730**	0.0627	0.521***
	(0.302)	(0.0119)	(0.0694)	(0.348)	(0.0540)	(0.0986)
R-squared	0.126	0.0880	0.145	0.152	0.146	0.123
N	161	132	161	125	100	125

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.15: Dependent variable: HPCTNXY.

When we use the unadjusted capital expenditures the results are mixed. First of all, the interaction terms are insignificant at the 10% level accros the three models. Only the coefficients on CAPEXToRevenue of Model 2 and 3 are significant at the 10%. To interpret the result, recall that Hypothesis 5 stated that airlines facing higher levels of investment opportunities should hedge more. In particular airlines with higher external financing cost. Using Model 3 as an example we take the derivative of Equation 4.3 with respect to CAPEXToRevenue.

$$\frac{\partial \widehat{\text{HPCTNXY}}}{\partial \text{CAPEXToRevenue}} = -0.486 - 0.0174\text{NetDOPLAdjMVE}$$

According to Model 3, when airlines experience an increase in the level of investment opportunities, they react by decreasing their level of hedging. This negative effect is stronger for airlines with higher debt levels.

If instead we look at the result of Model 6, we find that the relation is positive. The effect on HPCTNXY from an increase in investment opportunities is larger for airlines with higher debt levels. E.g. according to Model 6 an airline with a net debt ratio of 0.5 is expected to increase its level of hedging by approximately $0.201 \cdot 0.1 + 0.000204 \cdot 0.5 \cdot 0.1 = 0.0201102 \approx 2\%$-points as a result of an increase in the level of investment opportunities of 10%.

To conclude, although Model 4 through 6 all suggest a positive coefficient on the interaction term, no coefficients are significant. Therefore we find only weak, if any, evidence of Hypothesis 5.

4.3.5 Empirical Analysis Of Hypothesis 6

In this section we test Hypothesis 6 and investigate, whether the stock market values airlines, that hedge, in accordance with the Froot et al. (1993) framework. To test the hypothesis we use the approach of Carter et al. (2006, p. 76).

The idea is to use capital expenditures as a proxy for investment opportunities and test, whether the effect of an increase in investment opportunities on firm performance depends on the level of hedging. In other words, are investment opportunities more valued among high hedgers than low hedgers.

In our setup we extend equation 4.2 from section 4.2.4 to include an interaction term between HPCTNXY and our investment opportunity proxies CAPEXToRevenue and its lease adjusted equivalent. The regression we estimate is presented in Equation

4.4 below.

$$\begin{aligned}\text{Tobin's Q} = \beta_0 &+ \beta_1\text{HPCTNXY} + \beta_2\text{HPCTNXYCAPEXToRevenue}\\ &+ \beta_3\text{CAPEXToRevenue} + \beta_4\text{DistanceToDefaultOPLAdj}\\ &+ \beta_5\text{TotalFleet} + \beta_6\text{EBITToRevenue} + \beta_7\text{NetDOPLAdjMVE}\\ &+ \text{Controls For Time Fixed Effects} + \epsilon \quad (4.4)\end{aligned}$$

Again the equation presents the pooled OLS regression model. As before we also consider a first difference and fixed effects model setup. We repeat these three regressions where we switch the unadjusted CAPEXToRevenue with the lease adjusted measure. The results of the six regressions are presented in Table 4.16.

Ind. Variabels	(1) Pooled OLS	(2) FD	(3) FE	(4) Pooled OLS	(5) FD	(6) FE
HPCTNXY	-0.313	-0.364	-0.0674	-0.162	0.0688	0.0155
	(0.353)	(0.247)	(0.184)	(0.159)	(0.444)	(0.289)
HPCTNXYCAPEXToRevenue	0.379	6.006	2.839			
	(3.309)	(4.430)	(2.471)			
CAPEXToRevenue	0.786	-2.932	-1.235			
	(1.760)	(2.390)	(1.152)			
HPCTNXYCAPEXOPLAdjToRevenue				-0.361	0.633	0.854
				(0.737)	(0.764)	(0.544)
CAPEXOPLAdjToRevenue				0.711^{***}	-0.199	-0.321
				(0.223)	(0.359)	(0.245)
DistanceToDefautlOPLAdj	0.0436	0.0290^{*}	0.0522^{**}	0.0603^{*}	0.0227	0.0386^{*}
	(0.0318)	(0.0152)	(0.0223)	(0.0307)	(0.0174)	(0.0221)
TotalFleet	-0.000142	0.00000791	0.000442	-0.000121	0.0000183	0.000355
	(0.000149)	(0.0000526)	(0.000485)	(0.000144)	(0.0000579)	(0.000410)
EBITToRevenue	4.160^{***}	0.933^{***}	3.009^{***}	4.735^{***}	0.992^{***}	3.293^{***}
	(1.069)	(0.326)	(1.049)	(1.010)	(0.267)	(0.995)
NetDOPLAdjMVE	0.00804	0.00274	0.00567^{*}	0.00939^{*}	0.00773^{***}	0.00575^{**}
	(0.00502)	(0.00275)	(0.00296)	(0.00497)	(0.00250)	(0.00276)
Constant	0.488^{*}	-0.195^{*}	0.332^{*}	0.284	-0.257^{**}	0.231
	(0.252)	(0.100)	(0.171)	(0.191)	(0.0973)	(0.212)
R-squared	0.602	0.329	0.591	0.626	0.216	0.569
N	161	132	161	136	107	136

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.16: Dependent Variable: Tobin's Q

Model 1, 2, 3, 5 and 6 suggest a positive coefficient on the interaction term. The first difference and fixed effects models suggest a coefficient on CAPEXToRevenue below 0 while the pooled OLS models suggest a positive value. To interpret the results, we first take the derivative of Equation 4.4 with respect to CAPEXToRevenue and plug in the parameter estimates of Model 6:

$$\frac{\partial \widehat{\text{TobinQ}}}{\partial \text{CAPEXToRevenue}} = \hat{\beta}_3 + \hat{\beta}_2 \text{HPCTNXY} \qquad = -0.321 + 0.854\text{HPCTNXY}$$

Figure 4.15 shows the relationship given a 1% increase in CAPEXToRevenueOPLAdj.

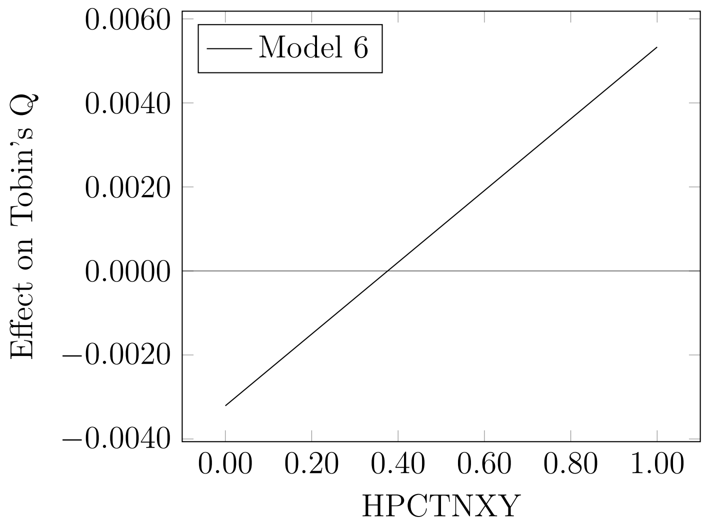

Figure 4.15: Plot of the effect on Tobin's Q given a 1% increase in the level of investment opportunities. The function we plot is Tobin's Q $= -0.321 \cdot 0.01 + 0.854 \cdot 0.01$HPCTNXY

We see that the effect on Tobin's is smallest among the low hedgers. In fact the effect is negative for firms hedging below:

$$-0.321 + 0.854\text{HPCTNXY} = 0 \Leftrightarrow \text{HPCTNXY} = \frac{0.321}{0.854} = 38\%$$

Firms hedging below 38% are expected to experience a negative impact on Tobin's Q if CAPEXToRevenue increases by 1%. Firms hedging above 38% can increase their firm performance, if they increase their level of hedging. From this level the effect on Tobin's Q increases in the level of hedging. Model 5 suggest this level to be at approximately $0.199/0.633 = 31.44\%$.

Summarizing on the above results we find a positive effect on firm performance from an increase in the level of investment opportunities, for some levels of hedging. The effect is positive among high hedgers and negative among low hedgers. Firms hedging below a level of 30-40% are expected to experience a negative effect on performance. The positive sign on the interaction term is in line with Hypothesis 6. Thus this analysis provides some empirical evidence of Hypothesis 6.

4.3.6 Discussion

Prior research

In the empirical analysis of Hypothesis 4, we find that the correlation between internally generated cash flows and investment opportunities is positive. As mentioned in section 2.2, previous research have found this relation to be negative, because investment opportunities increase in times of high fuel prices. The interpretation is that airlines sell aircraft at low prices, when they suffer from high fuel prices.

The empirical analysis of Hypothesis 5 found weak evidence that airlines with high cost of external financing increase hedging, when investment opportunities increase. Geczy et al. (1997) test the same hypothesis in the context of currency hedging by analyzing 372 large American companies from different industries. They regress hedging on the interaction term of proxies for cost of external financing and investment opportunities. The proxies are leverage and the inverse of the book-to-market ratio, respectively. The finding is, that the interaction term has a positive and significant coefficient, which is consistent with our test results of Hypothesis 5 (Geczy et al., 1997, p. 1339).

The empirical analysis of Hypothesis 6 found, that the effect on Tobin's Q from an increase in investment opportunities, is larger for airlines that hedge more compared to airlines that hedge less. However airlines with a level of hedging below a certain threshold are expected to experience a negative effect on Tobin's Q. Carter et al. (2006) also test whether hedging in accordance with the Froot et al. (1993) and Froot et al. (1994) framework in the airline industry is positively related to Tobin's Q. In a regression of Tobin's Q on the interaction term of hedging and CAPEX, the interaction term has a positive coefficient. Thus an increase in CAPEX increases Tobin's Q more for airlines hedging more compared to those hedging less (Carter et al., 2006, p. 76-77).

Carter et al. (2006, p. 77) also estimate the effect of hedging on Tobin's Q using 2SLS. In the first stage they regress CAPEX on the lagged hedging percentage. In the second stage they regress Tobin's Q on the predicted CAPEX from the first stage. Hence, they implicitly argue, that the only effect of the lagged hedge percentage on Tobin's Q is through CAPEX. We will try to replicate a similar setup, by estimating the following equations, where the first stage equation is:

$$\begin{aligned} \text{CAPEXToRevenue}_{it} = \pi_0 &+ \pi_1 \text{HPCTNXY}_{i,t-1} + \pi_2 \text{HPCTNXY}_{it} \\ &+ \pi_3 \text{DistanceToDefault}_{it} + \pi_4 \text{TotalFleet}_{it} \\ &+ \pi_5 \text{EBITToRevenue}_{it} \\ &+ \pi_6 \text{NetDMVE}_{it} + \text{Controls For Time Fixed Effects} + v_{it} \end{aligned} \quad (4.5)$$

And the second stage equation:

$$\begin{aligned} \text{TobinQ}_{it} = \beta_0 &+ \beta_1 \widehat{\text{CAPEXToRevenue}}_{it} + \beta_2 \text{HPCTNXY}_{it} + \beta_3 \text{DistanceToDefault}_{it} \\ &+ \beta_4 \text{TotalFleet}_{it} + \beta_5 \text{EBITToRevenue}_{it} + \beta_6 \text{NetDMVE}_{it} \\ &+ \text{Controls For Time Fixed Effects} + u_{it} \end{aligned} \quad (4.6)$$

As mentioned earlier instrument relevance implies, that the coefficient on the instrument, $\hat{\pi_1}$ (lagged HPCTNXY), has an absolute t-value larger than 3.2 in the first stage.

The idea of using HPCTNXY_{t-1} as an instrument is, that airlines hedging in period $t-1$ will be able to invest in period t and therefore be more valuable (Carter et al., 2006, p. 77). According to the instrument exogeneity assumption mentioned in section 3.3, the instrument can only affect Tobin's Q through CAPEX. This implies that the instrument is uncorrelated with the error term, u_{it}, in the second stage equation.

If the coefficient on the predicted CAPEXToRevenue variable is positive in Equation 4.6, it is an indication that hedging according to the Froot et al. (1993) and Froot et al. (1994) framework creates value. Table 4.17 presents the parameter estimates, when we estimate the first and the second stage equations above. We consider two specifications. In the first specification we estimate the two equations using the unadjusted values of the variables. In the second specification we repeat the procedure, but switch these variables to their lease adjusted equivalents.

First of all we find that the t-value of the instrument in the first stage regression is $\text{t-value}_{\hat{\pi_1},\text{Model 1}} = \hat{\pi_1}/se(\hat{\pi_1}) = 0.00743/0.0503 = 0.1477$ for Model 1 and $\text{t-value}_{\hat{\pi_1},\text{Model 3}} = 0.130/0.152 = 0.8553$ for Model 3. This is an indication of a weak instrument which causes $\hat{\beta_1}$ to be a biased estimator of β_1 in Equation 4.6. In the second stage we find that the coefficient on CAPEXToRevenue is -29.22 and the coefficient on CAPEXOPLAdjToRevenue is -0.982 for Model 2 and 4 respectively.

Both coefficients are insignificant.

Ind. Variabels	(1) CAPEXToRevenue First stage	(2) TobinQ Second stage	(3) CAPEXOPLAdjToRevenue First stage	(4) TobinQOPLAdj Second stage
CAPEXToRevenue		-29.22		
		(164.7)		
CAPEXOPLAdjToRevenue				-0.982
				(2.339)
L.HPCTNXY	0.00743		0.130	
	(0.0503)		(0.152)	
HPCTNXY	-0.0375	-0.926	0.147	0.162
	(0.0336)	(6.774)	(0.149)	(0.440)
DistanceToDefault	-0.000197	0.0328		
	(0.00211)	(0.0850)		
DistanceToDefaultOPLAdj			-0.00163	0.0213*
			(0.00673)	(0.0129)
TotalFleet	0.0000513	0.00197	0.000478***	0.000767
	(0.0000686)	(0.00925)	(0.000120)	(0.00125)
EBITToRevenue	-0.0146	2.355	-0.613**	2.043
	(0.150)	(6.159)	(0.258)	(1.733)
NetDMVE	-0.000602	-0.00498		
	(0.000854)	(0.0947)		
NetDOPLAdjMVE			-0.000109	0.00502*
			(0.00106)	(0.00276)
Constant	0.112***	3.558	-0.0114	0.482**
	(0.0371)	(19.14)	(0.129)	(0.188)
R-squared	0.277		0.213	
N	132	132	132	132

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.17: Instrumental variable regression of Tobin's Q on CAPEX using lagged HPCTNXY as instrument. Model 1 and 2 use unadjusted variables, whereas Models 3 and 4 use operating lease adjusted variables. All models have been regressed using untabulated year dummy variables.

Carter et al. (2006, p. 78) find positive and significant results for both the unadjusted and operating lease adjusted variables. The t-value of their instrument is $0.0742/0.056 = 1.325$, and thus their instrument might also cause a bias in the estimated parameter values. We are unable to confirm their instrumental variable regression results. Thus, the instrumental variable regression provides mixed and uncertain evidence of Hypothesis 6.

Extension of the framework

Until now we have assumed that managers are maximizing shareholder value. This section challenges this assumption by introducing the theory of agency cost by Tufano (1998). Tufano (1998) claims that managers can have different investment preferences than the shareholders of the firm. The reason is that managers may be unwilling to decrease investments and generally prefer higher investment levels than the shareholders (Tufano, 1998, p. 70). Several implications arise because of these agency problems.

Firstly Tufano (1998) describes, that hedging to alleviate underinvestment can be problematic because it allows airlines to rely on internally generated cash flows. If external financing is unnecessary then providers of capital are not there to evaluate whether the investments undertaken by the airlines are good or bad. External capital providers would usually require the firm to disclose information about the investment projects to evaluate the profitability.

An example of an investment is entrance on a new flight route. If the manager wants to operate a larger airline, his objectives might deviate from those of the shareholders. In case the investment is a negative NPV investment, providers of external capital would not provide the required capital. This would keep managers from making negative NPV investments such as starting to operate on a very competitive flight route.

As mentioned earlier, prior research suggests, that aircraft is inexpensive during periods of high fuel prices. If managers acquire excess aircraft during these periods, the Froot et al. (1993) framework, could have an adverse affect, because it increases agency cost (Tufano, 1998, p. 71).

Secondly, the optimal hedging strategy according to airlines managers might be different from the the optimal strategy according to the shareholders. If we assume that demand and supply of cash flows of the airlines are negatively correlated, this would imply that managers prefer to buy call options instead of long forwards.

Forwards move cash flows from low fuel price states to high fuel price states. This gives managers less cash during low fuel price states, and prevents excessive spending (Tufano, 1998, p. 69). Options, however, add cash flows in high fuel price states without a negative payoff in low fuel price states (Tufano, 1998, p. 70). Hence the level of investments can be higher allowing managers to invest in negative NPV projects.

Thus Tufano (1998) illustrates some negative effects of the Froot et al. (1993) framework. In the empirical analysis of Hypothesis 6 we found some evidence of the Froot et al. (1993) framework. Following Tufano (1998) we might be able to explain why the evidence is limited.

Practical Considerations

We use CAPEX to proxy for investment opportunities in the empirical analysis of Hypothesis 4. We find a negative relation between CAPEX and jet fuel prices instead of a positive relation. Thus, airlines do not increase investments in times of high fuel prices. We do not know why, but suggest that airlines do not have enough cash to fund all the investment opportunities during periods of high fuel prices.

CAPEX is not purely affected by the amount of investment opportunities but airlines' ability to fund investments also matters. For example, airlines might be unable to carry out the investments. Thus even though we see in the empirical analysis of Hypothesis 4, that CAPEX is lower during periods of high fuel prices, it is still possible that the true investment opportunities are high in these periods.

We could have used Tobin's Q as a proxy for investment opportunities, as it has a forward looking element which captures future investment opportunities (Gay and Nam, 1998, p. 54). CAPEX is a historical measure, and therefore Tobin's Q is expected to react faster. Tobin's Q may be a better proxy of investment opportunities for these reasons. However, Tobin's Q is affected by many factors, and thus CAPEX is a more direct measure of the level of investment opportunities.

4.3.7 Summary

We analyzed the investment coordination framework of Froot et al. (1993) in this section. The prediction of the framework, is that hedging to match internally generated cash flows and investment opportunities increase firm value.

Testing Hypothesis 4 we found that internally generated cash flows and investment opportunities were positively correlated. Analyzing the HPCTNXY variable we found, that airlines partially hedge according to the framework.

We found insignificant evidence of Hypothesis 5, which stated that airlines with high cost of external financing increase hedging more, than airlines with low cost of external financing, when investment opportunities increase.

Testing Hypothesis 6 we found, that airlines with hedging percentages above a certain threshold increase firm performance from an increase in investment opportunities. This is consistent with the framework of Froot et al. (1993) and Hypothesis 6. Using an instrumental variable regression we found evidence that is inconsistent with the hypothesis, but our estimator was biased because the instrument was weak.

4.4 Leasing

In this section we analyze leasing from the perspective of operational hedging. The structure is similar to the previous sections. Firstly, we start by illustrating leasing as an operational hedge through an example. Secondly we set up a hypothesis, and finally we discuss our results and conclude.

4.4.1 Example: JetBlue Airways

Assumptions

We now consider an example, where JetBlue Airways faces an opportunity to open a new route.

First we define the time frame. At time zero JetBlue Airways has to decide whether to lease or own the fleet to be operated on the route. JetBlue Airways starts to operate the route at time 1. Payments of aircraft and lease payments occur at time 1, where the jet fuel price also becomes available. Between time 1 and time 2 JetBlue Airways operates the route, but the airline first receive revenue and pays cost at time 2. At time 2 the aircraft are sold and the lease contract terminates. For simplicity we only evaluate the opportunity over one period of operation (from time 1 to time 2) under full leasing and ownership. The cost of capital for 1 period is assumed to be 7% and we ignore taxes.

At time zero JetBlue orders 10 aircraft. We consider a case of full ownership and full leasing. The purchase and resale price of one aircraft is assumed to be 50 million USD. To calculate lease payments we use the formula: PV(Lease Payments) = Purchase Price − PV(Residual Value). Plugging the aircraft purchase price of 50 and selling value of 50 into the formula result in a present value of lease $50-50/(1+7\%) =$ 3.27 million USD per aircraft. 3.27 million USD is the lease payment for one aircraft at time 1.

The formula only holds in a perfect capital market setting (Berk and DeMarzo, 2013, p. 861). The idea behind the formula is to make sure, that financing an aircraft investment through leasing has the same value as buying and later reselling an aircraft.

The leasing contract allows JetBlue Airways to cancel the lease of 5 airplanes costlessly resulting in lease payment at $t = 1$ related to 5 of the 10 airplanes. This simplification is rather strong, as the option to cancel the order of 5 airplanes has value, that in the perfect market setting would be embedded in the size of the lease payment. This would cause the choice of full ownership versus leasing to become irrelevant as mentioned in section 2.3. However the simplification serves to give a simple insight to the value of flexibility.

If the jet fuel price turn out to be low at time 1, we assume a per gallon price of 0.5257 USD. If it comes out high, we assume a price of 3.3257 USD per gallon. When the outcome of the jet fuel price is known, we assume that it will remain at the lower or higher level until time 2.

During 2015 the average jet fuel consumption per aircraft was $700/215 = 3.26$ gallons. Here, 700 constitute JetBlue Airways' total jet fuel consumption and 215 their number of aircraft. This leads to a per aircraft fuel cost of $0.5257 \cdot 3.26 \approx 1.71$ million USD, when the fuel price is low and $3.3257 \cdot 3.26 \approx 10.83$ million USD, when the jet fuel price comes out high. As in the previous examples we define the low jet fuel price state as the up state and the high jet fuel price state as the down state.

To get an estimate of other operating costs per aircraft for JetBlue Airways, unrelated to the consumption of jet fuel, we use other operating expenses for 2015 presented in Table 4.1. Dividing this cost by the total number of aircraft in 2015 we get $3507/215 = 16.31$ million USD. As the measure includes cost of other functions than direct cost incurred by the airplanes we assume that other functions such as administration increase and decrease with fleet size. We assume depreciation to be 0. If JetBlue Airways takes an aircraft out of service for one period, maintenance cost, storage cost of unutilized capacity are assumed to be 0.

When JetBlue Airways has entered the new route it is never a positive NPV project to leave the market again. This is due to high exit and reentry cost. Treanor (2012, p. 463) argues that the service industry is generally characterized by high entry costs caused by a high level of customer loyalty. This means that once JetBlue Airways leaves the market, reentering requires large investments making it a value diluting project to exit. Hence during times of high jet fuel cost JetBlue will stay in the market even when this implies a loss.

The demand and price level and therefore revenues on the route are assumed to be fixed at a level corresponding to USD 260 million. This means that operating one aircraft during 1 period entails a revenue of 26 million USD. We assume that for JetBlue Airways to avoid exiting the market, it needs to maintain its presence and have a level of activity of at least 110 million USD in revenues.

Full Leasing Or Full Ownership

Figure 4.16 illustrates JetBlue Airways investment in a decision tree. Reading the tree from the left, the first nodes depict the decision of full leasing versus full ownership of the fleet. The square boxes indicate that a decision has to be made whereas the circle boxes indicate information about the fuel price outcome (Berk and DeMarzo, 2013, p. 775).

If JetBlue Airways decides to lease the fleet it will have the option to adjust the fleet according to the fuel price outcome. In the up state JetBlue Airways will lease 10 airplanes to capture all of the revenue. This is also the case under full ownership. For our specific assumptions we will analyze, why they will scale down in the down state under both full leasing and full ownership as shown in the figure 4.16.

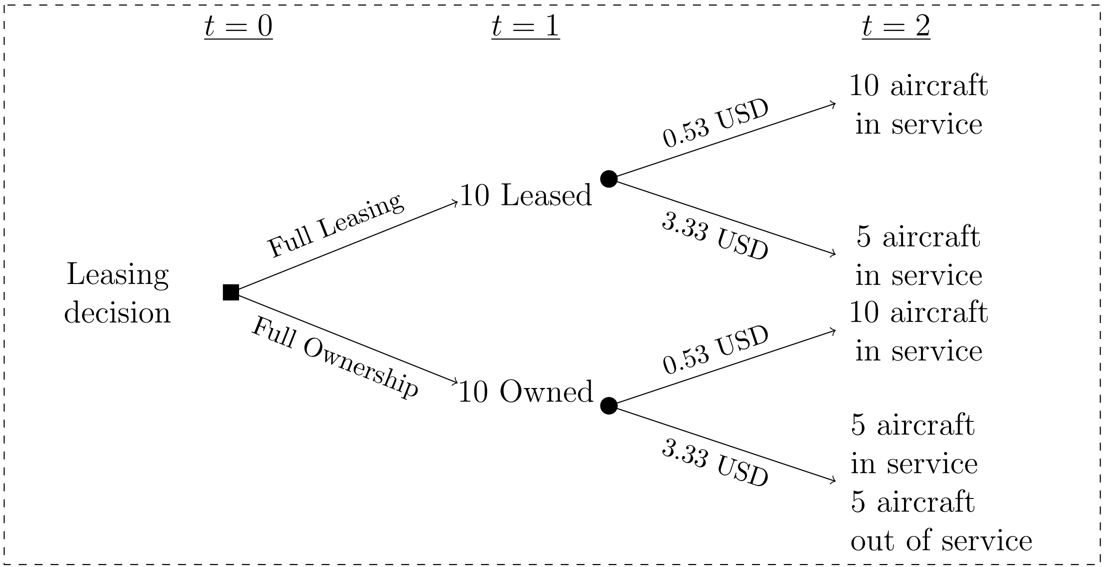

Figure 4.16

If JetBlue Airways enters the leasing agreement the NPV in the up state is:

$$\text{NPV(Leasing)}_{\text{Up}}^{\text{Full Fleet}} = \frac{10 \cdot -3.27}{1+7\%} + \frac{10 \cdot 26 - 10 \cdot 16.31 - 10 \cdot 1.71}{(1+7\%)^2} = 39.1016$$

The first term represents the present value of the lease payment of 10 airplanes made at time 1. The second term is the present value of the operating income received at time 2. As a result of no the arbitrage lease payments formula the NPV is the same in case of full ownership:

$$\begin{aligned}\text{NPV(Ownership)}^{\text{Full Fleet}}_{\text{Up}} &= \frac{10 \cdot -50}{1+7\%} + \frac{10 \cdot 50}{(1+7\%)^2} + \frac{10 \cdot 26 - 10 \cdot 16.31 - 10 \cdot 1.71}{(1+7\%)^2} \\ &= 39.1016\end{aligned}$$

The first two terms represent the present values of the buying and selling price of the 10 airplanes at time 1 and 2 respectively. The last term is the present value of the operating income received at time 2. Hence there is no reason to choose leasing over ownership in the up state. In the down state the NPV of leasing when operating the full fleet is:

$$\text{NPV(Leasing)}^{\text{Full Fleet}}_{\text{Down}} = \frac{10 \cdot -3.27}{1+7\%} + \frac{10 \cdot 26 - 10 \cdot 16.31 - 10 \cdot 10.83}{(1+7\%)^2} = -40.5235$$

As before the result is the same as if JetBlue Airways decides to operate the full fleet under full ownership:

$$\text{NPV(Leasing)}^{\text{Full Fleet}}_{\text{Down}} = \text{NPV(Ownership)}^{\text{Full Fleet}}_{\text{Down}}$$

If JetBlue Airways decides to operate the minimum required number of airplanes to cover revenues of at least 110, they need 5 airplanes. This generates revenues of $5 \cdot 26 = 130$. Under the leasing contract, this gives an NPV of:

$$\text{NPV(Leasing)}^{\text{Min. Fleet}}_{\text{Down}} = \frac{5 \cdot -3.27}{1+7\%} + \frac{5 \cdot 26 - 5 \cdot 16.31 - 5 \cdot 10.83}{(1+7\%)^2} = -20.2617$$

Under full ownership operating the minimum required fleet results in a NPV of:

$$\begin{aligned}\text{NPV(Ownership)}^{\text{Min. Fleet}}_{\text{Down}} &= \frac{10 \cdot -50}{1+7\%} + \frac{10 \cdot 50}{(1+7\%)^2} + \frac{5 \cdot 26 - 5 \cdot 16.31 - 5 \cdot 10.83}{(1+7\%)^2} \\ &= -35.5469\end{aligned}$$

The above calculations are summarized in table 4.18.

	Full Leasing			**Full Ownership**		
State	**Up**	**Down: Full fleet**	**Down: Min. Fleet**	**Up**	**Down: Full fleet**	**Down: Min. Fleet**
Owned aircraft	-	-	-	10	10	5
Leased aircraft	10	10	5	-	-	-
Aircraft not in service	-	-	-	-	-	5
Cash flows at time 1:						
- Purchase of aircraft	0	0	0	500	500	500
- Lease payment	33	33	16	0	0	0
Cash flows at time 2:						
+ Revenue	260	260	130	260	260	130
- Jet Fuel Cost	17	108	54	17	108	54
- Other Operating cost	163	163	82	163	163	82
+ Sale of aircraft	0	0	0	500	500	500
NPV at time 0	**39**	**-41**	**-20**	**39**	**-41**	**-36**

Table 4.18

Taking probabilities into account the NPV of leasing the fleet at time 0 is:

$$\begin{aligned}\text{NPV(Leasing)} &= 0.5\left(\text{NPV(Leasing)}_{\text{Up}}^{\text{Full Fleet}} + \text{NPV(Leasing)}_{\text{Down}}^{\text{Min. Fleet}}\right)\\ &= 0.5(39.1016 - 20.2617) = 9.4199 \text{ million USD}\end{aligned}$$

Equally in case of full ownership the NPV at time zero is:

$$\text{NPV(Ownership)} = 0.5(39.1016 - 35.5469) = 1.7773 \text{ million USD}$$

Therefore JetBlue Airways should lease the aircraft. The difference between the leasing and full ownership investment is:

$$\begin{aligned}\text{PV(Scale down option)} &= \text{NPV(Leasing)} - \text{NPV(Ownership)}\\ &= 9.4199 - 1.7773 = 7.6426 \text{ million USD}\end{aligned}$$

This amount corresponds to the present value of the saved lease payments at time 1 (i.e. $5 \cdot 3.27/(1 + 7\%) \approx 7.64$). Also this value can be interpreted as, the maximum fee JetBlue Airways will be willing to pay for the option to cancel the lease contract of the 5 aircraft. If the fee is set at a higher level full ownership becomes the best choice.

Exposure

To set up a measure of the NPVs' sensitivities to changes in the jet fuel price under leasing and full ownership we compute the slope coefficient of a linear function given two coordinates. I.e. Sensitivity = $\Delta y / \Delta x$. The sensitivities are:

$$\text{Sensitivity(Leasing)} = \frac{39.1016 - (-20.2617)}{0.5257 - 3.3257} = -21.2012 \text{ million USD}$$

and

$$\text{Sensitivity(Ownership)} = \frac{39.1016 - (-35.5469)}{0.5257 - 3.3257} = -26.6602 \text{ million USD}$$

The interpretation of the sensitivity measures is, that under leasing and full ownership the changes in the NPVs caused by a 1 USD increase in jet fuel price are -21 and -26 million USD respectively. Thus, in this example the value of the project under leasing is less sensitive to changes in the jet fuel price than under full ownership.

4.4.2 Hypothesis

In the above example the lease agreement gave JetBlue Airways the flexibility to scale down in case of a high jet fuel cost outcome. This increased the investment project's NPV and reduced its exposure to the jet fuel price. If we want to investigate why airlines hedge in a certain way, we must understand whether the above example is realistic in an empirical setting. We need to understand if leasing enhances firm value and can reduce exposure. If this is the case, leasing might serve as a substitute for financial hedging. This leads to the following hypothesis:

Hypothesis 7: *Leasing increase firm value and reduce exposure.*

4.4.3 Empirical Analysis Of Hypothesis 7

Grouping The Airlines

Before we start testing Hypothesis 7 we split the sample into two groups: A low leasing group and a high leasing group. We use the lease to total fleet ratio as a measure of how much an airline use leasing. To set up the two groups, we identified the median lease to total fleet ratio for each airline and assigned 50% of the airlines to a low leasing group and the remainder to a high leasing group. International Airlines Group, Air Berlin PLC and Transat A. T. Inc. did not disclose information about their number of leased aircraft and are dropped from the analysis. Consequently we are left with 27 airlines in our analysis of leasing.

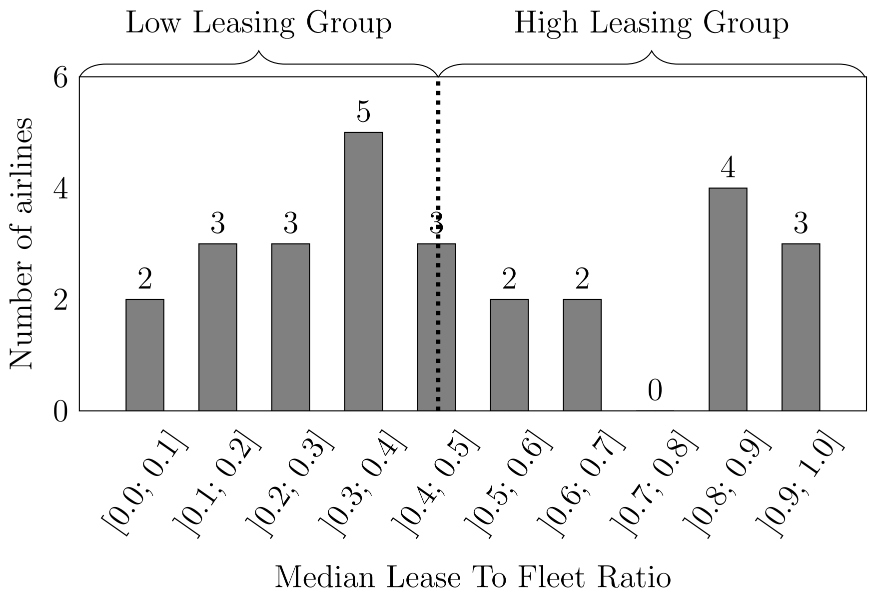

Figure 4.17: The histogram shows the distribution of the airlines median lease to total fleet ratios. The vertical dotted line marks the median of the medians and therefore also marks the point separating the low leasing group from the high leasing group. The median of the of medians is 0.4221. International Airlines Group, Air Berlin PLC and Transat A. T. Inc. do not disclose information on the number of leased aircraft in their fleet and are therefore excluded from the analysis of leasing.

Figure 4.17 illustrates how the airlines are divided. As we have an odd number of airlines in the sample we put 14 airlines in the low leasing group and 13 in the high leasing group.

Graphical Analysis

In this section we use graphical analysis to see whether, we can find empirical evidence of Hypothesis 7 using the two groups as our starting point.

Figure 4.18 presents box plots of the absolute exposure coefficients and lease adjusted Tobin's Q across the low and high leasing group.

The box plots illustrating the absolute exposure coefficients, shows that the distribution of absolute coefficients for the low and high leasing group are both positively skewed. This suggests, that both distributions are characterized by a large group of exposure coefficients in the left tail of the distribution.

The mean values in low and high leasing group are 0.59 and 0.63 respectively. This suggest that leasing increases an airlines exposure to jet fuel price changes slightly. The median confirms this indication.

The dispersion across the two groups is different. The dispersion in the low leasing group, measured by the interquartile range ($IQR = Q_3 - Q_1$) is $0.6933 - 0.2135 = 0.4798$ and $1.0049 - 0.1924 = 0.8125$ in the high leasing group. This means that the variation in the observed exposure coefficients is higher for the airlines leasing a higher fraction of their total fleet.

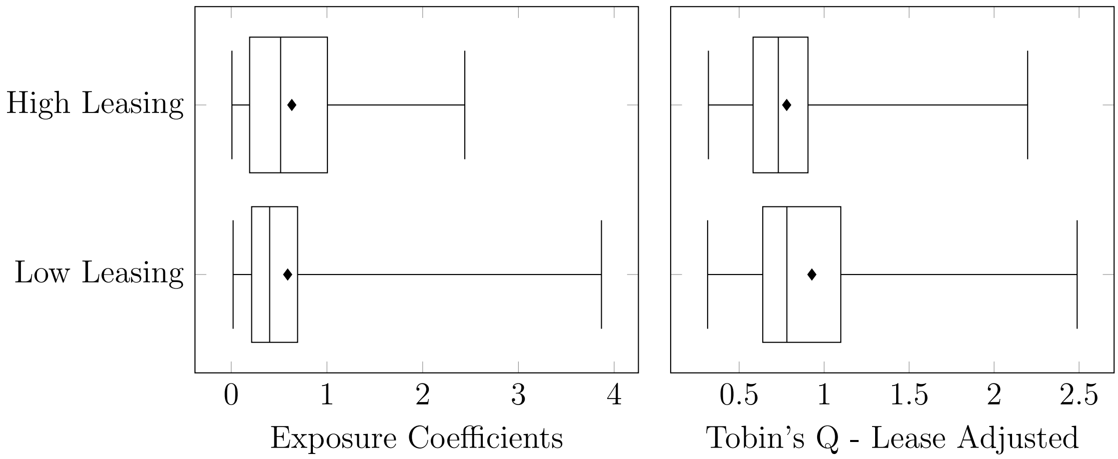

Figure 4.18: Box plot of absolute exposure and operating lease adjusted Tobin's Q across the high and low leasing group. The box plot contains observations of the 27 airlines.

The distributions of the operating lease adjusted Tobin's Q, indicated by the box plots in Figure 4.18, are positively skewed. This suggests that a larger group of airlines at the same level while a smaller group of airlines have performance at the higher levels.

The means of the Tobin's Q values across the two groups are 0.93 and 0.78 for the low and high leasing group respectively. This indicate that the low leasing airlines on average perform better than the high leasing. The same pattern is suggested by the medians.

The dispersion of Tobin's Q values according to the interquartile range in the low leasing group is also higher. E.g. 50% of the estimated Tobin's Q values lie within the lower and upper quartile of 0.6388 and 1.0979. Similarly these 50% in the high leasing group lie within 0.5818 and 0.9048. This implies a higher degree of dispersion in firm performance in the low leasing group relative to the high leasing group.

Therefore this simple graphical analysis suggests, that higher lease to fleet ratios leads to a slightly higher absolute exposure and a lower Tobin's Q. This is evidence against Hypothesis 7.

Testing

The box plots gave an overview and some initial empirical evidence against Hypothesis 7. In this section we analyze the exposure coefficients and Tobin's Q testing for statistical differences in population means across the low and high leasing group. Table 4.19 presents the means across the two groups for absolute exposure, actual exposure, the unadjusted Tobin's Q and its operating lease adjusted equivalent. We conduct a two-sided tests.

Table 4.19

	LowLeasing Mean	HighLeasing Mean	Difference Diff.	Std. Error	Obs.
AbsoluteEXP	0.5898	0.6330	-0.0432	0.0948	162
EXP	-0.4362	0.0577	-0.4939***	0.1272	162
TobinQOPLAdj	0.9278	0.7796	0.1482**	0.0569	164
TobinQ	0.9027	0.7217	0.1811**	0.0739	164
TotalFleet	402.9195	146.5065	256.4130***	40.1727	164
HPCTNXY	0.4145	0.3972	0.0173	0.0488	150

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The difference between the mean absolute exposure coefficient (AbsoluteEXP) of the low and high leasing group is -0.0432 and statistically insignificant at the 10% level. Hence statistically we cannot reject the null that there is no difference between being in the low and high leasing group with regards to exposure. Consequently this result slightly modifies the interpretation from the graphical analysis. From a statistical point of view leasing does not reduce exposure however does not increase exposure either.

The means of the actual exposure coefficients for the low and high leasing groups are -0.4362 and 0.0577. Hence according to this measure leasing significantly reduces exposure at the 1% level. As we mentioned in section 4.1.3 the cancel out effect between positive and negative values hides the exposure, that airlines actually experience.

If we consider Tobin's Q and the operating lease adjusted Tobin's Q in Table 4.19, both suggest that firm performance decrease in the amount of leasing. The difference for both measures is significant at the 5% level.

Thus according to the above analysis of means, leasing has no significant impact on exposure, while Tobin's Q is significantly and negatively associated with the amount of leasing.

In addition we look at other variables related to leasing. Firstly, we suggest that fleet size influences leasing behavior. Larger firms are likely to have other areas to employ excess capacity, which reduce the need for flexibility provided by leasing (Sharpe and Nguyen, 1995, p. 280). Therefore firm size should be negatively related to leasing.

Using the total fleet size (TotalFleet) as a proxy for firm size we observe large difference in firm size for the high and low leasing group. The high leasing group has far less airlines than the low leasing group. The mean fleet size of the low leasing group is 403 aircraft, while it is 147 aircraft for the high leasing group. This difference is both large in magnitude and significant at the 1% level. This is in line with the idea the larger firms have less incentives to hedge than smaller firms.

If leasing is considered a tool to reduce an airline's exposure, it is likely to reduce the need for financial hedging. Thus we would expect to observe a higher level of financial hedging in the low leasing group.

The average level of hedging in the low leasing group is 41.45% while 39.72% in the high leasing group. This difference is insignificant at the 10% level and only provide weak evidence that leasing reduce the need for financial hedging.

Regression Analysis

We now turn to regression analysis. Firstly, we try to see if we can find any evidence that leasing has an effect on Tobin's Q. Secondly, we investigate whether leasing has an effect on airlines exposure. The specification of the first regression model is:

$$\begin{aligned}\text{Tobin's Q} = \beta_0 + \beta_1\text{LeaseToFleet} + \beta_2\text{DistanceToDefault} + \beta_3\text{TotalFleet} \\ + \beta_4\text{HPCTNXY} + \beta_5\text{FleetAge} + \beta_6\text{LoadFactor} + \beta_7\text{EBITToRevenue} \\ + \beta_8\text{CAPEXToRevenue} + \text{Controls For Time Fixed Effects} + \epsilon \quad (4.7)\end{aligned}$$

Model 1 through 6 of Table 4.20 presents the results of the pooled OLS, the first difference and the fixed effects model.

Ind. Variabels	(1) Pooled OLS	(2) FD	(3) FE	(4) Pooled OLS	(5) FD	(6) FE
LeaseToFleet	0.0844	0.162	-0.0977	0.0989	0.593	0.434
	(0.309)	(0.379)	(0.284)	(0.493)	(0.573)	(0.405)
LeaseToFleetTotalFleet				-0.0000631	-0.00394	-0.00352*
				(0.00106)	(0.00232)	(0.00186)
DistanceToDefault	0.0107	0.0500	0.0518	0.0104	0.0474	0.0429
	(0.0349)	(0.0339)	(0.0308)	(0.0355)	(0.0337)	(0.0289)
TotalFleet	-0.000229	-0.000406*	0.0000616	-0.000207	0.00194	0.00199*
	(0.000138)	(0.000225)	(0.000522)	(0.000417)	(0.00140)	(0.00106)
HPCTNXY	-0.0656	0.234	0.0896	-0.0648	0.274	0.260
	(0.149)	(0.403)	(0.252)	(0.150)	(0.416)	(0.295)
FleetAge	0.0197	-0.0156	0.0184	0.0199	-0.0133	0.00577
	(0.0164)	(0.0228)	(0.0212)	(0.0162)	(0.0215)	(0.0220)
LoadFactor	0.0114	0.00250	-0.0135	0.0117	0.000806	-0.0139
	(0.0135)	(0.0232)	(0.0161)	(0.0172)	(0.0222)	(0.0149)
EBITToRevenue	4.360***	2.425**	3.513***	4.351***	2.222**	3.259***
	(1.234)	(0.967)	(1.004)	(1.200)	(0.922)	(0.870)
CAPEXToRevenue	1.097	-1.104	-0.948	1.100	-0.999	-0.822
	(0.903)	(1.023)	(0.740)	(0.894)	(0.961)	(0.629)
Constant	-0.739	-0.0586	1.295	-0.772	-0.0552	0.971
	(1.129)	(0.0459)	(1.333)	(1.538)	(0.0463)	(1.247)
R-squared	0.654	0.322	0.567	0.654	0.336	0.588
N	123	98	123	123	98	123

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.20: Dependent variable: Tobin's Q

From the table we see that Model 1 and 2 provide only little evidence of Hypothesis 7. Increasing the lease to fleet ratio by 1%-point on average increases Tobin's Q by $0.0844 \cdot 0.01 = 0.000844$ or $0.162 \cdot 0.01 = 0.00162$ for Model 1 and 2. The results are insignificant at the 10% level, and thus we cannot reject the null hypothesis, that the effect on Tobin's Q is zero. Model 3 suggests that the sign is negative, meaning that increasing the lease to fleet ratio on average is associated with a decrease in Tobin's Q. Consequently the three models do not provide any clear evidence of a significant relation between Tobin's Q and the lease to fleet ratio. The models even disagree on the sign of the coefficient

As an alternative specification of equation 4.7 we also try to include an interaction term. In the last section we argued that firm size and leasing were related. Thus, we analyze whether the effect of leasing on Tobin's Q depends on the fleet size.

When we include the interaction term in Model 4, 5 and 6 suggest a positive sign on the LeaseToFleet variable and negative sign on the interaction term. The two coefficients i model 4 and 5 are both insignificant, while the coefficient on the interaction term in model 6 suggests that firm size does matter. Below we analyze the partial effect, using the parameter estimates of Model 6. We do this by increasing the level of leasing by 10%-points for an average sized airline:

$$\widehat{\frac{\partial \text{TobinQ}}{\partial \text{LeaseToFleet}}} = 0.434 \cdot 0.10 - 0.00352 \cdot \overline{\text{LeaseToFleet}} \cdot 0.10$$
$$= 0.434 \cdot 0.10 - 0.00352 \cdot 282.1193 \cdot 0.10 = -0.0559$$

Thus an airline with a fleet size of the sample mean of 282 aircraft should expect a decrease in Tobin's Q of -0.0559, when increasing LeaseToFleet by 10%-points. Increasing fleet size makes the negative impact on Tobin's Q larger. Decreasing fleet size causes the relation to become positive. The point at which the effect on Tobin's Q changes is:

$$\widehat{\frac{\partial \text{TobinQ}}{\partial \text{LeaseToFleet}}} = 0 \Leftrightarrow \text{LeaseToFleet} = \frac{-0.434 \cdot 0.10}{-0.00352 \cdot 0.10} = 123.2954$$

Therefore the turning point is a fleet size of 123 aircraft. To put this number into perspective, 12 airlines in our sample have fleet size medians below 123 aircraft. The same point suggested by Model 4 is 1567 and 151 for model 5. Note that 1567 is larger than the largest observed fleet size of 1285 (American Airlines, fiscal year 2014).

Figure 4.19 below shows the effect on Tobin's Q for different fleet sizes.

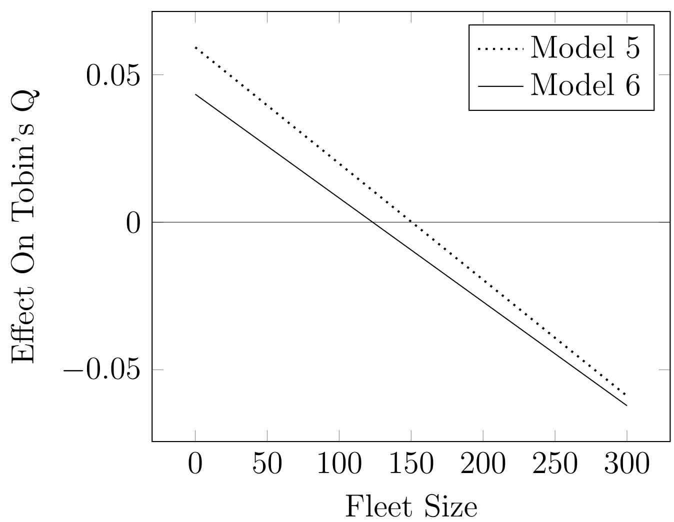

Figure 4.19: The graph illustrates the effect of a 10%-point increase in the lease to fleet ratio for different fleet sizes. Thus Model 5 suggest that the effect on Tobin's Q is postive for airlines with fleet sizes below 151 and negative for airlines above. The interpretation is the same for model 6, although the threshold at which the sign of the effect on Tobin's Q changes is at 123

Figure 4.19 also show, that Model 5 suggest a more sensitive relationship between the effect of leasing on Tobin's for different levels of fleet sizes than Model 6. I.e. if we increase the fleet size by 1 the change in the effect on Tobin's Q is larger for model 5 than model 6 resulting in the steeper line.

To sum up, we find some evidence in line with Hypothesis 7. The relationship between the lease to fleet ratio and Tobin's Q is positive, although only for airlines with a fleet size below a threshold around $123 - 150$ (Suggested by Model 5 and 6). According to Hypothesis 7 this relation should be positive for all fleet sizes.

To test whether leasing reduce exposure we set up Equation 4.7 again, but substitute Tobin's Q with the absolute exposure coefficient (AbsoluteEXP). Table 4.21 present the results of the regressions.

Ind. Variabels	(1) Pooled OLS	(2) FD	(3) FE	(4) Pooled OLS	(5) FD	(6) FE
LeaseToFleet	0.191	1.423*	1.428***	0.401	1.835**	2.092***
	(0.301)	(0.756)	(0.446)	(0.400)	(0.782)	(0.498)
LeaseToFleetTotalFleet				-0.000910	-0.00377	-0.00440*
				(0.00125)	(0.00381)	(0.00238)
DistanceToDefault	-0.234***	-0.212*	-0.214**	-0.238***	-0.214*	-0.226**
	(0.0775)	(0.106)	(0.0986)	(0.0779)	(0.106)	(0.0988)
TotalFleet	0.000275	0.00555***	0.00196**	0.000601	0.00780***	0.00436***
	(0.000263)	(0.00148)	(0.000815)	(0.000499)	(0.00211)	(0.00132)
HPCTNXY	-0.0519	0.945**	0.755	-0.0410	0.983**	0.968**
	(0.215)	(0.379)	(0.455)	(0.212)	(0.380)	(0.411)
FleetAge	0.00150	-0.0520	0.00599	0.00463	-0.0499	-0.00989
	(0.0137)	(0.108)	(0.0633)	(0.0146)	(0.112)	(0.0691)
LoadFactor	0.00828	0.0564*	0.0195	0.0130	0.0547*	0.0184
	(0.0138)	(0.0313)	(0.0239)	(0.0135)	(0.0312)	(0.0222)
EBITToRevenue	0.0600	-7.765*	-6.628***	-0.0893	-7.959*	-6.922***
	(1.058)	(3.857)	(2.200)	(0.957)	(3.841)	(2.088)
CAPEXToRevenue	0.160	-0.633	-1.021	0.209	-0.537	-0.867
	(1.040)	(1.029)	(0.743)	(1.058)	(1.060)	(0.684)
Constant	0.770	-0.0994	-1.217	0.272	-0.0966	-1.567
	(1.224)	(0.185)	(1.679)	(1.215)	(0.184)	(1.536)
R-squared	0.362	0.385	0.417	0.366	0.387	0.428
N	122	97	122	122	97	122

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.21: Dependent variable: Absolute exposure

Model 1 through 3 suggest that increasing the lease to fleet ratio is associated with higher exposure. The coefficients on the lease to fleet ratio of Model 2 and 3 are significant at the 5% and 10% level.

In Model 4 through 6 we implement the idea, that the effect on exposure from increasing the lease to fleet ratio depends on fleet size. These models suggest a different relationship. According to Model 6, the relation between the lease to fleet ratio becomes negative for airlines with fleet sizes above $-2.092/-0.0044 = 475$ aircraft (Model 4 suggest 441 and Model 5 487). Thus the models suggest, that only larger airlines are able to reduce exposure by increasing the lease to fleet ratio. The parameter estimates on LeaseToFleet and the interaction of Model 6 are significant at the 10% level.

According to Hypothesis 7, increasing the lease to fleet ratio should enhance flexibility and thus reduce exposure to jet fuel price movements. We find that this relation only seems to be true for larger airlines.

4.4.4 Discussion

Prior Research

Treanor (2008, p. 136-139) analyze the effect of leasing on Tobin's Q and finds that the relation is negative. The results are robust to different model specifications and estimation procedures. In all models Treanor (2008) find, that increasing the lease to fleet ratio causes a significant reduction in firm value. Treanor (2008) uses the log of Tobin's Q in his models. When we change the dependent variable to the log of Tobin's Q in Equation 4.7 the coefficient on LeaseToFleet in Model 2 and 3 becomes negative (See Appendix A.9 on page 130). The sign on the interaction remains negative in Model 5 and 6 like the coefficient in Model 6 remains significant at the 10%.

Treanor (2008, p. 60) also analyze the relation between leasing and exposure and finds no evidence that leasing reduce exposure. Independent of model specification Treanor (2008) finds mostly evidence that leasing increase exposure. This result is in line with the results suggested by Model 1 through 3 in Table 4.21. When we include the interaction term, however, we found that the effect on AbsoluteEXP is positive for smaller airlines but negative for larger airlines.

Practical Considerations of Leasing

As in the previous sections, the above regressions are likely to suffer from simultaneity. E.g. it seems plausible that the level of leasing affect exposure. On the other hand an airline may asses exposure to be too high, and take action to reduce exposure by increasing the level of leasing. In this way exposure cause leasing.

For this reason we also try to implement the 2SLS model. We use the log of airline age (lnAirlineAge) as our instrument. We take the log of airline age to avoid perfect multi-collinarity between the airline age and the year dummies controlling for time fixed effects. The approach is inspired by Treanor et al. (2014) who use airline age as an instrument to explain the variation in fleet diversity. We use this approach directly on fleet diversity in section 4.5.4. However we believe that airline age is a potential instrument for LeaseToFleet due to the following reasons. Younger airlines are likely to have high external financing cost as a result of a high level of asymmetric information Sharpe and Nguyen (1995, p. 276). This leads younger airlines to lease more. Thus we argue that the instrument is relevant. Further we have to assume, that airline age is unrelated to any other sources affecting exposure other than those already included in the model. The first stage equation is:

$$\begin{aligned}\text{LeaseToFleet}_{it} &= \pi_0 + \pi_1 \text{lnAirlineAge}_{it} + \pi_2 \text{TotalFleet}_{it} + \pi_3 \text{EBITToRevenue}_{it} + \\ &\pi_4 \text{FleetAge}_{it} + \pi_5 \text{LoadFactor}_{it} + \pi_6 \text{HPCTNXY}_{it} + \pi_7 \text{CAPEXToRevenue}_{it} + \\ &\pi 8 \text{DistanceToDefault}_{it} + \text{Controls For Time Fixed Effects} + v_{it} \quad (4.8)\end{aligned}$$

And the second stage equation:

$$\begin{aligned}\text{TobinQ}_{it} &= \beta_0 + \beta_1 \widehat{\text{LeaseToFleet}}_{it} + \beta_2 \text{TotalFleet}_{it} + \beta_3 \text{EBITToRevenue}_{it} \\ &+ \beta_4 \text{FleetAge}_{it} + \beta_5 \text{LoadFactor}_{it} + \beta_6 \text{HPCTNXY}_{it} + \beta_7 \text{CAPEXToRevenue}_{it} \\ &+ \beta_8 \text{DistanceToDefault}_{it} + \text{Controls For Time Fixed Effects} + u_{it} \quad (4.9)\end{aligned}$$

The result of the 2SLS regression is presented in Table 4.22.

Ind. Variabels	(1) LeaseToFleet First stage	(2) TobinQ Second stage	(3) LeaseToFleet First stage	(4) TobinQOPLAdj Second stage
lnAirlineAge	0.154		0.147	
	(0.438)		(0.372)	
LeaseToFleet		5.103		7.691
		(15.57)		(21.77)
TotalFleet	-0.0000372	0.000199	-0.0000736	0.000212
	(0.000278)	(0.00185)	(0.000227)	(0.00208)
EBITToRevenue	0.233	2.314	-0.110	4.132
	(0.348)	(4.640)	(0.233)	(3.369)
FleetAge	0.00505	-0.0150	-0.0172	0.132
	(0.0181)	(0.128)	(0.0165)	(0.393)
LoadFactor	0.00386	-0.0347	0.00189	-0.0248
	(0.00580)	(0.0594)	(0.00418)	(0.0462)
HPCTNXY	-0.141	0.789	-0.0568	0.416
	(0.107)	(1.919)	(0.110)	(1.022)
CAPEXToRevenue	0.226	-2.175		
	(0.457)	(2.825)		
DistanceToDefault	0.0130	-0.0158		
	(0.0144)	(0.186)		
CAPEXOPLAdjToRevenue			0.109	-0.841
			(0.132)	(1.998)
DistanceToDefaultOPLAdj			0.0163	-0.100
			(0.0146)	(0.289)
Constant	-0.414	0.641	-0.0926	-2.221
	(1.855)	(4.141)	(1.528)	(11.06)
R-squared	0.133		0.158	
N	123	123	104	104

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.22: The dependent variable in model 1 and 3 is LeaseToFleet. The dependent variable of model 2 and 4 is the unadjusted and operating lease adjusted Tobin's Q respectively. All models have been regressed using untabulated year dummy variables.

The table presents two different specifications. Model 1 and 2 use the unadjusted measures of TobinQ, CAPEXToRevenue and DistanceToDefault, while Model 3 and 4 have these measures adjusted for operating leases. Model 1 shows the parameter estimates of the first stage equation and Model 2 the parameter estimates of the second stage equation. We find that the t-value on the coefficient on lnAirlineAge is $\hat{\pi_1}/se(\hat{\pi_1}) = 0.154/0.438 = 0.35$ (p-value = 0.728), which is well below the threshold of 3.2. This indicates that the instrument is weak. When we estimate the second stage equation we find that the coefficient on LeaseToFleet is 5.103 (p-value = 0.743) and insignificant at the 10% level. The direction of this result is in line with Hypothesis 7. Again the problem of a weak instrument is, that it causes $\hat{\beta_1}$ to be a biased estimator of β_1, and therefore we are reluctant to trust the results of the 2SLS. Model 3 and 4 finds a similar result but has the same problem of a weak instrument. Therefore the

2SLS procedure does not allow for any stronger inference than our previous results.

One potential problem of all the leasing regressions is that the lease to fleet ratio includes both financial and operational leases. As operational leases provides the highest level of flexibility, this may be a reason why we are unable to see any negative effects on exposure or Tobin's Q.

Saxon (2012, p. 23) argue that leasing is less flexible than theory predicts. Many airlines are unable to reduce their leased fleets during economic downturns, and thus leasing does not provide an operational hedge. This may be why we do not find clear evidence, that leasing reduce exposure. Further, the value of the option to flexibly adjust the fleet will often be embedded in the price of the lease contract. This likely has a negative impact on firm value.

Among other potentially value enhancing reasons for leasing, are tax reasons, savings on maintenance etc. (Berk and DeMarzo, 2013, p. 877-878). The many aspects of leasing makes it difficult extract the effect on Tobin's Q from the part of leasing that is solely caused by a stabilization of internal cash.

4.4.5 Summary

In the analysis of leasing we tested Hypothesis 7, that leasing (LeaseToFleet) improves firm performance and reduce exposure. We measured firm performance by Tobin's Q (TobinQ), and exposure by absolute exposure (AbsoluteEXP).

In a panel data regression analysis, regressing TobinQ on LeaseToFleet, we found no evidence that leasing improves Tobin's Q. We included an interaction term between LeaseToFleet and fleet size (TotalFleet) in the model to test for different effects on firm performance across firm size. Here we found some evidence that higher LeaseToFleet is associated with better firm performance among smaller airlines.

In the analysis of exposure and leasing we found some evidence that larger airlines are able to reduce exposure through leasing. Therefore we do not find clear evidence of Hypothesis 7.

4.5 Fleet diversity

This section analyses the fleet diversity framework described in section 2.4. We start by illustrating the framework through an example, and subsequently test it empirically. Finally we discuss the results.

4.5.1 Example: JetBlue Airways

Assumptions

At the end of 2015, JetBlue Airways' fleet consisted of 130 A320, 25 A321 and 60 Embraer E190. JetBlue's Embraer E190 have 100 seats, while the A320's have 150 seats. The A321's have between 159 and 190 depending on the seat configuration of the specific aircraft (JetBlue Airways Corporation, 2011–2016, see annual report 2015, p. 23). Thus, the composition of the fleet has some diversity. This example investigates the effect of fleet diversity, and is based on the framework of Treanor (2012) described in section 2.4.

In this example JetBlue Airways is, as in section 4.4, about to enter a new route. The context is the same as before, but some assumptions have to be added or modified. The airline can choose to invest in a uniform or a diverse fleet. A uniform fleet consist of 10 large aircraft, and a diverse fleet of 5 large aircraft and 15 small aircraft. It is assumed that jet blue can buy large aircraft for 50 million USD, and that they can buy small aircraft for $50/3 = 16.67$ million USD.

This example modifies some of the assumptions from the leasing example in section 4.4. The small aircraft are assumed to have 1/3 of the revenue and cost of the large aircraft. JetBlue Airways now owns all aircraft, but can choose whether or not to use them, without incurring additional cost.

Uniform Or Diverse Fleet Composition

Figure 4.20 illustrates the example. JetBlue decides on the fleet composition at time 0 marked with a square in the figure. The airline orders a uniform fleet or a diverse fleet at this point in time. Time 1 is an informational node, which is marked with a circle in Figure 4.20. When the airline reach time 1 it pays 500 for the fleet ordered at time 0. The price for the uniform fleet and the diverse fleet is the same. It also obtains knowledge about the future jet fuel price development, and have the ability to choose how many aircraft to operate. At time 2 JetBlue Airways receives revenues and pays cost. The airline also receives 500 from selling the aircraft again at time 2.

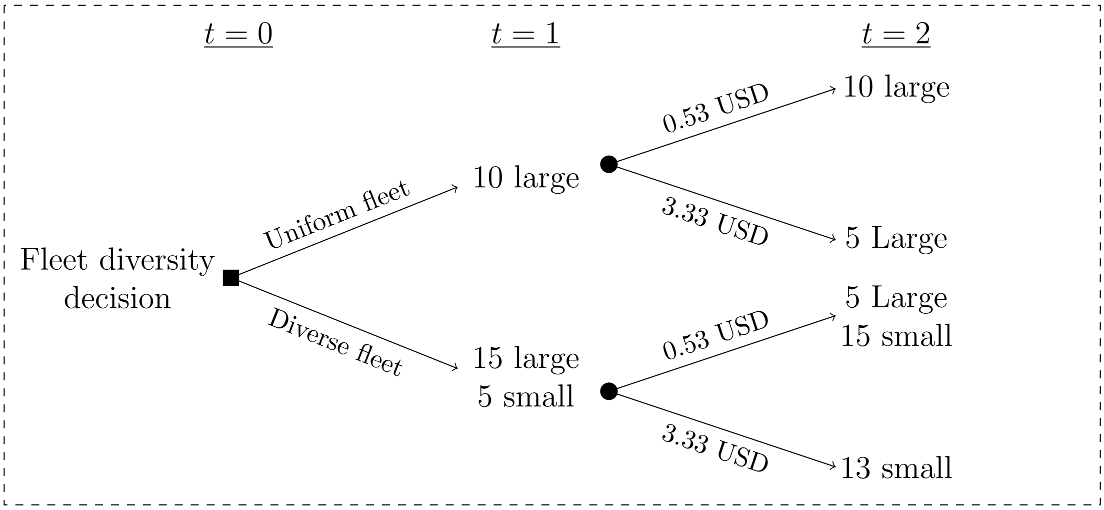

Figure 4.20: Fleet diversity example illustration

The up state occurs, if the jet fuel price turns out low at time 1. The formula below shows the calculation of the net present value in the up state for both fleet compositions, if the full fleet is utilized.

$$\text{NPV(Uniform and diverse)}^{\text{Full fleet}}_{\text{Up state}} = \frac{-500}{(1+7\%)} + \frac{260 - 17 - 163 + 500}{(1+7\%)^2} = 39.1016$$

Revenue in the up state of the fully operating uniform or diverse fleet is calculated as $26 \cdot 10 = 260$ and $26 \cdot 5 + 8.6667 \cdot 15 = 260$ respectively. 26 is the revenue per large aircraft and 8.6667 is the revenue of the small aircraft. 10 is the number of large aircraft in a uniform fleet, while revenue of a diverse fleet is calculated using 5 small aircraft and 15 large aircraft. The fuel cost in the up state of the uniform fleet is $0.5257 \cdot 3.26 \cdot 10 = 17$ and $0.5257 \cdot 3.26 \cdot 5 + 0.5257 \cdot 3.26/3 \cdot 15 = 17$ for the diverse fleet. 0.5257 is the fuel cost per gallon in the down state and 3.26 is the amount of jet fuel used per large aircraft. Other operating cost is calculated as $16.31 \cdot 10$ and $16.31 \cdot 5 + 16.31/3 \cdot 15 = 163$, where 16.31 million USD per large aircraft is explained in the assumptions of section 4.4. The calculation result in an NPV of 39. In the up state, the uniform and diverse fleets are equally profitable. Thus, JetBlue Airways is indifferent between the uniform and the diverse fleet. The equality of NPVs between the two types of fleet compositions is consistent with the model of Treanor (2012, p. 466).

JetBlue maximizes its NPV by operating the entire fleet in the up state, because the marginal contribution from employing another aircraft is constant. This result holds regardsless of fleet composition. In addition to profit being independent of fleet composition in the up state, profit is also independent of fleet composition in the down state, as long as JetBlue Airways is operating with the entire fleet:

$$\begin{aligned}\text{NPV(Uniform and diverse)}^{\text{Full fleet}}_{\text{Down state}} &= \frac{-500}{(1+7\%)} + \frac{260-108-163+500}{(1+7\%)^2} \\ &= -40.5235\end{aligned}$$

In the above equation the fuel cost is calculated as $3.3257 \cdot 3.26 \cdot 10 = 108$ for the uniform and $3.3257 \cdot 3.26 \cdot 5 + 3.3257 \cdot 3.26/3 \cdot 15 = 108$ for the diverse fleet. The effect on profit is the same for both fleet compositions when the entire fleet is utilized.

If JetBlue Airways reduces its activities in the down state, the effect of fuel price changes will be different. The diverse fleet will be affected less adversely than the uniform fleet, which is demonstrated in the below calculations:

$$\text{NPV(Uniform)}^{\text{Min. fleet}}_{\text{Down state}} = \frac{-500}{(1+7\%)} + \frac{130-54-82+500}{(1+7\%)^2} = -35.5469$$

$$\text{NPV(Diverse)}^{\text{Min. fleet}}_{\text{Down state}} = \frac{-500}{(1+7\%)} + \frac{113-47-71+500}{(1+7\%)^2} = -34.8834$$

The net present value will be less negative in the down state, if operations are stopped completely, but the assumption of high reentry cost makes this impossible. JetBlue must keep a minimum revenue of 110 million USD to secure its future presence on the new route according to the assumptions stated in section 4.4. The above calculations show that JetBlue can limit the loses by reducing the scale of the operations until the fuel price decreases again. Figure 4.20 illustrates that a uniform fleet will allow JetBlue Airways to reduce the fleet size from 10 to 5 large aircraft. A diverse fleet will enable a reduction from 15 small and 5 large aircraft to just 13 small aircraft. This is because a fleet of 5 large aircraft results in a revenue of $5 \cdot 26 = 130$, but a fleet of 13 small aircraft will obtain a revenue of $13 \cdot 26/3 = 113$. Thus, a diverse fleet makes a lower level of activity possible, while still complying with the required minimum revenue of 110 million USD. This means that a diverse fleet can get closer to the minimum required revenue than a uniform fleet, and therefore better reduce losses. The result is an NPV of -36 for the uniform fleet whereas it is -35 for the diverse fleet. Table 4.23 summarizes the above calculations and results.

	Uniform fleet			Diverse fleet		
State	**Up**	**Down: Full fleet**	**Down: Min fleet**	**Up**	**Down: Full fleet**	**Down: Min fleet**
Owned large aircraft	10	10	10	5	5	5
Owned small aircraft	-	-	-	15	15	15
Unused large aircraft	-	-	5	-	-	5
Unused small aircraft	-	-	-	-	-	2
Cash flows at time 1:						
- Purchase of aircraft	500	500	500	500	500	500
Cash flows at time 2:						
+ Revenue	260	260	130	260	260	113
- Fuel cost	17	108	54	17	108	47
- Other operating cost	163	163	82	163	163	71
+ Sale of aircraft	500	500	500	500	500	500
NPV at time 0	**39**	**-41**	**-36**	**39**	**-41**	**-35**

Table 4.23: Income calculation for the uniform and the diverse fleet composition.

The message from Table 4.23 is that the uniform fleet and the diverse fleet generates the same positive income in the up state, but that the diverse fleet has a less negative income in the down state, if activities are reduced. This difference exist because the diverse fleet has a higher degree of divisibility compared to the uniform fleet. The argument is therefore that a the diverse fleet is better at adapting to changing circumstances.

The expected value at time zero of the uniform and diverse fleet can be calculated as:

$$\begin{aligned}\text{NPV(Uniform)} &= 0.5\left(\text{NPV(Uniform)}_{\text{Up}}^{\text{Full Fleet}} + \text{NPV(Uniform)}_{\text{Down}}^{\text{Min. Fleet}}\right)\\ &= 0.5(39.1016 - 35.5469) = 1.7773 \text{ million USD}\end{aligned}$$

The NPV of the minimum fleet is used to calculate the expected value in the down state, because JetBlue Airways will choose the least negative income.

$$\begin{aligned}\text{NPV(Diverse)} &= 0.5\left(\text{NPV(Diverse)}_{\text{Up}}^{\text{Full Fleet}} + \text{NPV(Diverse)}_{\text{Down}}^{\text{Min. Fleet}}\right)\\ &= 0.5(39.1016 - 34.8834) = 2.1091 \text{ million USD}\end{aligned}$$

The probability adjusted NPV of the uniform fleet is 1.78, whereas it is 2.11 for the diverse fleet. Finding the difference between these two values result in the value of the possibility to scale down operations:

$$\begin{aligned}\text{PV(Scale down option)} &= \text{NPV(Diverse)} - \text{NPV(Uniform)}\\ &= 2.1091 - 1.7773 = 0.3318 \text{ million USD}\end{aligned}$$

The option the scale down has a value of 0.3318 million USD.

Exposure

As in the leasing example of section 4.4, the option to scale operations down decreases the exposure to fuel price changes. This can be shown by calculating the sensitivity of each fleet composition's NPV to jet fuel price changes.

$$\text{Sensitivity(Uniform)} = \frac{39.1016 - (-35.5469)}{0.5257 - 3.3257} = -26.6602 \text{ million USD}$$

and

$$\text{Sensitivity(Diverse)} = \frac{39.1016 - (-34.8834)}{0.5257 - 3.3257} = -26.4232 \text{ million USD}$$

The above calculations shows that a 1 USD per gallon increase in the fuel price will decrease the NPV of the uniform fleet by 26.6602 million USD. The reduction in NPV of the diverse fleet will be 26.4232 million USD. Thus, exposure is reduced by $26.6602 - 26.4232 = 0.237$ million USD, through the use of a diverse fleet.

4.5.2 Hypothesis

This section will define the hypothesis to be tested empirically in the next section.

The example of fleet diversity from the previous section demonstrated that fleet diversity increased the value of the investment project and reduced its exposure to the jet fuel price. Therefore Hypothesis 8 becomes:

Hypothesis 8: *Fleet diversity increase firm value and reduce exposure.*

4.5.3 Empirical Analysis Of Hypothesis 8

Grouping The Airlines

The average fleet size of the 29 airlines, that reported fleet information was 282 aircraft over the sampling period. The average number of aircraft types over the same period was 4.79 for the 28 airlines, that provided this information. We were not able to locate aircraft type information for Dart Group Plc and Transat AT Inc. Croatia Airlines had the smallest fleet with 12 aircraft between 2013 and 2015. The largest fleet was owned by American Airlines ultimo 2014 and consisted of 1285 aircraft. American Airlines had 12 different aircraft types in 2014, while Croatia Airlines had 2 aircraft types in the period from 2013 to 2015. This section will use aircraft type data to test whether Hypothesis 8 can be rejected. More specifically, the effect of fleet diversity is analyzed using the aircraft dispersion index (ADIndex) variable as a proxy.

As described above JetBlue Airways had a total of 215 aircraft in 2015. 130 of these were A320s, 25 were A321s and 60 E190s. The A320s and the A321s were categorized as one category called the A320 family. Therefore JetBlue Airways had a fleet consisting of two types of aircraft and the ADIndex was calculated in the following way:

$$\begin{aligned}\text{ADIndex}_{\text{JetBlue Airways,2015}} &= 1 - \sum_{j=1}^{N} \frac{(\text{Number of aircraft in category}_j)^2}{(\text{Total number of aircraft}_j)^2} \\ &= 1 - \frac{155^2}{215^2} + \frac{60^2}{215^2} = 0.4024\end{aligned}$$

The mean, standard deviation, minimum and maximum of each airlines ADIndex is shown in appendix A.10. Following this table the mean ADIndex value for all the 163 observations is 0.4940. The minimum is 0 which means that the airline only had one aircraft type and the maximum is 0.8849.

Before doing further analysis, we split the airlines into a low and high ADIndex group based on their median ADIndex. Each group consist of 14 airlines. Figure 4.21 illustrates the frequency of the airlines median ADIndex and the division into a low and high ADIndex groups.

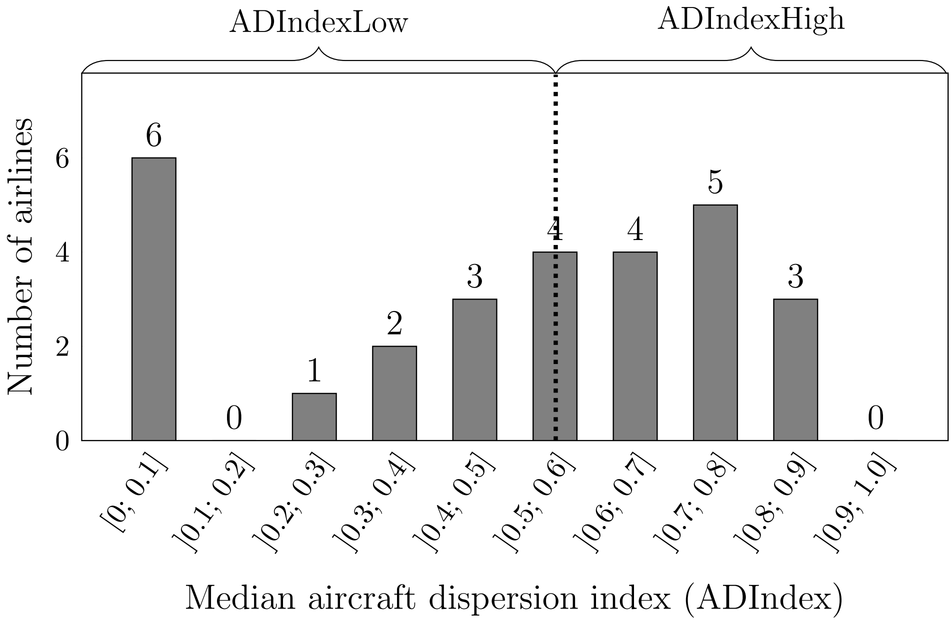

Figure 4.21: 28 airlines split in high and low ADIndex groups.

Following figure 4.21 6 airlines have an ADIndex below 0.1. These are Ryanair, Easyjet, Spirit Airlines, Norwegian, Westjet, Southwestern. Ryanair operates only one aircraft type in the form of the Boeing 737 aircraft. The following quote describe the ideas of Ryanair's managements with respect to fleet size:

> *"Management believes that its strategy, to date, of having reduced its fleet to two generations of an aircraft type enables Ryanair to limit the cost associated with personnel training, the purchase and storage of spare parts, and maintenance." - (Ryanair Holdings Plc, 2011–2016, see annual report 2015, p. 76)*

Figure 4.21 also describe that the 3 airlines with the highest fleet diversity have an ADIndex between 0.8 and 0.9. These airlines are of Air France - KLM, Finnair Oyj and American Airlines.

Graphical analysis

Tobin's Q values and the absolute exposure coefficients have been plotted in Figure 4.22 for ADIndexHigh and ADIndexLow to analyze Hypothesis 8.

The box plot of Tobin's Q show that the mean and median of the ADIndexLow airlines are above the corresponding value for the ADIndexHigh. The first and third quartiles of the ADIndexLow airlines are also above the values of the ADIndexHigh airlines. Hence the box plot indicate that ADIndexLow airlines have a higher Tobin's Q than ADIndexHigh airlines.

The interquartile range for airlines in the ADIndexLow group is higher than the range for ADIndexHigh airlines. This indicates that low fleet diversity airlines have a larger variation in their firm performance compared with to the high fleet diversity airlines.

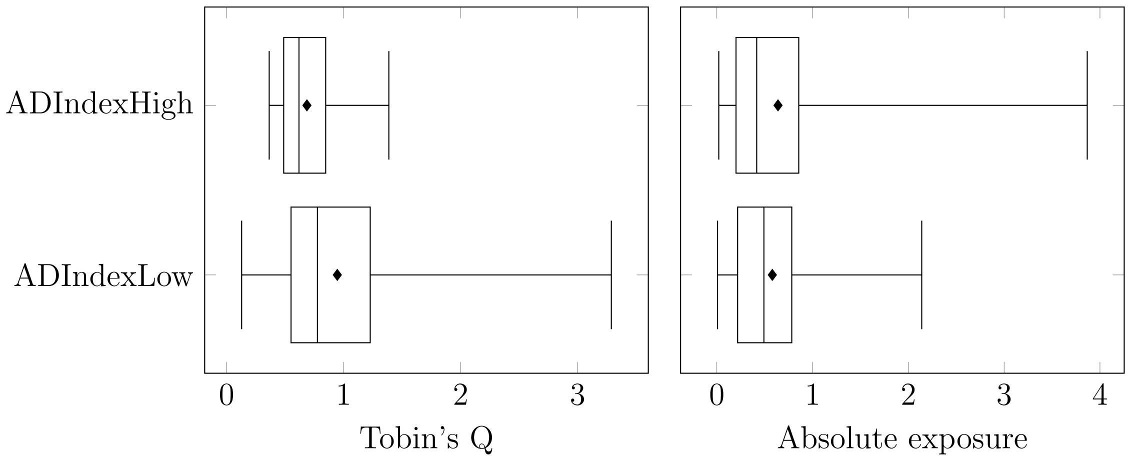

Figure 4.22: Box plot of Tobin's Q unadjusted for operating lease and absolute exposure. The diamond describes the average values.

Figure 4.22 show that the mean of the absolute exposure coefficients is slightly lower for ADIndexLow airlines than for ADIndexHigh airlines. However the median shows the opposite and hence the statistics provide contradicting evidence.

Also, Figure 4.22 displays that the absolute exposure coefficients' first and third quartiles of ADIndexLow are close to the quartiles of ADIndexHigh. The interquartile ranges are also similar for the two groups indicating that ADIndexLow and ADIndexHigh airlines have approximately the same variation in exposure to the jet fuel price.

Hypothesis 8 asserted that exposure was decreasing in fleet diversity while Tobin's Q was increasing. The graphical analysis provides evidence, that Tobin's Q is decreasing in fleet diversity, while it is unable to explain whether the absolute exposure coefficients decrease or increase in fleet diversity.

Statistical test

We will now apply a statistical test to analyze whether the results found in the graphical analysis are significant. Table 4.24 shows averages of variables divided into ADIndexHigh and ADIndexLow groups. The table also includes a statistical test.

ADIndexLow airlines have a Tobin's Q mean of 0.9466 while it is 0.6869 for ADIndexHigh airlines. The difference in the sample means of Tobin's Q are significant at the 1% level. Analysing Tobin's Q adjusted for operating lease we find means of 0.9463 for ADIndexLow and 0.7587 for ADIndexHigh. Although the difference is smaller in magnitude it is still statistically significant. This is opposite of the expectations described be Hypothesis 8. Using the interpretation of Tobin's Q stated in section 3.2.2, the means indicate, that low fleet diversity airlines have a higher profitability than high fleet diversity airlines.

	ADIndexLow	ADIndexHigh	Difference		
	Mean	Mean	Diff	Std. Error	Obs
TobinQ	0.9466	0.6869	0.2596***	0.0673	169
TobinQOPLAdj	0.9663	0.7587	0.2076***	0.0524	169
EXP	-0.1765	-0.2360	0.0595	0.1299	167
AbsoluteEXP	0.5797	0.6390	-0.0593	0.0941	167
NegativeEXP	-0.6091	-0.7143	0.1052	0.1294	103
PositiveEXP	0.5314	0.5200	0.0115	0.1302	64
TotalFleet	145.3483	454.9125	-309.5642***	39.0684	169
EBITToRevenue	0.0795	0.0499	0.0296***	0.0102	169
CAPEXToRevenue	0.1023	0.0747	0.0276***	0.0088	169
LeaseToFleet	0.4909	0.4689	0.0220	0.0464	154
FleetAge	8.2023	10.8530	-2.6507***	0.6333	150
LoadFactor	80.2386	80.7671	-0.5285	0.8101	162

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.24: Averages and statistical test of high and low fleet diversity airlines. Dart Group and Transat AT Inc have been excluded, because they did not report fleet information.

The actual mean exposure coefficient of ADIndexLow airlines is -0.1765 and -0.2360 for the ADIndexHigh airlines.

Considering the the absolute exposure coefficients of ADIndexLow airlines we find a mean of 0.5797 whereas it is 0.6390 for ADIndexHigh airlines. Comparing the absolute exposure coefficients means we find a difference between ADIndexLow airlines and ADIndexHigh airlines of 0.0593. ADIndexHigh airlines thus have the highest exposure coefficients on average. The magnitude of the number describes that the stock price of ADIndexHigh airlines on average have been effected by 0.0593%-point more than ADIndexLow airlines when the jet fuel price has increased by 1%.

We do note that the absolute exposure variable is affected by extreme observations as shown in the boxplot of figure 4.22.

The variables PositiveEXP and NegativeEXP have also been included in Table

4.24. These only average the positive or the negative exposure coefficient observations in the data set. Negative exposure observations of airlines from the ADIndexLow group on average have an exposure coefficient of -0.6091, while ADIndexHigh firms have a coefficient of -0.7143 on average. The NegativeEXP variable shows a difference of 0.1052%. The difference between the average of the positive exposure coefficients for ADIndexLow and ADIndexHigh airlines is close to zero.

We do not find a statistically significant relation between any of the four exposure measures and fleet diversity. The difference in means of actual exposure, absolute exposure and negative exposure indicated that exposure increases in fleet diversity. This is contrary to the prediction provided by Hypothesis 8, where exposure should decrease when fleet diversity increases.

The overall result of the statistical test of Tobin's Q and the exposure measures is that they are not able to confirm Hypothesis 8.

TotalFleet of Table 4.24 shows, that the ADIndexHigh group airlines have 455 aircraft on average, while ADIndexLow group airlines have 145 aircraft on average. This indicate that TotalFleet is related to ADIndex.

The EBITToRevenue ratio shown in Table 4.24 is higher for low fleet diversity airlines than for high fleet diversity airlines. The difference between the means is significant at the 1% level. This is evidence that airlines with a diverse fleet are less efficient than airlines with uniform fleets at turning revenue into profits. ADIndexHigh airlines thus have too low fuel cost savings or too high additional cost from operating a diverse fleet. Another indicator is that CAPEXToRevenue is higher for ADIndexLow airlines meaning that they reinvest a larger portion of their revenue compared to ADIndexHigh airlines.

Table 4.24 also show that fleet age is significantly higher for ADIndexHigh compared to ADIndexLow. The difference in years is approximately 2.5 years. The differences of the variables LeaseToFleet and LoadFactor are statistically insignificant. Hence it does not seem that fleet diversity is related to leasing and the load factor of airlines.

Regression Analysis

In the last section we found that variables such as TotalFleet and EBITToRevenue were related to ADIndex. We suggest that these are also related to Tobin's Q and include them as control variables in the regression models of this section. We also include additional control variables that we might be related to Tobin's Q and

ADIndex. Table 4.25 shows six regression models of Tobin's Q on ADIndex and ADIndex squared.

From the pooled OLS regression in Model 1 we find a negative and significant relationship between ADIndex and Tobin's Q. Hence this model describes, that Tobin's Q decreases when fleet diversity increases.

Model 2 and Model 3 find a positive relationship between fleet diversity and Tobin's Q. Therefore the models indicate that fleet diversity improves firm performance. These results are contrary to our statistical test section above. The coefficients are insignificant and thus we only have weak evidence of a positive relation between fleet diversity and Tobin's Q.

Ind. Variabels	(1) Pooled OLS	(2) FD	(3) FE	(4) Pooled OLS	(5) FD	(6) FE
ADIndex	-0.423***	0.0738	0.0915	-1.391**	-0.568	-0.886*
	(0.131)	(0.267)	(0.339)	(0.549)	(0.389)	(0.494)
ADIndexSq				1.273*	1.094*	1.570**
				(0.697)	(0.614)	(0.644)
TotalFleet	-0.000149	-0.000324*	0.000142	-0.000352*	-0.000384*	-0.0000386
	(0.000141)	(0.000186)	(0.000474)	(0.000183)	(0.000199)	(0.000383)
EBITToRevenue	2.555**	1.728*	2.802**	2.683**	1.552*	2.648***
	(1.094)	(0.938)	(1.046)	(1.122)	(0.899)	(0.915)
CAPEXToRevenue	0.292	-1.178	-1.036	0.337	-1.181	-0.799
	(0.854)	(1.104)	(0.623)	(0.845)	(1.118)	(0.690)
FleetAge	0.0267	-0.0174	0.0185	0.0277*	-0.0126	0.0146
	(0.0164)	(0.0281)	(0.0170)	(0.0149)	(0.0272)	(0.0164)
LoadFactor	0.0151	0.00834	-0.00997	0.0111	0.0107	-0.00885
	(0.0127)	(0.0237)	(0.0155)	(0.0131)	(0.0241)	(0.0159)
HPCTNXY	-0.115	0.165	0.0718	-0.138	0.162	0.0869
	(0.157)	(0.352)	(0.199)	(0.161)	(0.351)	(0.191)
DistanceToDefault	0.0188	0.0503*	0.0437	0.0217	0.0478*	0.0419
	(0.0321)	(0.0255)	(0.0260)	(0.0340)	(0.0253)	(0.0262)
Constant	-0.724	-0.0780**	0.966	-0.333	-0.0831**	0.897
	(0.932)	(0.0355)	(1.313)	(1.011)	(0.0354)	(1.338)
R-squared	0.647	0.291	0.547	0.665	0.299	0.567
N	132	105	132	132	105	132

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.25: Tobin's Q regressed on ADIndex, ADIndex squared and control variables. The models have been regressed using untabulated year dummy variables.

Model 4 to 6 includes a squared term of ADIndex denoted ADIndexSq. Thus, we analyze whether a squared relationship between fleet diversity and Tobin's Q exist.

Model 4 suggests a negative and significant coefficient on ADIndex. The coefficient on the squared term, ADIndexSq, is positive and significant. Almost the same results are found in regression Model 5 and 6. Model 6 finds a negative coefficient on ADIndex, that is significant at the 10% level. ADIndexSq is positive and significant at the 5% level.

The parameter estimates of Model 6 are -0.886 for ADIndex and 1.570 for ADIndexSq. The relation between ADIndex and Tobin's Q can be analyzed by finding the effect on Tobin's Q of changing ADIndex, assuming that everything else is constant. If fleet diversity for example increase from 0 to 0.10 Tobin's Q on average decrease by $(-0.886 \cdot 0.10 + 1.570 \cdot 0.10^2) - (-0.886 \cdot 0 + 1.570 \cdot 0^2) = -0.0729$. Airlines such as Ryanair and Easyjet with low fleet diversity will on average be less profitable, if they increase their fleet diversity by a small amount.

If the airlines increase the ADIndex from 0 to 0.6, Tobin's Q would increase by $(-0.886 \cdot 0.60 + 1.570 \cdot 0.60^2) - (-0.886 \cdot 0 + 1.570 \cdot 0^2) = 0.0336$. Model 6 of Table 4.25 therefore provide evidence of a relationship where the effect of increasing fleet diversity is negative for airlines with uniform fleets but positive for airlines with reasonably diverse fleets. The level of fleet diversity, at which the effect of increasing fleet diversity becomes positively related to Tobin's Q can be calculated by differentiating and setting the regression equation equal to zero:

$$\frac{\partial \widehat{\text{Tobin's Q}}}{\partial \text{ADIndex}} = -0.886 + 2 \cdot 1.570 \cdot \text{ADIndex} = 0$$
$$\Leftrightarrow \text{ADIndex} = \frac{-0.886}{2 \cdot 1.570} = 0.2822$$

Thus, Model 6 shows that airlines with a fleet diversity ratio above 0.2822 benefits from increasing the level of fleet diversity further. In Appendix A.10 we find, that 20 of the 28 airlines have a mean ADIndex above 0.2822. These 20 airlines could on average benefit from increasing their fleet diversity.

An example of an airline with an ADIndex above the 0.2822 threshold is Hawaiian Holdings Inc. with a 2015 total fleet size of 54 aircraft and 4 aircraft types. SAS is also in this region with 152 aircraft and 6 different aircraft types.

Airlines with a low ADIndex benefit from decreasing the diversity due to increased specialization. The benefits from flexibility is so small that at low levels of fleet diversity the positive effect of specializing is higher, than the effect of reducing losses during high fuel price periods.

These results are partially consistent with Hypothesis 8, which stated that Tobin's Q increases in fleet diversity. We find that this is the case for airlines, that already have a certain level of fleet diversity.

Table 4.26 analyze the relation between fleet diversity and absolute exposure. Similar to before the table contains 6 models. Model 1 finds a negative relationship between ADIndex and absolute exposure. Model 2 confirms the negative relationship, while model 3 provides evidence of the contrary. However none of the estimated coefficients are significant, and thus we are unable to assert that the relationship is positive or negative.

Ind. Variabels	(1) Pooled OLS	(2) FD	(3) FE	(4) Pooled OLS	(5) FD	(6) FE
ADIndex	-0.173	-0.198	0.115	0.748	-0.195	0.376
	(0.194)	(0.722)	(0.512)	(0.652)	(0.732)	(1.171)
ADIndexSq				-1.214	0.0202	-0.447
				(0.901)	(0.146)	(1.971)
TotalFleet	0.000323	0.00581***	0.00164**	0.000517	0.00582***	0.00169**
	(0.000272)	(0.00131)	(0.000778)	(0.000320)	(0.00128)	(0.000799)
EBITToRevenue	-0.533	-7.307*	-5.673***	-0.646	-7.306*	-5.602**
	(0.900)	(3.795)	(1.977)	(0.888)	(3.832)	(2.048)
CAPEXToRevenue	-0.0222	-0.663	-0.712	-0.0627	-0.643	-0.777
	(0.819)	(0.843)	(0.983)	(0.809)	(0.869)	(0.974)
FleetAge	0.00276	-0.0433	0.0157	0.00187	-0.0418	0.0168
	(0.0109)	(0.108)	(0.0658)	(0.0107)	(0.108)	(0.0649)
LoadFactor	0.00286	0.0548*	0.0219	0.00623	0.0552*	0.0209
	(0.0103)	(0.0272)	(0.0227)	(0.00992)	(0.0268)	(0.0215)
HPCTNXY	-0.132	0.988***	0.574	-0.108	0.990***	0.574
	(0.149)	(0.321)	(0.417)	(0.159)	(0.325)	(0.415)
DistanceToDefault	-0.211***	-0.143	-0.143	-0.214***	-0.143	-0.142
	(0.0712)	(0.0892)	(0.0865)	(0.0718)	(0.0901)	(0.0868)
Constant	1.331*	-0.145	-0.974	0.995	-0.153	-0.894
	(0.672)	(0.185)	(1.649)	(0.650)	(0.190)	(1.566)
R-squared	0.347	0.349	0.350	0.358	0.349	0.351
N	131	104	131	131	104	131

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.26: Absolute exposure regressed on ADIndex, ADIndex squared and control variables. The models have been regressed using untabulated year dummy variables.

We also test whether a squared relationship exist between fleet diversity and exposure in Table 4.26. This is interesting because we found that fleet diversity and Tobin's Q were related through a squared relationship in Table 4.25.

The coefficients of ADIndex and ADIndexSq of Model 4 to 6 in Table 4.26 are insignificant and does not display a clear relation between ADIndex and exposure. The following calculation show the effect of changing ADIndex using the parameter estimates of Model 6.

$$\frac{\widehat{\partial \text{Exposure}}}{\partial \text{ADIndex}} = 0.376 + 2 \cdot (-0.447) \cdot \text{ADIndex}$$

The above equation and equivalents for model 4 and 5 are plotted in Figure 4.23.

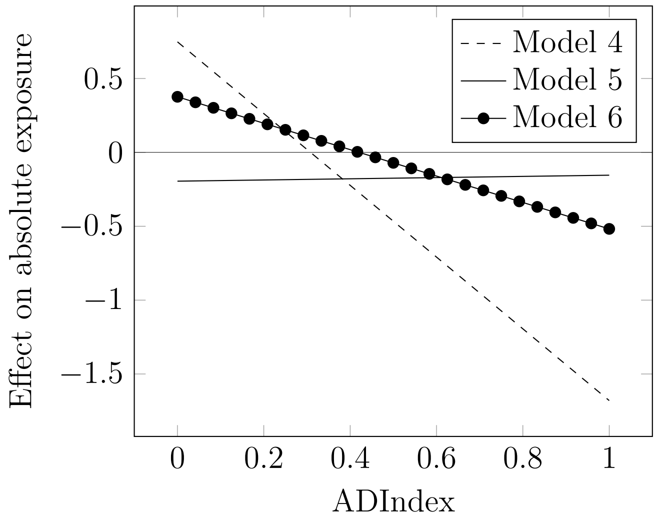

Figure 4.23

The lines of Model 4 and Model 6 shows that the effect of increasing fleet diversity is to increase exposure for airlines with low fleet diversity while exposure decreases for airlines that already have high fleet diversity. The line of Model 5 is slightly increasing but close to zero. None of the coefficients are statistically significant, but we find that model 4 and model 6 indicate similar relationships. The ADIndex level at which the effect changes from increasing exposure to decreasing exposure is found by setting the above equation equal to zero:

$$\frac{\widehat{\partial \text{Exposure}}}{\partial \text{ADIndex}} \Leftrightarrow \text{ADIndex} = \frac{-0.376}{2 \cdot (-0.447)} = 0.4206$$

Model 6 changes from increasing to decreasing at an ADIndex of 0.4206, while Model 4 estimates the level to be 0.3081.

The analysis describes that airlines uniform fleets, such as Ryanair, will be adversely effected from increasing their fleet diversity. Airlines such as American Airlines and Finnair Oyj, will benefit from an increase in fleet diversity.

The evidence found shows that exposure decreases when fleet diversity increases, which is consistent with Hypothesis 8, but the relationship is insignificant.

4.5.4 Discussion

Prior research

In the empirical analysis of Hypothesis 8 we found that fleet diversity increased Tobin's Q for airlines above a certain threshold level of fleet diversity. Airlines that had a lower level of fleet diversity would not benefit from increasing the ADIndex. Treanor (2008, p. 137-140) finds evidence that increased fleet diversity decreases Tobin's Q, but does not test to see if the effect depend on the level of fleet diversity. He therefore concludes that the disadvantages of fleet diversity are higher than the advantages.

Treanor et al. (2014, p. 152-167) test the hypothesis that fleet diversity reduces exposure using several statistical methods. When applying OLS and a fixed effects model, they find that fleet diversity is positively related to exposure. These results indicate a rejection of Hypothesis 8.

They do however provide evidence of a negative and significant relation between fleet diversity and jet fuel exposure using an instrumental variable regression (Treanor et al., 2014, p. 167). This result makes us unable to reject Hypothesis 8 and the theory of Treanor (2012).

To see if we can obtain the same results we also analyze our data using an instrumental variable regression. The setup of Treanor et al. (2014) uses the age of the airlines as instrument for ADIndex. The idea is that older airlines have had longer time to acquire more aircraft types than younger airlines and therefore have a higher ADIndex. At the same time airline exposure is unrelated to the age of the airlines through other channels than fleet diversity. In section 4.4 we found that AirlineAge and LeaseToFleet were unrelated, and thus we have no evidence that AirlineAge is related to exposure through other channels than ADIndex. Table 4.27 show our results of the instrumental variable regression.

Ind. Variabels	(1) ADIndex First stage	(2) AbsoluteEXP Second stage	(3) ADIndex First stage	(4) AbsoluteEXP Second stage
ADIndex		-0.747		-1.818
		(1.799)		(1.847)
TotalFleet	0.000191	0.00184**	0.0000396	0.000548
	(0.000246)	(0.000717)	(0.000195)	(0.000738)
EBITToRevenue	0.492	-5.150**	1.086	-1.252
	(0.560)	(2.346)	(0.731)	(2.996)
CAPEXToRevenue	0.323	-0.394		
	(0.195)	(1.156)		
CAPEXOPLAdjToRevenue			0.0653	0.534
			(0.0804)	(0.533)
FleetAge	-0.00224	0.0197	0.00490	0.0646
	(0.00911)	(0.0662)	(0.0125)	(0.0927)
DistanceToDefault	0.000122	-0.145*		
	(0.00496)	(0.0863)		
DistanceToDefaultOPLAdj			-0.00431	-0.136*
			(0.00459)	(0.0761)
LNAirlineAge	0.977**		1.152**	
	(0.413)		(0.514)	
LoadFactor	-0.00522	0.0159	-0.0104**	-0.0160
	(0.00537)	(0.0256)	(0.00474)	(0.0328)
HPCTNXY	0.112	0.708	0.0973	0.858*
	(0.0860)	(0.570)	(0.0846)	(0.480)
Constant	-2.915**	-0.294	-3.188	2.345
	(1.376)	(2.149)	(1.869)	(2.619)
R-squared	0.314		0.419	
N	132	131	112	112

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.27: Instrumental variable regression of Tobin's Q on ADIndex. ADIndex has been instrumented with AirlineAge as the instrument. Model 1 and 2 uses unadjusted variables while model 3 and 4 is adjusted for operating lease. All models are fixed effects models, while model 2 and 4 are fixed effects models that also uses an instrument. All models have been regressed using untabulated year dummy variables.

The t-value in the first stage regression of LNAirlineAge in Model 1 is $0.977/0.413 = 2.3656$ and $1.152/0.514 = 2.2412$ in Model 3. Because these t-values are in the area of 3.2, which is required for an instrument to be relevant, we argue that AirlineAge is not a weak instrument for ADIndex. An additional requirement for the instrument to work, is that it is unrelated to the error term of the second stage equation. If AirlineAge is related to a variable, that affect exposure of the airlines but is not being controlled for, then this requirement will not be satisfied.

Model 2 shows the second stage of the instrumental variable regression, that has not been adjusted for operating lease. The coefficient on ADIndex is negative meaning that exposure decrease in fleet diversity. We also find a negative coefficient in Model 4 in Table 4.27, which includes the operating lease adjusted variables. Both coefficients are insignificant and the model is sensitive to alternative specifications, such as taking the logarithm of different variables. Thus in addition to the results of Treanor et al. (2014), our results provide weak evidence in favor of Hypothesis 8, that fleet diversity decreases exposure.

The analysis of Berghöfer and Lucey (2014, p. 131-138) indicates a positive relation between fleet diversity and exposure. This result is found using a fixed effects model. They do not apply an instrumental variable regression. Instead they conclude opposite to Treanor et al. (2014) and our results, that a positive relation exist.

Practical aspects

The empirical analysis partially confirms the fleet diversity framework, but our evidence does not clearly show that the theory hold empirically. Several practical aspects potentially cause this. An example is that in the fleet diversity framework we assumed that the reentry cost were high enough to stop airlines from leaving flight routes. If reentry cost in reality is low, then airlines will simply leave the routes, when fuel prices increase, and reenter when fuel prices decrease again. This means that we have to compare the cost of reentry to the benefits of fleet diversity, before we know whether fleet diversity is profitable.

Another issue with the framework is that it does not consider the potential differences in efficiency between large and small aircraft. It assumes that profit increases proportionally to revenue, and that airlines earn the same on each passenger, whether they operate small or large aircraft. If larger aircraft are more efficient, it means that the advantage from operating a diverse fleet, can be offset by the higher fuel consumption caused by the lower efficiency of the smaller aircraft.

Other cost differences are also possible. Firstly, maintenance cost might differ because one large aircraft potentially requires less repairing than two small aircraft. Secondly, since pilots need specific skills to operate each airplane, it might be difficult for these employees to move from one aircraft model to another in a diverse fleet. The extra cost of operating the diverse fleet arise because airlines might need more pilots.

The framework of Treanor (2012) assumes that all airlines have a fleet of either large aircraft or a fleet of large aircraft and small aircraft. This assumption is problematic because some airlines such as Ryanair only operate small aircraft, leading to an ADIndex of zero. Ryanair do however, still has a lot of flexibility because it operates many small aircraft. Thus, we risk getting biased results because low ADIndex airlines can have high levels of flexibility. An alternative approach would be to exclude airlines that only operate small aircraft.

As earlier we possible have the problem of simultaneity, but we attempt to avoid this problem through the use of the instrumental variable regression above.

4.5.5 Summary

In this section we tested Hypothesis 8, which stated that fleet diversity increase firm value and decrease exposure.

We found a squared relationship between Tobin's Q and ADIndex indicating that the value of low fleet diversity airlines decrease when fleet diversity increase. Above a certain ADIndex threshold level, the relation between Tobin's Q and ADIndex changes and becomes positive. These results were statistically significant at the 10% level.

Using a fixed effects regression we found that airlines with an ADIndex below 0.4206 on average increase absolute exposure, when ADIndex increases. The absolute exposure of airlines above this threshold on average decrease when ADIndex increase. In an instrumental variable regression we found a negative relationship between ADIndex and absolute exposure.

Thus, our data partially confirmed Hypothesis 8 and the fleet diversity framework of Treanor (2012).

5 Conclusion

We obtained data from thirty airlines over the period from 2010 to 2015. Hedging behavior was analyzed from the perspectives of the financial distress theory of Smith and Stulz (1985) and the investment coordination framework of Froot et al. (1993) and Froot et al. (1994). Further we analyzed leasing and fleet diversity from a hedging perspective.

The financial distress framework of Smith and Stulz (1985) states that firms can reduce their cost of external financing through hedging. To test the framework we set up three hypothesis. These were, airlines with higher leverage hedge more, airlines with low credit ratings use more hedging, and airlines with high interest expenses use more hedging. We were unable to find empirical evidence of the former two. However, in the analysis of the latter we found weak evidence that higher interest expenses increase the level of hedging.

We studied the investment coordination framework of Froot et al. (1993) and Froot et al. (1994) through an example of JetBlue Airways. The example showed how the airline could improve firm value by moving cash flows between future states with differing levels of investment opportunities. In the empirical analysis we found that airlines partially hedge according to the predictions of the framework. When we tested Hypothesis 5 we found insignificant evidence, that airlines facing high external financing cost hedge more, than airlines with low external financing cost, when investment opportunities increase. This result is in line with the investment coordination framework. In the analysis of Hypothesis 6 we found, that hedging in accordance with the investment coordination framework improves firm performance for airlines with hedging percentages above a certain threshold.

The theory of leasing argues that leasing provides a valuable option to scale operations according to market conditions. Consequently leasing provides an operational hedge, that stabilizes internal cash flows. Thus, we hypothesized that leasing increase firm value and reduce exposure. In the analysis we were only able to find weak evidence, that smaller airlines can increase firm value through leasing. Also, we find evidence that only larger airlines are able to reduce exposure.

We illustrated the fleet diversity framework of Treanor (2012) considering an example of JetBlue Airways. The airline's ability to reduce losses during high jet fuel price periods was better than the ability of a uniform fleet. In the empirical analysis of Hypothesis 8, we found a positive relation between firm value and fleet diversity for airlines, that already had a diverse fleet. Finally we were able to provide evidence, that fleet diversity reduces exposure for all airlines.

The problem formulation questioned why we observe different fuel hedging strategies in the airline industry? We have tried to explain the differences using 4 different rationales for hedging.

The financial distress framework suggests, that airlines hedge to lower the cost of debt. This means that the optimal hedging strategy might differ from one airline to another depending on the airlines' probability of bankruptcy. For instance we found that credit ratings of airlines differ, which makes the Smith and Stulz (1985) framework relevant in explaining the differences. We found weak evidence in favor of this rationale.

The investment coordination framework of Froot et al. (1993) and Froot et al. (1994) provides another explanation for the differences in hedging behavior. Airlines facing different levels of investment opportunities or different abilities to generate internal cash flows, will not have the same need to align the two through the use of hedging. Thus, the optimal hedging strategy of the airlines differ according to the framework, and we found weak evidence in favor of the investment coordination rationale's ability to explain hedging behavior.

To explain and understand the different levels of operational hedging in the airline industry we analyzed leasing and fleet diversity. Airlines find the optimal level of leasing and fleet diversity by balancing the value of the option to flexibly adjust operations, and the cost of this option. The value of the option depend on how exposed the airlines are, and therefore we see different levels of leasing and fleet diversity. We found partial evidence that airlines operate in accordance with the theories and are successfully in doing so.

The relationship between the operational and financial hedging strategies are also interesting. We have touched upon the subject shortly, and found that airlines using more leasing on average use less financial hedging, but the difference was small. An idea for further research is therefore to analyze, if financial and operational hedging strategies are substitutes or complements.

References

Articles

Aretz, Kevin, Söhnke M. Bartram, and Gunter Dufey (2007). “Why hedge? Rationales for corporate hedging and value implications”. In: *The Journal of Risk Finance* 8.5, pp. 434–449.

Berghöfer, Britta and Brian Lucey (2014). “Fuel hedging, operational hedging and risk exposure - Evidence from the global airline industry”. In: *International Review of Financial Analysis* 34, pp. 124–139.

Carter, David A., Daniel A. Rogers, and Betty J. Simkins (2006). “Does Hedging Affect Firm Value? Evidence from the US Airline Industry”. In: *Financial Management* 35.1, pp. 53–86.

Chung, Kee H. and Stephen W. Pruitt (1994). “A Simple Approximation of Tobin’s q”. In: *Financial Management* 23.3, pp. 70–74.

Crosbie, Peter J. and Jeffrey R. Bohn Bohn (2003). “Modeling Default Risk”. In: *Published by Moody’s KMW Corporation.*

Damodaran, Aswath (1999). “Dealing with Operating Leases in Valuation”. In: *New York University Working Paper*, pp. 1–25.

Froot, Kenneth A., David S. Scharfstein, and Jeremy C. Stein (1993). “Risk Management: Coordinating Corporate Investment and Financing Policies”. In: *The Journal of Finance* 48.5, pp. 1629–1658.

— (1994). “A Framework for Risk Management”. In: *Harvard Business Review*, pp. 91–102.

Gay, Gerald D. and Jouahn Nam (1998). “The Underinvestment Problem and Corporate Derivatives Use”. In: *Financial Management*, pp. 53–69.

Geczy, Christopher, Bernadette A. Minton, and Catherine Schrand (1997). “Why Firms Use Currency Derivatives”. In: *The Journal of Finance* 52.4, pp. 1323–1354.

Haushalter, G. David (2000). “Financing Policy, Basis Risk, and Corporate Hedging: Evidence from Oil and Gas Producers”. In: *The Journal of Finance*, pp. 107–152.

Koopmans, Carl and Rogier Lieshout (2016). “Airline cost changes: To what extent are they passed through to the passenger?” In: *Journal of Air Transport Management*, pp. 1–11.

Kraus, Alan and Robert H. Litzenberger (1973). “A State-Preference Model of Optimal Financial Leverage”. In: *The Journal of Finance*, pp. 911–922.

Morrell, Peter and William Swan (2006). “Airline Jet Fuel Hedging: Theory and Practice”. In: *Transport Reviews* 26.6, pp. 713–730.

Nance, Deana R., Clifford W. Smith, and Charles W. Smithson (1993). “On the Determinants of Corporate Hedging”. In: *The Journal of Finance*, pp. 267–284.

Pulvino, Todd C. (1998). “Do asset fire sales exist? An Empirical Investigation of Commercial Aircraft Transactions”. In: *The Journal of Finance* 53.3, pp. 939–978.

Saxon, Steve (2012). “Getting more value from your eet”. In: *McKinsey On Finance, Spring* 1.43, pp. 22–27. URL: http://www.mckinsey.com.

Sharpe, Steven A. and Hien H. Nguyen (1995). “Capital market imperfections and the incentive to lease”. In: *Journal of Financial Economics* 39.1, pp. 271–294.

Smith, Clifford W. and Rene M. Stulz (1985). “The Determinant of Firms’ Hedging Policies”. In: *The Journal of Financial Quantitative Analysis* 20.4, pp. 391–405.

Treanor, Stephen D. (2012). “The flexibility and benefits of operating a diverse fleet: an analysis using real options”. In: *Management Research Review* 35.6, pp. 462–472.

Treanor, Stephen D. et al. (2014). “Does Operational and Financial Hedging Reduce Exposure? Evidence from the U.S. Airline Industry”. In: *The Financial Review* 49.1, pp. 149–172.

Tufano, Peter (1998). “Agency Cost of Corporate Risk Management”. In: *Financial Management* 27.1, pp. 67–77.

Books

Berk, Jonathan and Peter DeMarzo (2013). *Corporate Finance*. 3rd ed. Boston, United States: Pearson Education, Inc.

Damodaran, Aswath (2012). *Investment Valuation - Tools and Techniques for Determining the Value of Any Asset*. 3rd ed. Hoboken, New Jersey: John Wiley & Sons, Inc.

Morrell, Peter S. (2007). *Airline Finance*. 3rd ed. United Kingdom: Ashgate Publishing Limited.

Newbold, Paul, William L. Carlson, and Betty M. Thorne (2013). *Statistics for Business and Economics (Global Edition)*. 8th ed. Harlow, England: Pearson Education Limited.

Treanor, Stephen D. (2008). *The Effectiveness of the Operational and Financial Hedge: Evidence from the Airline Industry*. 1st ed. Oklahoma, United States: Submitted to Oklahoma State University.

Vasigh, Bijan, Kenneth Fleming, and Barry Humphreys (2015). *Foundations of Airline Finance - Methodology and practice*. 1st ed. New York, United States: Routledge.

Wooldridge, Jeffrey M. (2014). *Introductory Econometrics*. 6th ed. United States: Cengage Learning.

Financial Reports

Aegean Airlines (2011–2016). *Aegan Airlines Annual Reports 2010-2015*. URL: https://en.about.aegeanair.com/investor-relations/financial-results/?_ga=2.109824261.1685504816.1494236131-1816909669.1492013257.

Aer Lingus Group Plc (2011–2015). *Aer Lingus Annual Reports 2010-2014*. URL: http://www.iairgroup.com/phoenix.zhtml?c=240949&p=irol-irhome.

Aeroflot Group (2011–2016). *Aeroflot Group Annual Reports 2010-2015*. URL: http://ir.aeroflot.com/shareholders-and-investors/.

Air Canada (2011–2016). *Air Canada Annual Reports 2010-2015*. URL: https://www.aircanada.com/ca/en/aco/home/about/investor-relations.html.

Air France - KLM (2011–2016). *Air France - KLM Annual Reports 2010-2015*. URL: http://www.airfranceklm.com/en/finance/publications.

AirBerlin Group (2011–2016). *AirBerlin Group Annual Reports 2010-2015*. URL: http://ir.airberlin.com/en/ir.

Alaska Air Group Inc (2011–2016). *Alaska Air Group Inc Annual Reports 2010-2015*. URL: http://phx.corporate-ir.net/phoenix.zhtml?c=109361&p=irol-reportsannual.

Allegiant Air (2011–2016). *Allegiant Air Annual Reports 2010-2015*. URL: http://ir.allegiantair.com.

American Airlines Group Inc (2011–2016). *American Airlines Group Inc Annual Reports 2010-2015*. URL: http://phx.corporate-ir.net/phoenix.zhtml?c=117098&p=irol-irhome.

Croatia Airlines (2011–2016). *Croatia Airlines Annual Reports 2010-2015*. URL: http://www.croatiaairlines.com/About-us.

Dart Group PLC (2010–2016). *Dart Group PLC Annual Reports 2010-2015*. URL: http://www.dartgroup.co.uk/investor_relations/.

Delta Air Lines (2011–2016). *Delta Air Lines Annual Reports 2010-2015.* URL: http://ir.delta.com.

Easyjet Plc (2011–2016). *Easyjet Plc Annual Reports 2010-2016.* URL: http://corporate.easyjet.com/investors.

FedEx (2010–2016). *FedEx Annual Reports 2010-2016.* URL: http://investors.fedex.com/investor-home/default.aspx.

Finnair Group (2011–2016). *Finnair Group Annual Reports 2010-2015.* URL: https://investors.finnair.com.

Flybe Group Plc (2011–2016). *Flybe Group Plc Annual Reports 2010-2015.* URL: http://www.flybe.com/corporate/investors/.

Hawaiian Holdings Inc. (2011–2016). *Hawaiian Holdings Inc. Annual Reports 2010-2015.* URL: http://www.croatiaairlines.com/About-us.

Icelandair Group (2011–2016). *Icelandair Group Annual Reports 2010-2015.* URL: http://www.icelandairgroup.is/investors/.

International Airlines Group (2011–2016). *International Airlines Group Annual Reports 2010-2015.* URL: http://www.iagshares.com/phoenix.zhtml?c=240949&p=irol-irhome.

JetBlue Airways Corporation (2011–2016). *JetBlue Airways Corporation Annual Reports 2010-2015.* URL: http://blueir.investproductions.com/investor-relations.

Lufthansa Group (2011–2016). *Lufthansa Group Annual Reports 2010-2015.* URL: https://investor-relations.lufthansagroup.com/en.html.

Norwegien Air Shuttle (2011–2016). *Norwegian Air Shuttle Annual Reports 2010-2015.* URL: https://www.norwegian.com/dk/om-os/company/investor-relations/.

Ryanair Holdings Plc (2011–2016). *Ryanair Holdings Plc Annual Reports 2010-2015.* URL: https://investor.ryanair.com.

SAS Group (2011–2017). *SAS Group Annual Reports 2010-2016.* URL: http://www.sasgroup.net/en/category/investor-relations/.

South West Airlines (2011–2016). *South West Airline Annual Reports 2010-2015.* URL: http://www.southwestairlinesinvestorrelations.com.

Spirit Airlines (2012–2016). *Spirit Airlines Annual Reports 2011-2015.* URL: http://ir.spirit.com.

Transat (2011–2016). *Transat Annual Reports 2010-2016.* URL: https://www.transat.com/en-CA/corporate/investors.

Turkish Airlines (2011–2016). *Turkish Airlines Annual Reports 2010-2015.* URL: http://investor.turkishairlines.com/en.

United Airlines (2011–2016). *United Airlines Annual Reports 2010-2015*. URL: http://ir.united.com.

WestJet Airlines (2011–2016). *WestJet Airlines Annual Reports 2010-2015*. URL: https://www.westjet.com/en-ca/about-us/media-investor-relations/index.

Web Pages

Airbus S.A.S (2017). *Airbus - Aircraft families*. URL: http://www.airbus.com/aircraftfamilies/.

BIS (2017). *BIS - Long-term Rating Scales Comparison*. URL: http://www.bis.org/bcbs/qis/qisrating.htm.

CNN (2016). *Delta loses $450 million bet on fuel prices*. URL: http://money.cnn.com/2016/07/05/news/companies/delta-fuel-hedges/.

Compustat (2017). *Wharton database - Compustat*. URL: https://wrds-web.wharton.upenn.edu/wrds/.

Damodaran, Aswath (2017a). *Cost of Capital By Industry (Global)*. URL: http://www.stern.nyu.edu/~adamodar/pc/datasets/waccGlobal.xls.

— (2017b). *Cost of Capital By Sector (US)*. URL: http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/wacc.htm.

— (2017c). *Debt to capital & debt to equity ratios, with key drivers*. URL: http://www.stern.nyu.edu/~adamodar/pc/datasets/dbtfundGlobal.xls.

Datastream (2017). *Datastream*. URL: http://www.cbs.dk/bibliotek/databaser/datastream.

eia.gov (2017). *U.S. Energy Information Administration webpage*. URL: https://www.eia.gov.

Federal Reserve Bank of St. Louis (2017a). *Kerosene-Type Jet Fuel Prices: U.S. Gulf Coast*. URL: https://fred.stlouisfed.org/series/WJFUELUSGULF.

— (2017b). *Trade Weighted U.S. Dollar Index: Broad*. URL: https://fred.stlouisfed.org/series/TWEXBMTH.

IAG (2015). *IAG, News: Aer Lingus Offer Now Closed*. URL: http://www.iagshares.com/phoenix.zhtml?c=240949&p=irol-newsArticle&ID=2084313.

IATA (2016). *Economic Performance of the Airline Industry - Industry Forecast - December 2016*. URL: http://www.iata.org/whatwedo/Documents/economics/Central-forecast-end-year-2016-tables.pdf.

— (2017). *Current Airline Members*. URL: http://www.iata.org/about/members/Pages/airline-list.aspx?All=true.

S&P (2016). *S&P Global Ratings Definitions*. URL: http://img.en25.com/Web/StandardPoorsRatings/RatingsDirect_Commentary_1695715_Sep-13-2016_15_16.pdf.

S&P Global Fixed Income Research (2016). *2015 Annual Global Corporate Default Study and Rating Transitions*. URL: http://www.spratings.com/documents/20184/774196/2015+Annual+Global+Corporate+Default+Study+And+Rating+Transitions/.

The Boeing Company (2017). *Boeing, History, Products, 747*. URL: http://www.boeing.com/history/products/747.page.

Thomson ONE Banker (2017). *Thomson ONE Banker*. URL: http://www.cbs.dk/en/library/databases/thomson-one-banker.

Appendix

A.1 Database File

The link below is a link to our database file. The file contains all the variables and numbers used throughout the analysis: https://drive.google.com/drive/folders/0B6E_NYKbgUFcY1dhUFRNQ3Y2Yms?usp=sharing

A.2 Airlines In The Sample

Airlines in the sample.		
SAS Group (2011–2017)	Air Canada (2011–2016)	AirBerlin Group (2011–2016)
Lufthansa Group (2011–2016)	Alaska Air Group Inc (2011–2016)	International Airlines Group (2011–2016)
United Airlines (2011–2016)	American Airlines Group Inc (2011–2016)	JetBlue Airways Corporation (2011–2016)
South West Airlines (2011–2016)	Spirit Airlines (2012–2016)	WestJet Airlines (2011–2016)
Norwegien Air Shuttle (2011–2016)	Hawaiian Holdings Inc. (2011–2016)	Dart Group PLC (2010–2016)
Air France - KLM (2011–2016)	Croatia Airlines (2011–2016)	Icelandair Group (2011–2016)
Ryanair Holdings Plc (2011–2016)	Aeroflot Group (2011–2016)	Finnair Group (2011–2016)
Easyjet Plc (2011–2016)	Delta Air Lines (2011–2016)	Allegiant Air (2011–2016)
Aer Lingus Group Plc (2011–2015)	Turkish Airlines (2011–2016)	Transat (2011–2016)
Flybe Group Plc (2011–2016)	Aegean Airlines (2011–2016)	FedEx (2010–2016)

The table shows the 30 airlines in the sample. The year intervals listed in parenthesis are the publication years of the annual reports, that we have used to gather our information.

A.3 Aircraft Types

Aircraft Types			
A300	MD10	Fokker F70	Tupolev Tu-134
A310	MD-11	Fokker F100	Tupolev Tu-154
A318/A319/A320/A321	ATR	Bombardier Q series	Tupolev Tu-204
A330/A340/A350	E135	Bombardier D100 (Challenger 300)	Antonov An-12
A380	E140	Bombardier CRJ	Antonov An-24
B717	E145	Cessna Citation	Antonov An-26
B727	E170	Cessna 208 Caravan	Antonov An-148
B737	E175	MD-80 Series (82/83/88/87)	Yak 40
B747	E190/E195	MD-90 series	Mil- Mi-8
B757	Saab 340B	DC-9	Superjet 100
B767	Saab 2000	Ilyushin Il-86	
B777	Avro RJ Family	Ilyushin Il-96	
B787	Fokker F50	DHC-6 Twin Otter Series	

Several aircraft types exist, and we split these into 49 aircraft types, which we use to calculate the aircraft dispersion index (ADIndex)

A.4 Percentage Hedged Next Year

	Mean	Std.	Min	Max	Obs.
AEGEAN AIRLINES	0.2842	0.2431	0.0300	0.6600	6
AER LINGUS GROUP PLC	0.6646	0.1330	0.5730	0.9000	5
AEROFLOT-RUSSIAN AIRLINES	0.3975	0.3578	0.0000	0.7000	4
AIR BERLIN PLC	0.5058	0.1235	0.3730	0.7150	6
AIR FRANCE - KLM	0.5833	0.0333	0.5300	0.6200	6
ALASKA AIR GROUP INC	0.4633	0.0408	0.4200	0.5000	6
ALLEGIANT TRAVEL CO	0.0000	0.0000	0.0000	0.0000	6
AMERICAN AIRLINES GROUP INC	0.1600	0.1365	0.0000	0.3500	6
AIR CANADA	0.2183	0.0240	0.1800	0.2400	6
DART GROUP PLC	0.9657	0.0420	0.9000	1.0000	7
DELTA AIR LINES INC	0.3058	0.1804	0.0500	0.4681	4
DEUTSCHE LUFTHANSA AG	0.7562	0.0271	0.7200	0.7880	6
EASYJET PLC	0.7671	0.0502	0.7000	0.8300	7
FEDEX CORP	0.0000	0.0000	0.0000	0.0000	7
FINNAIR OYJ	0.6525	0.0276	0.6000	0.6725	6
FLYBE GROUP PLC	0.6750	0.1529	0.4260	0.9000	6
HAWAIIAN HOLDINGS INC	0.3698	0.0714	0.3043	0.5008	6
ICELANDAIR GROUP HLDGS	0.3567	0.1531	0.1800	0.5700	6
INTL CONSOL AIRLINES GROUP	0.6550	0.0409	0.6000	0.7100	5
JETBLUE AIRWAYS CORP	0.1533	0.1033	0.0500	0.2800	6
NORWEGIAN AIR SHUTTLE ASA	0.1613	0.1982	0.0000	0.5000	6
RYANAIR HOLDINGS PLC	0.8867	0.0606	0.7700	0.9500	6
SAS AB	0.5300	0.1252	0.4300	0.8000	7
SOUTHWEST AIRLINES	0.2214	0.2088	0.0000	0.5187	6
SPIRIT AIRLINES INC	0.0980	0.1458	0.0000	0.3500	5
TRANSAT A T INC	0.3557	0.1101	0.1800	0.4800	7
TURK HAVA YOLLARI AO	0.4150	0.0212	0.4000	0.4300	2
UNITED CONTINENTAL HLDGS INC	0.2796	0.0847	0.1700	0.4000	6
WESTJET AIRLINES LTD	0.0717	0.1114	0.0000	0.2300	6
Total	0.4158	0.2924	0.0000	1.0000	168

Percentage of next years expected fuel consumption hedged (HPCTNXY)

A.5 Unadjusted Tobin's Q

	Mean	Std.	Min	Max	Obs.
AEGEAN AIRLINES	0.4527	0.2739	0.1290	0.7558	6
AER LINGUS GROUP PLC	0.3947	0.1751	0.2258	0.6921	5
AEROFLOT-RUSSIAN AIRLINES	0.7482	0.1418	0.5483	0.9442	6
AIR BERLIN PLC	0.6888	0.2143	0.5013	1.0745	6
AIR FRANCE - KLM	0.5428	0.0631	0.4817	0.6473	6
ALASKA AIR GROUP INC	1.0008	0.4283	0.6222	1.6580	6
ALLEGIANT TRAVEL CO	2.0035	0.4687	1.3533	2.5056	6
AMERICAN AIRLINES GROUP INC	0.6815	0.3724	0.3645	1.2791	6
AIR CANADA	0.5500	0.1480	0.4102	0.7692	6
CROATIA AIRLINES	1.2057	0.2044	0.9587	1.4695	6
DART GROUP PLC	0.4730	0.1869	0.2443	0.7597	7
DELTA AIR LINES INC	0.7537	0.2140	0.5442	1.0370	6
DEUTSCHE LUFTHANSA AG	0.4432	0.0390	0.3683	0.4755	6
EASYJET PLC	0.9853	0.4498	0.4619	1.6299	7
FEDEX CORP	1.0820	0.2135	0.8265	1.3871	7
FINNAIR OYJ	0.3995	0.0519	0.3543	0.4924	6
FLYBE GROUP PLC	0.4393	0.0962	0.3226	0.5751	6
HAWAIIAN HOLDINGS INC	0.6711	0.2486	0.4627	1.0374	6
ICELANDAIR GROUP HLDGS	0.8699	0.4499	0.3481	1.5410	6
INTL CONSOL AIRLINES GROUP	0.7114	0.2039	0.4155	0.9422	6
JETBLUE AIRWAYS CORP	0.7796	0.1920	0.5910	1.0893	6
NORWEGIAN AIR SHUTTLE ASA	0.9467	0.1481	0.6773	1.0938	6
RYANAIR HOLDINGS PLC	1.2154	0.3879	0.7766	1.8174	6
SAS AB	0.5396	0.0900	0.4134	0.6338	7
SOUTHWEST AIRLINES	0.9917	0.4877	0.5512	1.6177	6
SPIRIT AIRLINES INC	1.8519	1.0034	1.0718	3.2884	5
TRANSAT A T INC	0.2068	0.1377	0.0258	0.4524	7
TURK HAVA YOLLARI AO	0.7607	0.1155	0.5818	0.8647	6
UNITED CONTINENTAL HLDGS INC	0.7160	0.2305	0.4755	1.0641	6
WESTJET AIRLINES LTD	0.7145	0.1590	0.4969	0.9173	6
Total	0.7867	0.4738	0.0258	3.2884	183

A.6 Adjusted Tobin's Q

	Mean	Std.	Min	Max	Obs.
AEGEAN AIRLINES	0.6519	0.2080	0.3975	0.8572	6
AER LINGUS GROUP PLC	0.4613	0.1538	0.3191	0.7247	5
AEROFLOT-RUSSIAN AIRLINES	0.8553	0.1008	0.6986	0.9637	6
AIR BERLIN PLC	0.8428	0.1098	0.7205	1.0226	6
AIR FRANCE - KLM	0.6275	0.0616	0.5710	0.7255	6
ALASKA AIR GROUP INC	1.0001	0.3663	0.6827	1.5588	6
ALLEGIANT TRAVEL CO	1.9396	0.4693	1.3321	2.4887	6
AMERICAN AIRLINES GROUP INC	0.7618	0.2828	0.5307	1.2182	6
AIR CANADA	0.6198	0.1171	0.5054	0.7966	6
CROATIA AIRLINES	1.1352	0.1320	0.9710	1.2983	6
DART GROUP PLC	0.5208	0.1673	0.3144	0.7752	7
DELTA AIR LINES INC	0.8024	0.1708	0.6388	1.0310	6
DEUTSCHE LUFTHANSA AG	0.4767	0.0381	0.4033	0.5065	6
EASYJET PLC	0.9861	0.4153	0.5066	1.5872	7
FEDEX CORP	1.0603	0.1558	0.8733	1.2834	7
FINNAIR OYJ	0.5258	0.0463	0.4595	0.5818	6
FLYBE GROUP PLC	0.6874	0.0854	0.5745	0.8056	6
HAWAIIAN HOLDINGS INC	0.7615	0.1780	0.6087	1.0292	6
ICELANDAIR GROUP HLDGS	0.8963	0.3415	0.5031	1.3998	6
INTL CONSOL AIRLINES GROUP	0.7572	0.1746	0.5022	0.9522	6
JETBLUE AIRWAYS CORP	0.8142	0.1632	0.6546	1.0794	6
NORWEGIAN AIR SHUTTLE ASA	0.9762	0.0707	0.8525	1.0555	6
RYANAIR HOLDINGS PLC	1.2103	0.3774	0.7864	1.8001	6
SAS AB	0.6827	0.0893	0.5725	0.7741	7
SOUTHWEST AIRLINES	0.9944	0.4021	0.6425	1.5044	6
SPIRIT AIRLINES INC	1.4348	0.5183	1.0343	2.1974	5
TRANSAT A T INC	0.4530	0.1058	0.3403	0.6441	7
TURK HAVA YOLLARI AO	0.7777	0.1052	0.6152	0.8715	6
UNITED CONTINENTAL HLDGS INC	0.8003	0.1608	0.6354	1.0444	6
WESTJET AIRLINES LTD	0.7718	0.1231	0.6105	0.9319	6
Total	0.8389	0.3689	0.3144	2.4887	183

Tobin's Q adjusted for operating lease

A.7 Exposure

	Mean	Std.	Min	Max	Obs.
AEGEAN AIRLINES	0.0392	0.7040	-1.2127	0.8962	6
AER LINGUS GROUP PLC	-0.2598	1.0258	-1.5261	1.2469	5
AEROFLOT-RUSSIAN AIRLINES	0.5630	0.7377	-0.2231	1.7543	6
AIR BERLIN PLC	0.1986	0.3996	-0.3477	0.8013	6
AIR FRANCE - KLM	-0.2624	0.4318	-0.6778	0.4496	6
ALASKA AIR GROUP INC	-0.6096	0.5485	-1.6231	-0.0928	6
ALLEGIANT TRAVEL CO	-0.6040	0.2319	-0.9634	-0.2642	6
AMERICAN AIRLINES GROUP INC	-1.8265	1.5127	-3.8672	-0.2999	6
AIR CANADA	-0.1067	0.5258	-1.0162	0.4430	6
CROATIA AIRLINES	-0.1354	1.5668	-2.1395	2.0179	6
DART GROUP PLC	0.0899	0.3541	-0.2477	0.7307	7
DELTA AIR LINES INC	-0.4066	0.3242	-0.9108	-0.0479	6
DEUTSCHE LUFTHANSA AG	-0.0864	0.5713	-0.6744	0.8279	6
EASYJET PLC	-0.1686	0.3338	-0.5048	0.3394	7
FEDEX CORP	-0.1397	0.4138	-0.9232	0.3165	7
FINNAIR OYJ	0.0081	0.7778	-1.0049	1.0911	6
FLYBE GROUP PLC	0.5292	0.7570	-0.5161	1.4065	5
HAWAIIAN HOLDINGS INC	-0.8405	0.8407	-2.2178	0.1573	6
ICELANDAIR GROUP HLDGS	0.0646	0.2755	-0.3244	0.3833	6
INTL CONSOL AIRLINES GROUP	-0.1959	0.5165	-0.9360	0.3058	6
JETBLUE AIRWAYS CORP	-0.7747	0.8538	-1.8570	0.1394	6
NORWEGIAN AIR SHUTTLE ASA	-0.2902	0.6141	-1.0519	0.5050	6
RYANAIR HOLDINGS PLC	0.0838	0.3992	-0.3018	0.6787	6
SAS AB	0.7170	1.1451	-1.0549	2.4397	7
SOUTHWEST AIRLINES	-0.3706	0.4956	-0.6933	0.6227	6
SPIRIT AIRLINES INC	0.1102	1.1013	-1.3834	1.1343	4
TRANSAT A T INC	-0.0105	1.0017	-1.3218	1.4700	7
TURK HAVA YOLLARI AO	-0.1570	0.5363	-0.8838	0.5889	6
UNITED CONTINENTAL HLDGS INC	-0.6999	0.4848	-1.3652	0.0849	6
WESTJET AIRLINES LTD	-0.0718	0.3428	-0.6414	0.2434	6
Total	-0.1861	0.8225	-3.8672	2.4397	181

A.8 Other variables

Variable	Mean	Std.	Min	Max	Obs.
AbsoluteEXP	0.6019	0.5890	0.0077	3.8672	181
ADIndex	0.4940	0.2999	0.0000	0.8849	163
CAPEXToRevenue	0.0866	0.0596	0.0000	0.3227	183
CAPEXOPLAdjToRevenue	0.1187	0.1324	-0.0661	1.0872	153
CashToRevenue	0.1324	0.1082	0.0000	0.6169	183
CashflowToRevenue	0.1051	0.0794	-0.2372	0.2988	183
DebtToAssets	0.2796	0.1584	0.0000	0.7392	183
DistanceToDefault	3.2355	1.4137	-1.1419	9.1192	175
DistanceToDefaultOPLAdj	3.1630	1.4287	-1.1878	9.0329	183
DMVE	1.6282	4.1370	0.0000	48.7909	183
DOPLAdjMVE	3.6031	8.8479	0.0599	98.9402	183
EBITToRevenue	0.0626	0.0676	-0.1021	0.2945	183
EXP	-0.1861	0.8225	-3.8672	2.4397	181
FleetAge	9.4570	4.1612	3.0000	22.8810	150
HPCTNXY	0.4158	0.2924	0.0000	1.0000	168
InterestExpenseToDebt	0.0805	0.3023	-0.0055	4.0000	175
Jetfuelprices	2.3776	0.7062	1.0690	3.2560	183
DistanceToDefaultOPLAdj	3.1630	1.4287	-1.1878	9.0329	183
LeaseToFleet	0.4673	0.2899	0.0000	1.0000	161
LoadFactor	80.7925	5.6307	61.7000	93.0000	169
NetDMVE	1.1606	3.9062	-1.7906	47.1111	183
NetDOPLAdjMVE	3.1355	8.5944	-0.4471	97.2604	183
RevenueUSD	10968.3471	13253.9703	200.9726	50365.0000	183
SPFitchRating	BB-	-	D	BBB+	91
TotalFleet	282.1193	288.2712	12.0000	1285.0000	176
TobinQ	0.7867	0.4738	0.0258	3.2884	183
TobinQOPLAdj	0.8389	0.3689	0.3144	2.4887	183
TotalAssetsUSD	11936.1155	14516.0652	121.1421	54121.0000	183
TotalDebtUSD	3493.8550	4524.8814	0.0000	20561.0000	183

Summary statistics of other variables. S&PFitch Rating has been translated into numerical values and translated back to the original ratings after averaging

A.9 Log of TobinQ

Ind. Variabels	(1) Pooled OLS	(2) FD	(3) FE	(4) Pooled OLS	(5) FD	(6) FE
LeaseToFleet	0.00759	-0.0951	-0.143	-0.227	0.161	0.193
	(0.200)	(0.281)	(0.242)	(0.301)	(0.431)	(0.325)
LeaseToFleetTotalFleet				0.00102	-0.00235	-0.00223*
				(0.000862)	(0.00175)	(0.00110)
DistanceToDefault	0.0107	0.0417**	0.0534**	0.0151	0.0402*	0.0479**
	(0.0264)	(0.0196)	(0.0192)	(0.0255)	(0.0198)	(0.0183)
TotalFleet	-0.000109	-0.000294	0.000145	-0.000475	0.00110	0.00136*
	(0.000127)	(0.000194)	(0.000455)	(0.000315)	(0.00102)	(0.000727)
HPCTNXY	-0.0452	0.163	0.206	-0.0583	0.187	0.314
	(0.168)	(0.188)	(0.156)	(0.160)	(0.195)	(0.184)
FleetAge	0.0107	-0.00812	0.0161	0.00723	-0.00675	0.00815
	(0.0137)	(0.0236)	(0.0195)	(0.0123)	(0.0234)	(0.0200)
LoadFactor	0.0170	-0.00233	-0.00765	0.0119	-0.00333	-0.00789
	(0.0143)	(0.0236)	(0.0205)	(0.0160)	(0.0237)	(0.0204)
EBITToRevenue	4.581***	3.143***	4.977***	4.736***	3.023***	4.816***
	(1.249)	(0.804)	(1.061)	(1.311)	(0.796)	(1.077)
CAPEXToRevenue	1.116	-1.006	-1.024*	1.058	-0.944	-0.944*
	(1.032)	(0.612)	(0.577)	(1.021)	(0.577)	(0.520)
Constant	-2.309*	-0.133***	-0.480	-1.778	-0.131***	-0.684
	(1.156)	(0.0358)	(1.650)	(1.319)	(0.0366)	(1.611)
R-squared	0.743	0.484	0.741	0.750	0.491	0.749
N	123	98	123	123	98	123

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The regression output present the parameter estimates of Equation 4.7 on page 90 where we have switched the dependent TobinQ variable to the log of TobinQ

A.10 ADIndex

	Mean	Std.	Min	Max	Obs.
AEGEAN AIRLINES	0.2590	0.2127	0.0000	0.4681	6
AER LINGUS GROUP PLC	0.2860	0.0446	0.2535	0.3368	3
AEROFLOT-RUSSIAN AIRLINES	0.7106	0.0476	0.6643	0.7853	6
AIR BERLIN PLC	0.6504	0.0279	0.5997	0.6740	6
AIR FRANCE - KLM	0.8745	0.0076	0.8649	0.8837	6
ALASKA AIR GROUP INC	0.4319	0.0302	0.4024	0.4740	6
ALLEGIANT TRAVEL CO	0.2385	0.2067	0.0000	0.4997	6
AMERICAN AIRLINES GROUP INC	0.8579	0.0094	0.8456	0.8716	6
AIR CANADA	0.7173	0.0127	0.6957	0.7273	6
CROATIA AIRLINES	0.4985	0.0016	0.4970	0.5000	6
DELTA AIR LINES INC	0.8697	0.0124	0.8507	0.8849	6
DEUTSCHE LUFTHANSA AG	0.7858	0.0372	0.7358	0.8336	6
EASYJET PLC	0.0140	0.0293	0.0000	0.0783	7
FEDEX CORP	0.8010	0.0095	0.7943	0.8186	7
FINNAIR OYJ	0.5623	0.1173	0.4444	0.7039	6
FLYBE GROUP PLC	0.5431	0.1357	0.3235	0.6853	6
HAWAIIAN HOLDINGS INC	0.6525	0.0516	0.5694	0.6953	6
ICELANDAIR GROUP HLDGS	0.5500	0.0230	0.5128	0.5773	6
INTL CONSOL AIRLINES GROUP	0.5964	0.0325	0.5734	0.6194	2
JETBLUE AIRWAYS CORP	0.4129	0.0091	0.4024	0.4273	6
NORWEGIAN AIR SHUTTLE ASA	0.0589	0.0701	0.0000	0.1486	6
RYANAIR HOLDINGS PLC	0.0000	0.0000	0.0000	0.0000	6
SAS AB	0.6900	0.0798	0.5802	0.7914	7
SOUTHWEST AIRLINES	0.1028	0.1139	0.0000	0.2214	6
SPIRIT AIRLINES INC	0.0000	0.0000	0.0000	0.0000	5
TURK HAVA YOLLARI AO	0.6782	0.0164	0.6658	0.7098	6
UNITED CONTINENTAL HLDGS INC	0.7598	0.0148	0.7360	0.7715	6
WESTJET AIRLINES LTD	0.1091	0.1318	0.0000	0.3073	6
Total	0.4940	0.2999	0.0000	0.8849	163

Aircraft dispersion index