Does Fuel Hedging Make Economic Sense? The Case of the US Airline Industry

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Abstract

Does hedging add value to the firm, and if so, is the source of the added value consistent with hedging theory? We investigate jet fuel hedging behavior of firms in the US airline industry during 1994-2000 to examine whether such hedging is a source of value for these companies. We illustrate that the investment climate in the airline industry conforms well to the theoretic framework of Froot, Scharfstein, and Stein (1993). In general, airline industry investment opportunities correlate positively with jet fuel costs, while higher fuel costs are consistent with lower cash flow. Given that jet fuel costs are hedgeable, airlines with a desire for expansion may find value in hedging future purchases of jet fuel. Our results show that jet fuel hedging is positively related to airline firm value. The coefficients on the hedging indicator variables in our regression analysis suggest that the "hedging premium" constitutes approximately a 12-16 percent increase in firm value. We find that the positive relation between hedging and value increases in capital investment. This result is consistent with the assertion that the principal benefit of jet fuel hedging by airlines comes from reduction of underinvestment costs.

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I. Introduction

Recent literature in corporate finance has fostered an improved understanding of why nonfinancial firms may hedge.[1] However, very little research has focused on whether hedging achieves reasonable economic objectives. In particular, many researchers are interested in whether hedging increases firm value. Allayannis and Weston (2001) examine the relation between foreign currency hedging and Tobin's Q. They conclude that hedging is associated with higher firm value.

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1 Allayannis and Ofek (2001), Berkman and Bradbury (1996), Dolde (1995), Gay and Nam (1998), Géczy, Minton, and Schrand (1997), Graham and Rogers (2002), Haushalter (2000), Mian (1996), Nance, Smith, and Smithson (1993), Rogers (2002), Schrand and Unal (1998), and Tufano (1996) are many of the published studies examining the determinants of corporate hedging behavior.

One obvious question resulting from the results of Allayannis and Weston (2001) pertains to the source of value from hedging. They speculate that the source of added value from hedging is likely attributable to its ability to reduce underinvestment as theorized by Bessembinder (1991) and Froot, Scharfstein, and Stein (1993). Unfortunately, their study is unable to draw this specific conclusion.

In this paper, we study the dual questions of "does hedging add value?" and "if so, what is the source of added value?" To do so, we identify a more targeted sample than used by Allayannis and Weston (2001). We analyze hedging of jet fuel price risk exposure by US airlines. Because average jet fuel costs constitute approximately 13 percent, on average, of airlines' operating costs, jet fuel price risk is economically meaningful to airlines.

In addressing the value question, we adopt a similar framework to Allayannis and Weston (2001). The results show that airlines increase value by hedging their jet fuel price exposures. Additionally, changes in hedging are positively associated with changes in firm value. As in Allayannis and Weston, we interpret certain results from our regressions as the "hedging premium" (i.e., the added firm value attributable to hedging). Our results suggest that the average hedging premium for airlines is in the range of 12-16 percent.

The airline sample allows us to also address the source of value question. We find that the airline industry exhibits two characteristics consistent with the general assumptions and framework developed in Froot et al. (1993). First, the airline industry's history of investment spending is not negatively correlated with jet fuel costs, as one might expect. In fact, the relation between these two variables is largely positive. Second, airlines face significant distress costs, as shown by Pulvino (1998, 1999), because distressed airlines are forced to sell aircraft at below-market prices. Froot et al. (1993) suggest that firms facing significant expected distress costs will choose to underinvest. In essence, the underinvestment cost is an indirect cost of financial

distress (e.g., Stulz (1996)). They show that hedging is a mechanism to alleviate this underinvestment incentive. In their model, hedging is more valuable when investment opportunities display lower correlations with cash flows from hedgeable risks. Thus, rather than assuming that underinvestment reduction is the reason that hedging adds value (as is done by Allayannis and Weston), our sample industry is chosen because it "fits" the theory. Given this, an additional contribution of our study is to illustrate the source of economic benefits of hedging in an industry environment where investment opportunities may be positively correlated with a hedgeable risk.

Given investment patterns in the airline industry, the value premium suggests that hedging allows airlines more ability to fund investment during periods of high jet fuel prices. The positive relation between hedging and value suggests that investors view such investment as positive net present value projects. We find that the interaction of hedging and capital expenditures captures at least 72 percent of the hedging premium. We also examine a two-stage system in which hedging impacts value through its effect on capital expenditures. While the system shows no statistically significant effect of hedging on capital expenditures, the economic impact of hedging on value suggests that, if a hedging premium exists, it results largely from the effect of hedging on capital investment.

An additional rationale for our choice of studying hedging in the airline industry is that the firms face substantial price risk associated with jet fuel price volatility. Guay and Kothari (2003) suggest that most sample firms used in many prior studies defining hedging using interest rate and/or currency derivatives may be unable to gain significant benefits from their derivative holdings. We note that jet fuel prices are more volatile than prices of other underlying assets typically studied, particularly currencies. Annualized jet fuel price volatility measured from monthly averages over 1994-2000 is approximately 26 percent. As a point of comparison, Guay

and Kothari (2003) find that the annualized volatility of major currencies is only 11 percent (measured over 1988-1997). Additionally, using the median percentage of fuel consumption hedged, we show that the cash flow sensitivity to extreme jet fuel price changes (defined similarly to the measure calculated by Guay and Kothari) of the median firm in our sample is 21.6 percent of capital expenditures. Overall, airline exposure to jet fuel price risk is economically significant, and considerable cash would be realized by hedging airlines in the event of an extreme price increase.

The paper proceeds as follows. Section II provides a brief review of relevant hedging literature. Section III investigates investment and financing patterns in the US airline industry. Section IV presents data on the magnitude of jet fuel costs and jet fuel hedging by the sample of airlines. Economic exposure to fuel price risk for US airline firms is also examined in Section IV. The value of hedging is analyzed in Section V, and we investigate whether the hedging premium is associated with the investment opportunities framework. Section VI concludes the paper.

II.   Literature Review

A.   *General Overview*

Much of the theoretical research in corporate risk management identifies value-maximizing rationales for hedging.[2] Empirical research in this area primarily focuses on identifying the rationales that are associated with corporate hedging behavior. For example, many published articles conclude that firms hedge to reduce expected costs of distress.[3] Other

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[2] These articles include Bessembinder (1991), Froot et al. (1993), Mello and Parsons (2000), and Smith and Stulz (1985).

[3] Berkman and Bradbury (1996), Dolde (1995), Gay and Nam (1998), Graham and Rogers (2002), Haushalter (2000), and Howton and Perfect (1998) are examples of papers reaching this conclusion.

papers deduce that firms hedge because of high investment opportunities.[4]

While empirical research in hedging has identified rationales that drive corporate derivatives usage, there is little evidence to date that these financial policies assist in value creation. Two recent studies make attempts to address this shortcoming. Allayannis and Weston (2001) examine the effect of currency derivatives usage on relative market value (as defined by Tobin's Q). They find a positive relation between currency hedging and Tobin's Q, and interpret this as evidence that hedging improves firm value. Graham and Rogers (2002) test the effect of derivatives hedging on debt in a capital structure model. They find that hedging has a positive effect on debt ratios. They measure the incremental tax benefits of the additional debt due to derivatives hedging, and show that the average hedging firm achieves gross tax benefits of approximately $30 million.

This paper seeks to provide additional evidence on the market value impact of hedging policy. Our aim is to identify the value effect of a single hedging policy in an investment and financing environment where hedging should be valued as in the theoretic framework discussed by Froot et al. (1993). We discuss their setting in more detail next.

B. Investment, Financing, Cash Flow, and Hedging

Froot et al. (1993) illustrate the value of hedging for firms facing financial constraints. Their basic framework shows that, when the costs of external capital include deadweight costs, firms requiring outside financing will underinvest when internal cash flow is sufficiently low.

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[4] Allayannis and Ofek (2001), Dolde (1995), Gay and Nam (1998), Géczy et al. (1997), and Nance et al. (1993) find that hedging increases with the level of R&D expenditures.

Hedging generates additional cash in these states, thus circumventing the underinvestment problem.[5]

An important feature of the Froot et al. (1993) model is that it allows for the firm's investment opportunity set to be correlated with cash flows from the hedgeable risk. If a positive correlation exists, less hedging is necessary because the firm enjoys a natural hedge (i.e., when cash flows are low, so are investment opportunities). Thus, hedging is more valuable to firms with investment opportunities that are uncorrelated or negatively correlated with the risk factor's cash flows. Additionally, the Froot et al. model shows that if outside financing costs increase as hedgeable cash flows decrease, then hedging becomes more valuable. In essence, hedging allows a firm to minimize its need to access outside capital when it is most expensive.

Tufano (1998) illustrates that, by adding manager-shareholder agency costs to the Froot et al. (1993) model, hedging may allow managers to destroy value. Tufano's framework assumes that managers are able to appropriate an amount in excess of the value created from an investment project. External capital providers know this agency problem exists, and therefore, refuse to provide capital for this project. Managers may hedge to avoid the inability to invest in the "pet" project after low cash flow realizations.

One of the testable implications of the Froot et al. model is that investment-cash flow sensitivity should be declining with hedging. Allayannis and Mozumdar (2000) show that investment-cash flow sensitivity is lower for firms that hedge with foreign currency derivatives. This result is consistent with Froot et al. (1993), suggesting that firms hedge to ensure sufficient amounts of cash to take advantage of valuable investment opportunities during periods of unfavorable cash flow shocks. Alternatively, their results may be consistent with Tufano (1998).

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[5] Bessembinder (1991) and Mello and Parsons (2000) make a similar argument as to the benefit of hedging.

Hedgers may be insulating investment from the scrutiny of outside investors so managers can obtain private benefits from "pet" projects.

Adam (2002) studies the implications of Froot et al. (1993) in a sample of North American gold mining firms. He provides evidence suggesting that firms with higher expected investment hedge a greater degree of expected investment. Furthermore, he documents that the positive relation between investment and external financing is smaller for hedging firms. He interprets the combination of results as indirect evidence consistent with Froot et al. (1993). Nevertheless, Adam does not examine the value implications of hedging, so his results may also be consistent with Tufano (1998).

We show in the next section that the US airline industry provides a natural industrial setting to examine hedging in the context of the Froot et al. (1993) framework. Ultimately, our goal is to address whether hedging allows airlines to increase value. We test this hypothesis in Section V.

C. What About Other Hedging Rationales?

We motivate this study by illustrating the applicability of the airline industry environment to the underinvestment rationale for hedging. However, several rationales exist for increased value from hedging beyond the Froot et al. (1993) study. We discuss the potential applicability of these rationales below, and argue that other value-increasing reasons for hedging do not fit the airline data particularly well.[6]

First, Smith and Stulz (1985) argue that reducing the volatility of taxable income generates greater firm value if the firm faces a convex tax function. Graham and Smith (1999)

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[6] Because we are interested in value effects, we do not consider managerial motives as a hedging motive (e.g., Tufano (1996)) because there is not a clear link that hedging for such reasons has a positive value effect.

illustrate the economic magnitude of the tax savings available from hedging as a result of estimated tax function convexity. However, Graham and Rogers (2002) find that such tax savings have no power to explain hedging behavior by a large cross-section of firms. We examine whether tax function convexity may explain hedging in the airline industry by constructing Graham and Smith's (1999, p. 2256) predicted convexity variable for each sample airline exhibiting a non-trivial jet fuel hedging policy. Of these 13 active jet fuel hedgers, the Graham and Smith regression predicts tax savings (as a percentage of taxable income) in excess of 2.5 percent for five firms (Airtran, America West, Amtran, Hawaiian, and Northwest) as of year-end 2000. However, the two largest hedgers in the sample (Delta and Southwest) display the lowest predicted convexities. In fact, Southwest is predicted to have an effectively concave tax function. We also multiply the predicted convexity values by taxable income to find the implied dollar amount of tax savings from reducing volatility. As a percentage of equity market value, the median firm's tax benefit as a percentage of equity market value is only 0.08 percent, and the maximum tax benefit is only 0.47 percent. Overall, the economic benefit of hedging to take advantage of tax function convexity appears limited.

Stulz (1996) provides discussion highlighting the fact that the underinvestment costs outlined in Froot et al. (1993) is an important indirect cost of financial distress. Alternatively, direct costs of financial distress may be an important element in the hedging decision. As an example of bankruptcy costs in the airline industry, Weiss and Wruck (1998) report that Eastern Airlines incurred $114 million in direct costs associated with its bankruptcy case. In Weiss and Wruck (1998), estimates of Eastern's value at the date of Chapter 11 filing ranged from $3.51 billion to $4.929 billion. Thus, even if hedging completely eliminates the possibility of bankruptcy (which is improbable), the increase in Eastern's value from reduced expected

bankruptcy costs is 2.3 – 3.2 percent. However, this estimate is only an upper bound because of declining equity values prior to the bankruptcy filing.

Another source of value from hedging is related to reduction of distress probability. Leland (1998) argues that firms capable of significantly reducing distress probability by hedging would increase financial leverage upon hedging to achieve additional tax benefits. Graham and Rogers (2002) find that this strategy yields significant economic benefits for a number of hedging firms. If airlines follow such a strategy, we should observe increases in leverage by hedging firms in recent years as jet fuel hedging has become more pervasive. However, hedging airlines have typically decreased debt levels during the study's time frame.

The discussion above suggests that the benefits of hedging from tax convexity, expected direct bankruptcy costs, and increases in debt tax shields would be small for airlines over the time frame studied. Given that we find a hedging premium of 12-16 percent in our analysis, it seems the hedging rationales discussed above are relatively unimportant for airlines. Thus, we focus our attention on explaining why the airline industry fits the framework of the underinvestment rationale for hedging as presented by Froot et al. (1993).

III.   Investment, Jet Fuel Costs, Cash Flow and Financing in the Airline Industry

A.   Relation of Investment, Jet Fuel Costs and Cash Flow

There are two major ways in which hedging can assist in an airline's ability to invest. First, new aircraft purchases must be planned years in advance, and purchase orders submitted to the aircraft manufacturer. Purchase orders are disclosed as firm commitments in the financial statement footnotes; however, the orders appear to include deferral/cancellation options as most carriers recently exercised such options following the World Trade Center attacks. Hedging preserves internal cash flow to meet future commitments to purchase aircraft.

Second, periods of economic downturn often result in failure and/or asset sales by financially weak airlines. Financially stronger airlines may be in a position to buy these assets at prices below fair value (e.g., Pulvino, 1998, 1999). Investment may also take the form of acquisition of a financially weak carrier. Kim and Singal (1993) show that such acquisitions typically yield higher fare environments upon completion of the acquisition. If hedging improves its cash position during economic downturns, the hedged airline may rely less (or not at all) on external sources of funds to make such capital expenditures (e.g., Froot et al., 1993). For example, AMR discloses that its purchase of TWA during 2001 was funded with existing cash and assumption of TWA debt.

Froot et al. (1993) show that firms find hedging more valuable the lower the correlation between investment opportunities and cash flows resulting from hedgeable risks. For airlines, this framework implies that hedging makes sense if airlines possess valuable investment opportunities when jet fuel prices are high (and internal cash flow is low as a result).

To analyze whether the airline industry is characterized by the investment and financing environment discussed in Froot et al. (1993), we examine aggregate airline industry data on jet fuel costs, investment expenditures, and cash flow from 1979-2000. All airlines with at least $100 million in assets in the Compustat active and research databases are included in the aggregate statistics for investment expenditures and cash flows. The Froot et al. (1993) framework implies the higher the correlation between jet fuel costs and investment, combined with a negative relation between jet fuel costs and cash flow, the greater the benefit to hedging.

Table 1 illustrates the annual patterns of jet fuel costs, cash flow, and investment spending for US airlines during 1979-2000.[7] The first column shows the level of industry jet fuel

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[7] Per gallon jet fuel costs are not adjusted for inflation in the analysis presented in this section. As a robustness check, the analysis is repeated with inflation-adjusted jet fuel costs, but not reported in the text. Adjusting jet fuel costs for inflation does not affect the general conclusions reached in this section. As a side note, inflation in per

costs per gallon, as reported by the Air Transport Association. The cost of jet fuel has varied significantly over time. The average cost of jet fuel during 1979-2000 is about 69 cents per gallon. However, jet fuel prices were at their highest levels during the early 1980's, so the average over this time frame likely does not reflect current expectations.

Figure 1 illustrates the airlines' more recent jet fuel costs. Panel A of Figure 2 shows the monthly industry jet fuel costs from January 1988 through November 2001, as reported by the Air Transport Association. Domestic jet fuel costs principally range between 50 and 70 cents per gallon. The chart shows the spike occurring before and during the Persian Gulf War, and the more recent increases occurring during 2000.

Panel B of Figure 1 shows spot jet fuel prices at various locations around the US, as reported daily by the Oil Price Information Service (OPIS), beginning in January 1994 through June 2001. These prices more accurately reflect the base purchase price of jet fuel (depending on the region). Jet fuel supply contracts are typically based on reported regional jet fuel prices (plus or minus a differential for different airports). During 1994-2000, average daily jet fuel prices fall in the range of 55.8 cents per gallon (on the Gulf Coast) to approximately 62.5 cents per gallon (in Los Angeles and San Francisco). The volatility of jet fuel price ranges from about 15.2 cents per gallon (Gulf Coast) to almost 17 cents per gallon (San Francisco). The standard deviations are virtually identical if computed using monthly average jet fuel prices, as opposed to daily prices.

The second column of Table 1 shows net income plus depreciation (scaled by book value of assets). Industry cash flow was relatively low during the first half of the 1990's, and has since recovered to above average levels. The third column shows industry capital expenditures as a

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gallon jet fuel costs may be offset by fuel-saving measures used by airlines, such as using more fuel-efficient

percentage of book value of assets. Capital expenditures range from 6.6 percent in 1995 to 18.4 percent in 1979. The final set of columns in Table 1 presents summary statistics of investment percentages computed across firms for each year. These data suggest that there is significant variation in the investment spending of airlines during any given year. The average data exhibit similar patterns as observed in the aggregate industry investment data. Specifically, investment spending was relatively high during the 1980's, followed by a decline through 1996. The most recent years have been characterized by investment spending percentages last observed in the late 1980's.

Figure 2, Panel A shows annual jet fuel costs for the period 1979-2000 on the x-axis and industry capital expenditures (scaled by the end-of-year book value of industry assets) on the y-axis.[8] The figure presents the regression line estimated by OLS, and suggests that aggregate airline investment is high during periods of high fuel prices. While statistical significance is only marginal in this regression, the important point is that, in aggregate, airlines do not offset higher fuel costs by lowering capital expenditures. This is one of the key aspects of the Froot et al. (1993) framework. Nevertheless, this presents only one necessary condition for hedging to be useful. Jet fuel costs must be negatively associated with cash flow.

Figure 2, Panel B, shows the regression line through the historical data on airline cash flow and jet fuel costs. Higher jet fuel costs are typically associated with lower industry cash flow (as defined by net income plus depreciation scaled by total assets).[9] Although statistical

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airplanes, etc.

[8] All results discussed are similar if flow variables (such as capital expenditures) are scaled by assets as of the prior year-end.

[9] Given that airlines must commit to aircraft orders in advance, we examine the relation between investment and cash flow lagged two years. We find that the relation between investment and cash flow lagged two years is positively related (with weak statistical significance over 1979-2000). So, high levels of investment may be indicative of high cash flows at the time when the investment decision is binding. However, this finding does not eliminate the positive relation between investment and jet fuel costs. The level of jet fuel costs remains positively related to investment even when controlling for lagged cash flow (although statistical significance declines slightly).

significance is not strong, the overall basic pattern that emerges is one that is consistent with the Froot et al. (1993) theoretical framework.

The relations above incorporate data from the early 1980's (i.e., as the industry was being deregulated). To address concerns that the results discussed above may be driven by conditions more reminiscent of the early 1980's, we examine the data using only observations from 1987 – 2000. The implications of the results using more recent data remain: airline capital expenditures are high during periods of higher fuel costs, even while cash flow is typically lower.

One additional concern is that the relation between jet fuel costs and cash flow may drive the relation between jet fuel costs and investment. To examine this, we perform multivariate regressions of the investment measures on both jet fuel costs and cash flow measures. The positive relation between jet fuel costs and investment, while statistically weakened by the inclusion of cash flow measures in some cases, remains similar to the relations reported earlier. In fact, the positive coefficient on jet fuel costs is of considerably greater significance than the negative coefficient on cash flow.

B.   *Costs of Financial Distress and the Airline Financing Environment*

An additional extension of the Froot et al. (1993) argument is that external finance is increasingly expensive when the hedgeable risk factor negatively affects cash flows (i.e., when jet fuel costs are high). The source of the additional deadweight cost may be the result of distress costs, information asymmetry, as well as other possible sources. Pulvino (1998) presents evidence that airlines face significant distress costs. He shows that aircraft are often sold in "fire sales" by financially troubled airlines. In this context, Froot et al. (1993) implies that airlines would want to hedge against rising fuel prices if this strategy makes it possible to invest in aircraft (and other assets) of financially distressed airlines at discount prices. Alternatively,

airlines may wish to hedge to avoid the possibility of selling assets at below-market values, thus reducing expected financial distress costs (e.g., Smith and Stulz, 1985). However, as will be seen in the next section, smaller airlines (which face higher proportional costs of distress) hedge much less than the largest firms in the industry. Thus, the Froot et al. (1993) arguments seem more compelling in explaining airline hedging behavior.

To examine the relative cost of airline debt financing, we gather the S&P ratings for senior debt of the 15 sample airlines with ratings reported in the Compustat database. Table 2 shows the level of credit ratings as of January 1988 (or date of first rating thereafter), the median rating during 1/1988 – 12/2000, the highest and lowest ratings experienced and the rating as of the end of 2000. As of the end of 2000, only 3 airlines (AMR, Delta, and Southwest) have investment grade credit ratings. At the beginning of 1988, six airlines possessed investment grade ratings. Over the time frame examined, six airlines experience a decline in credit rating, one filed bankruptcy, and one was purchased after filing bankruptcy. Four airlines had no net change in credit rating over the period studied, and three airlines experienced increases in their credit ratings. The lower portion of the table shows the years of rating changes. The 1990-1994 period was characterized by relatively high jet fuel prices, recession, and subsequently low cash flows. During this time frame, credit ratings typically declined. Twenty-two credit downgrades occurred for seven airlines (versus only one upgrade). Continental, Trans World Airlines, and America West all filed Chapter 11 bankruptcy during this period as well (as well as other notable cases, such as Pan Am).

While jet fuel prices are not the sole source of the cash flow declines mentioned above, it is worth noting that they were relatively high during 1990 as the industry slump began. Alternatively, as jet fuel prices fell significantly during 1997-1999, airline debt was often upgraded. Eight credit upgrades (over seven airlines) occurred during 1997 and 1998. However,

this upgrade activity did not offset much of the downgrades occurring in the early 1990's. These observations imply that airlines face lackluster credit markets. As we have recently seen in the wake of the World Trade Center attacks, external shocks can have devastating impact on the industry's cash flows. Interestingly, the last major cash flow shock of the 1990's occurred during a period when major airlines had better credit ratings. In the current environment, hedging may be much more important to airlines wishing to take advantage of future periods of industry consolidation.

The data presented thus far suggests that firms in the airline industry may have significant investment opportunities when cash flows are low. Furthermore, industry investment has been positively related to the level of jet fuel costs, suggesting that airlines could hedge to preserve cash flow to use for such investment. Hedging may be important in this respect because airlines face significant distress costs, and typically face low credit ratings. In the next section, we present summary data regarding airline cost structures and jet fuel hedging practices over 1994-2000.

IV.   Airline Fuel Cost Structures, Hedging, and Exposure to Volatile Fuel Prices

A.   Airline Fuel Costs and Hedging

Table 3 lists the 27 US airlines (defined as firms with SIC codes 4512 or 4513) with available data on the Compustat database as of 2000. Our analysis includes only airline companies.[10]

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[10] We do not include other types of transportation firms (such as railroads and trucking companies) because they typically face very different fuel price risk exposures. For example, Banham (2000) notes that railroads are less affected by fuel price increases because diesel cost increases are partially offset by increased revenues from delivering coal (i.e., an alternative fuel source). Airlines typically lack these types of natural hedges.

Table 3, Panel A, shows average revenues, available seat mile (ASM) and market share data for each airline. Airlines are classified as major carrier (10 airlines), national carrier (15 airlines), or regional/commuter carrier (2 airlines) using the following Air Transport Association of America classifications: major carriers have annual revenue of more than $1 billion, national carriers have annual revenues between $100 million and $1 billion, and regional carriers have annual revenues of less than $100 million and their services are limited to a particular geographic region. Average revenues for each firm are calculated as the average over 1994-2000. ASM represents one seat flown one mile.[11] Market share is calculated as the percentage of total ASM for the period 1994-2000 that the airline flew. The top seven airlines, ranked by ASM, account for 86.4 percent of seat-miles flown by the sample firms.

Table 3, Panel B summarizes fuel usage and costs, jet fuel hedging policy and other institutional arrangements affecting fuel costs. For the full sample of airlines, fuel costs average just over 13 percent of operating costs during the 7-year period. The percentages ranged from 7.9 percent (World Airways) to 18.8 percent (Amtran). Jet fuel expenses are slightly lower, on average, for the major airlines. Their costs range from about 10 – 15 percent. Average fuel cost per available seat mile during the period was $0.0153 with a range of over 2 cents between the high of $0.03 (Great Lakes Aviation) and low of $0.0098 (Southwest Airlines). The average amount of jet fuel consumed annually during 1994-2000 is 662 million gallons per airline.

The next set of three columns in Table 3, Panel B, reports information (from 10-K filings) on jet fuel hedging by the sample airlines. We show the calendar years in which fuel

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[11] For example, an airline with 100 passenger seats, flown a distance of 100 miles, represents 10,000 available seat miles (ASM).

hedges are in place as of fiscal year-end, maximum maturity of the hedge in years, and percentage of next year's fuel requirements hedged, respectively.[12]

Major airlines are more commonly hedgers of jet fuel purchases than are smaller firms. Appendix A, Panels A and B, illustrates sample disclosures of jet fuel hedging. While all major airlines hedged during part of the period 1994-2000, only AMR and Southwest Airlines hedged over the entire period. Sixteen of the 27 firms reported hedging jet fuel in at least one year during 1994-2000. Of hedging firms, the average hedged percentage of next year's fuel consumption is approximately 19 percent. We observe wide variation in the amount of fuel hedged, even among hedgers. Delta Air Lines hedged an average of 68 percent of next year's fuel consumption, while US Airways hedged only about 6 percent. Recently, Southwest Airlines had 80 percent of its 2001 fuel consumption hedged as of the end of 2000. Most hedging airlines also report the maximum maturity of jet fuel hedges. Southwest, AMR, and Delta recently increased their maximum hedge maturities to 3 years. All other airlines limit their derivative maturities to 1 year or less.

Within the industry, some airlines use additional avenues to protect cash flows from rising fuel prices. For example, some smaller carriers contract with major airlines to provide service to smaller communities near the major airline's hub. These carriers may have a fuel pass-through agreement where the major carrier absorbs the risk of fluctuating fuel prices. Panel B of Table 3 indicates if carriers disclose such fuel pass-through agreements. Similar to fuel pass-through agreements, charter airlines typically do not bear the risk of fluctuating fuel prices. The charter's customer reimburses fuel costs. The final column of Table 3, Panel B indicates airlines

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[12] Disclosure of commodity derivatives is not required under SFAS 119 (the FASB standard for derivative disclosure starting in 1995). However, we are able to generally ascertain firm-years in which airlines use derivatives to hedge fuel purchases. Beginning in 1997, disclosures regarding significant market risks became required under SEC guidelines. Airlines often discuss their market risks with respect to jet fuel under this requirement.

classified as having charter operations.[13] Appendix A, Panel C, shows samples of disclosures regarding fuel pass-through agreements and fuel arrangements associated with charter operations.

B.   *Exposure to Fuel Price Volatility*

An obvious issue regarding fuel price risk that we have not addressed thus far is "how much economic exposure to volatile fuel prices do airlines face?" We address this issue briefly by illustrating that, on average, airlines face negative cash flow and stock price consequences from increases in the price of jet fuel.

Guay and Kothari (2003) suggest a measure of cash flow sensitivity to price risk in which a three standard deviation price change is used to illustrate the effects of an extreme move in underlying asset prices. In the case of jet fuel, a 45-cent (per gallon) change represents approximately three standard deviations (as discussed in Section III.A.). Thus, for each firm-year observation, we multiply gallons consumed by 45 cents to estimate the cash flow impact of an extreme jet fuel price change. Scaling this amount by firm-year capital expenditures provides an estimate of the decline in investment possible if jet fuel prices increase dramatically from one year to the next. Across 144 firm-years, the median of this value is 94 percent. Alternatively, this measure may be interpreted as the relative cash flow resulting if the firm has hedged 100 percent of its fuel consumption. The median percentage of next year's fuel consumption hedged is 23 percent (for firms that hedge). Multiplying the prior amounts by 23 percent suggests that "normal" amounts of hedging would generate cash flow equal to 21.62 percent of capital expenditures in the event of an extreme price move. By contrast, Guay and Kothari (2003) find

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[13] Charter carriers are defined as airlines that disclose that a significant part of their business is due to charter operations.

that the median firm in its sample would generate cash flow amounting to only 9 percent of investing cash flow (capital expenditures are greater than or equal to investing net cash flow for over half of our sample). Clearly, jet fuel hedging by airlines is economically meaningful in terms of Guay and Kothari's measure.

An alternative approach to measuring exposure is to estimate the effect of actual changes in jet fuel prices on operating cash flow. To examine this effect for each firm in our sample, we regress the year-over-year changes in quarterly operating income before depreciation (as a percentage of sales) on the changes in quarterly average jet fuel price (in cents per gallon).[14,15]

In untabulated results, we find that the median coefficient from the regression above is -0.0013, suggesting that airlines face significant cash flow risk from rising jet fuel prices. A 15-cent increase in jet fuel price (recall the standard deviation of Gulf Coast jet fuel prices was just over 15 cents) implies a decrease of 1.95 percent in cash flow as a percentage of sales. To put this in context, the median airline quarterly cash flow as a percentage of sales is 10.4 percent. Thus, a roughly one standard deviation increase in jet fuel price corresponds to approximately a 18.75 percent decrease in cash flow margin, on average (i.e., 1.95 ÷ 10.4).

As a final measure of exposure, we estimate a market model that includes a weekly jet fuel return factor. This type of methodology is standard in other research examining risk exposures.[16] For each firm-year in our sample, we conduct the following weekly time-series regression:

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[14] Year-over-year changes in quarterly data are used because of seasonality in airline operating income. The jet fuel prices used are simple averages of the five regional prices presented earlier averaged over the 3 months in each quarter. The data observations are from first quarter of calendar 1995 through the fourth quarter of calendar 2000.

[15] Common practice in exposure research (such as measuring currency exposure) is to use percentage change in the independent variable. This approach is appropriate when measuring stock return exposure. However, in this regression, we measure cash flow exposures to jet fuel price changes. A 15-cent price change should have similar cash flow effects on airlines whether jet fuel price is at 40 cents per gallon or 80 cents per gallon.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \gamma_i R_{Jt} + \varepsilon_{it}, \tag{1}$$

where R_{it} is the rate of return on the ith company's common stock in week t (as gathered from CRSP), R_{mt} is the return on the CRSP value-weighted market portfolio, R_{Jt} is the percentage change in OPIS jet fuel prices, and ε_{it} is the idiosyncratic error term.[17] For each firm, the estimated coefficient, γ_i, is a measure of the sensitivity of a firm's stock price to changes in jet fuel prices. We expect airlines to be negatively exposed to the price of jet fuel.

In untabulated results, we find that, on average, airlines' stock prices are negatively related to jet fuel prices, but the effect of short-term fluctuations in fuel prices is economically small (and coefficients are rarely statistically significant). The average jet fuel exposures range from –0.061 using the Gulf Coast jet fuel prices to –0.079 using New York prices.

V.   Do Investors Value Jet Fuel Hedging?

A.   Measurement of Firm Value

Thus far, we have shown that airlines have incentives to hedge jet fuel exposures to protect internal cash flow, and that jet fuel cost levels tend to be negatively correlated with industry investment. These conditions suggest that, if the market expects airlines to invest marginal cash flow in positive net present value projects, then investors should place positive value on jet fuel hedging. On the other hand, if investors view such investment unfavorably, hedging would have negative value consequences. The purpose of this section is to examine the relation between airline firm value and jet fuel hedging practices.

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[16] Currency exposures are studied by Bartov and Bodnar (1994), Bodnar and Wong (2000), Jorion (1990), and Pantzalis, Simkins, and Laux (2001). Petersen and Thiagarajan (2000) estimate gold price exposures for gold mining firms.

[17] When examining currency exposures, Bodnar and Wong (2000) point out that using the value-weighted index can distort the sign and size of the resulting exposures because of an inherent relation between market capitalization and exposure. They recommend using the equal-weighted index to prevent this distribution shift. We derive similar results if we use the equal-weighted market index.

We investigate whether airlines' jet fuel hedging activities positively affect value by estimating the empirical relationships between Tobin's Q (our proxy for firm value) and jet fuel hedging. Our approach is similar to the procedure used by Allayannis and Weston (2001) to investigate the relation between firm value and the use of foreign currency derivatives.

We measure firm value using the simple approximation of Tobin's Q, developed by Chung and Pruitt (1994).[18] This method offers several advantages: first, the computational cost is low relative to other more complex methods of calculating Tobin's Q. Second, the data are readily available using COMPUSTAT for small, as well as large, firms. Finally, Chung and Pruitt (1994) and Perfect and Wiles (1994) find a high degree of correlation between the simple approximation and more rigorous constructions of Q.[19] DaDalt, Donaldson, and Garner (2003) note these three advantages of utilizing a simple construction of Q, and conclude that the simple Q calculation is preferable in most empirical applications. Given the proportion of smaller firms in our sample, the availability of data is an especially important issue.

Because our purpose is to investigate the link between jet fuel hedging and value, we require variables to measure such hedging by airlines. In Section 4, we discuss ways by which airlines manage fuel price risk: hedging with derivatives, entering into fuel pass-through agreements, and passing fuel cost changes along to charter customers. We form dummy variables indicating each type of fuel price risk management and a dummy indicating usage of any of the

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[18] The Q ratio is calculated as the following sum divided by book value of total assets: (market value of equity + liquidation value of preferred stock + the book values of long-term debt and current liabilities − current assets + book value of inventory). We use Compustat to obtain the accounting data for our control variables, as well as to calculate Tobin's Q. We use *Moody's Industrial Manual* to obtain the yields on preferred stock for medium-grade industrials.

[19] Perfect and Wiles (1994) find that regression results using the simple approximation may differ from more complex estimations of Tobin's Q. However, when estimating relationships using changes in values, the simple approximation produces similar results to the other calculations of Q. We conduct tests using both value levels and changes.

three types. However, in subsequent regression analysis, only hedging with derivatives shows any explanatory power, so we limit our analysis to this type of variable.

We measure jet fuel hedging with derivatives in three ways. First, we define a hedging dummy if the airline discloses any use of derivatives to hedge jet fuel exposure, even if no other information is given. Second, for most of our data, firms disclose the percentage of its coming year's jet fuel requirements that it has hedged as of year-end. Finally, we define a dummy variable that is equal to one if the percentage hedged is greater than zero.

Our sample consists of 26 airlines over a maximum period of 1994 – 2000 with a total of 164 firm-year observations of Tobin's Q. Table 4 shows summary values of Q for each firm in the sample. The data are separated into major versus smaller carriers. The first two columns show Q-ratios calculated using the Chung and Pruitt (1994) approach. The second set of Q-ratios is adjusted to reflect the amount of obligations existing under operating leases. Because airlines often lease a significant portion of their aircraft, reported assets may be well below assets actually controlled by the airlines. The adjustment process used is explained in Damodaran (2002), and is used to find the present value of future operating lease obligations. This present value is then added to assets and debt, thus adjusting the value of Q.

Table 4, Panel A, shows that most airline Q-ratios are well below 1.0. This is true for both major airlines, as well as other carriers. However, Q does display significant variation across airlines and time. Eleven of the 26 airlines have average Q-ratios greater than 1.0 over 1994-2000. However, only two of these observations are from major airlines.

Panel B of Table 4 shows that average Q-ratios vary considerably over the sample period, especially for non-major airlines. In general, the data show no clear time trend, however, the Q-ratios of major airlines are more skewed in the last three years of the sample. The adjusted Q-ratios exhibit less skewness because the adjustment process tends to push the values toward one.

B.   *Control Variables*

Other factors, in addition to hedging, affect firm value. To control for these other effects, we include proxy variables to account for the following factors. In general, we structure the control variables to be consistent with those in the regression analysis of Allayannis and Weston (2001).

Size: Several prior studies find that large firms are more likely to use derivatives due to the high start-up costs necessary to develop a hedging program (see Nance et al., 1993; Mian, 1996; and Géczy et al., 1997). This effect is apparent in our sample as well (see Table 3). Thus, a positive effect between hedging and value may be due to a positive relation between size and value. For this reason, we include the natural logarithm of total assets to control for the effect of size. Allayannis and Weston (2001) find a negative relation between size and value in their sample.

Dividends: Following Allayannis and Weston (2001), we include a dummy variable if the firm paid a common dividend during the current year. Firms paying dividends are less likely to be capital constrained (e.g., see Fazzari, Hubbard, and Petersen, 1988) and thus may overinvest by accepting negative net present value projects. On the other hand, dividends may be seen as a positive signal from management (especially in an industry that has experienced a significant number of bankruptcy filings). Additionally, the initiation or increase (elimination/reduction) of a dividend is likely to be seen as positive (negative) by the market. Allayannis and Weston (2001) show contrasting evidence on the relation between dividend payment and firm value.

Leverage: Capital structure may affect firm value as well as the firm's decision to hedge if a higher level of debt, and hence, a higher probability of financial distress, induces the firm to hedge (e.g., Haushalter, 2000; and Graham and Rogers, 2002). We use the ratio of long-term

debt to total assets as a control for leverage. Leverage has an ambiguous effect on firm value in Allayannis and Weston (2001).

Profitability: Because the marketplace is likely to reward more profitable firms, highly profitable firms are expected to have higher values of Tobin's Q. We include return on assets (ROA) to control for profitability. Allayannis and Weston (2001) find a positive relation between ROA and firm value.

Investment opportunities: Firms with greater investment opportunities are likely to be valued higher by the market. Froot et al. (1993) and Géczy et al. (1997) argue that firms that hedge are more likely to have greater investment opportunities. We use the ratio of capital expenditures to sales as a proxy for investment opportunities. Allayannis and Weston (2001) find weak evidence of a positive relation between this variable and firm value.

Time effects: To control for the possibility of systematic time effects on airline firm value, we include dummy variables to indicate each year from 1996 through 2000 in all regressions on the levels of Q and indicator variables for 1997 through 2000 in the regressions on changes in Q. We do not report the results for these dummy variables in the tables presented.

C.   *Results – Firm Value and Hedging*

Table 5 presents the results for the estimation of the effect of jet fuel hedging on airline firm value. As in Allayannis and Weston (2001), the natural logarithm of Q is the dependent variable. By using the natural logarithm of Q, we can interpret coefficients on hedging dummy variables as the hedging premium. Models 1 through 3 are estimated using pooled OLS with robust standard errors, while Models 4 through 6 are estimated using a time-series cross-sectional GLS procedure with a heteroskedastically consistent covariance matrix.

The results for the regressions yield several interesting results. First, the estimates for size are always negative and highly significant, indicating that larger size in the airline industry does not convey an advantage, with respect to firm value. This result is consistent with those in Allayannis and Weston (2001). Second, the parameter estimates for the dividend dummy variable are positive and significant in all models. In contrast, Allayannis and Weston (2001) find that firms with foreign sales show a negative relation between the dividend dummy and firm value, while firms with zero foreign sales show a positive relation between the two. Our results suggest that airlines use dividends to signal their financial success.

We find relatively strong support for the role of hedging as a factor in firm value. Hedging jet fuel exposure with derivatives shows positive and statistically significant relations with airline firm value using all three measures of jet fuel hedging. The results are similar if we use the adjusted Q-ratios discussed earlier, but we do not report these for the sake of brevity.[20]

While statistical significance provides confidence that a value premium exists, we are equally (if not more) interested in the economic significance of the relation between hedging and value. Allayannis and Weston (2001) suggest that firms with positive foreign sales command close to a 5 percent premium for hedging currency risk. Our parameter estimates on the hedging dummy variables suggest that airlines hedging jet fuel demand a value premium in the range of 14.94 - 16.08 percent. When using the percentage hedged, the coefficient represents the average premium implied if an airline were to hedge 100 percent of its following year fuel requirements. Given an average hedging percentage of 19 percent, the corresponding premium is approximately 9 percent (0.4745 x 0.19). The magnitude of the jet fuel hedging premium relative

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[20] The regressions shown in Tables 5 and 6 are also conducted using fixed effects. The Table 5 (level of Q) models show evidence that the firm-specific effects are significant. However, firm-specific effects are not found in the change in Q (Table 6) models. Performing fixed effects detracts considerably from the statistical significance of all variables except ROA and percent hedged. Specifically, the percent hedged variable shows significance at the 10% level in the fixed effects models.

to the 5 percent currency hedging premium found by Allayannis and Weston may be due to their inclusion of many firms with relatively small foreign exchange exposures. Our study focuses solely on companies that spend a significant amount of money on jet fuel, thus are more likely to face larger value consequences when choosing whether or not to manage this risk.

An alternative means to measure the value consequences of hedging is to measure the change in value when firms change hedging policy. In fact, this type of regression is less likely to suffer from endogeneity that may call the Table 5 results into question. Table 6 shows the results of regressions examining the changes in firm value (i.e., changes in the natural logarithm of Q) versus the changes in the independent variables.

The addition of a hedging program using derivatives is positively related to firm value. Specifically, the dummy variable indicating a change from no hedging to a material amount of hedging shows a positively and statistically significant association with change in firm value. The coefficient on this variable may also be viewed as a hedging premium and the size of these coefficients, while slightly smaller than those shown in Table 5, are of similar magnitude. The evidence here suggests hedgers are 12.33 - 13.68 percent more valuable as a result of initiation of measurable jet fuel hedging. On the other hand, the market appears to place less value on changes in the extent of hedging. The coefficients on the changes in percentage hedged are positive but not statistically significant.

D.   Is the Hedging Premium Related to Investment Opportunities?

Earlier in the paper, we postulate that the benefit from jet fuel hedging is primarily related to the reduction of underinvestment as theorized by Froot et al. (1993). The analysis presented in the prior section establishes a positive relation between hedging and firm value. However, the prior analyses do not show a link between fuel hedging by airlines and their

investment opportunities. In this section, we discuss results of analyses designed to ascertain whether such a rationale explains the hedging premium.

As an initial test, Table 7 shows the results of two regression models that are comparable to Models 3 and 6 from Table 5. The only difference is the inclusion of an additional independent variable measuring the interaction of hedging with capital expenditures. The variable is computed as the product of the hedging indicator and the capital expenditures-to-sales ratio. In these specifications, the hedging dummy variable shows no significant relation with firm value, while a positive relation is evident on the interaction of capital expenditures and hedging. Given the binary specification of hedging, the positive relation may be interpreted as follows: for hedgers, an increase in capital spending creates more value, all else equal. Using the coefficients from Model 1 of Table 7, at the average level of capital expenditures-to-sales of 11 percent, a hedging firm is expected to be valued 12.8 percent higher than a non-hedging firm ((1.33 x 0.11) + -0.018). In fact, over 100 percent of the hedging premium is attributable to the interaction of capital expenditures and hedging in Model 1. The analysis presented in Model 2 using GLS implies that the hedging premium is approximately 15 percent ((0.98 x 0.11) + 0.042), while the interaction of investment and hedging constitutes approximately 72 percent of this premium ((0.98 x 0.11) ÷ 0.15).

While the analysis above is not a direct test that jet fuel hedging reduces the underinvestment problem for airlines, it does establish that capital spending is more valued for hedgers than for non-hedgers. Why might this be? A reasonable argument would be that jet fuel hedging makes future capital spending less susceptible to future increases in jet fuel prices. Thus, current capital expenditures may be more reflective of future capital expenditures. As a result, investors may place additional value on capital expenditures made today by hedgers because of greater confidence that these are a better proxy for future investment opportunities.

Thus far, we have limited the analysis to one-stage regression specifications. Much prior research in hedging has noted that a firm's hedging decision may be part of a simultaneous system.[21] The theoretic framework for our empirical study suggests the following link (e.g., Bessembinder (1991) and Froot et al. (1993)): 1) the hedging decision is made at time 0, 2) the outcome of investment decisions (i.e., capital expenditures) are observed between time 0 and time 1, and 3) firm value and the firm's next hedging decision are observed at time 1. This sequence of events implies the following two-stage empirical framework:

Capital expenditures$_t$ = f(hedging$_{t-1}$, other controls)

Firm value$_t$ = f(capital expenditures$_t$, hedging$_t$, other controls)

To model this framework, we estimate capital expenditures as an instrumental variable from the other independent variables shown in the analysis presented in Table 5. We also add cash flow-to-sales, lagged Q, and lagged hedging variables to the capital expenditures specification.[22] The fitted values from the first-stage capital expenditures estimation are then utilized in the second-stage estimation of Q.

Table 8 presents results of the first-stage estimation of capital expenditures-to-sales, and the second-stage estimation of Q. To obtain the estimated hedging premium from this system, we first add the two hedging coefficients in the first-stage estimation then multiply this sum by the coefficient on the capital expenditures variable in the second-stage estimation. This portion represents the hedging premium associated with its effect on the firm's capital spending. To

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[21] Géczy et al. (1997) and Graham and Rogers (2002) model hedging and leverage as simultaneous decisions. Tufano (1996) notes that executive compensation and hedging decisions are made simultaneously. Rogers (2002) models the simultaneity of executive portfolio structure and hedging. Conducting tests for endogeneity (e.g., Kennedy (1992)) of hedging in the value regression (and vice versa), we find no support for a simultaneous system of equations involving value and hedging.

[22] Fazzari et al. (1988) model investment as a function of cash flow and Q to estimate investment-cash flow sensitivity.

obtain the total hedging premium, we then add the coefficient on the hedging variable in the second-stage Q estimation.

As may be seen in Models 1 through 3, the effect of hedging on value through both its direct effect and its effect on capital expenditures is ambiguous. One point worth noting is that statistical significance of the coefficients on the hedging variables is non-existent. We do not debate this point; rather we focus on the economic significance of the coefficients in comparing those to results from the one-stage estimations discussed earlier. On one hand, the total hedging premiums estimated by Models 1 and 2 are similar to those shown in Table 5. In fact, the economic magnitude of the premium appears larger in the two-stage systems relative to the one-stage systems modeled in Table 5 (18 vs. 16 percent in Model 1 and 55 vs. 47 percent in Model 2). Meanwhile, Model 3 uses a dummy variable indicating that the percentage hedged is specifically stated as greater than zero, and this variable shows a small negative effect on value in the two-stage system.

Assuming the hedging premiums illustrated in Models 1 and 2 of Table 8 are valid, the portion of the hedging premium attributable to the effect of hedging on capital investment is debatable. Results of Model 1 suggest that approximately 52 percent of the hedging premium comes from the effect of hedging on capital expenditures. On the other hand, Model 2 results imply that more than 100 percent of the hedging premium comes from its effect on capital expenditures.

VI.   Conclusion

The US airline industry offers a unique sample allowing for a more direct test of the value implications of hedging predicted by Froot et al. (1993). High jet fuel prices coincide with low industry cash flows, and industry investment is positively related to the level of jet fuel

costs. Because jet fuel constitutes a large percentage of airline operating costs and jet fuel prices are highly volatile, airlines face an incentive to hedge fuel price risk. Such hedging provides firms with the opportunity to buy underpriced assets from distressed airlines during periods of high jet fuel prices and/or protects the ability to meet previously contracted purchase commitments.

We find that airlines employing jet fuel hedging trade at a premium, after controlling for other factors impacting value. This result provides evidence in support of Allayannis and Weston's (2001) findings that hedging adds value. While Guay and Kothari (2003) question the validity of the Allayannis and Weston results, we argue that our results offer clearer evidence that hedging adds value because reduction of jet fuel price risk exposure is clearly economically significant.

Furthermore, our sample choice allows us to form a more educated opinion as to the source of value gain from hedging. Large airlines are typically in the best position to buy distressed airlines or desired assets. Hedging future jet fuel purchases allows these firms a means to manage a significant source of variation in cash flows. Given that jet fuel price increases often coincide with distress in the airline industry, hedging provides an additional source of cash for making acquisitions during these periods. Our results show that the value increase from hedging increases with capital investment, and that this interaction provides the vast majority of the hedging premium. This result implies that investors value hedging more in airlines where they expect hedging to protect the ability to invest in bad times. The results of two-stage regressions, while ambiguous regarding the existence of a hedging premium, suggest that the effect of hedging on investment opportunities provides at least half of the hedging value premium.

One caveat of our results is necessary. If jet fuel hedging is a valuable activity, then why don't all airlines engage in this practice? In other words, do non-hedgers act suboptimally? The

answer is probably not. The hedging premiums discussed reflect the *average* net benefit of fuel hedging. In the framework developed in this paper, many smaller airlines may find that additional cash flows provided by hedging are too small to allow for acquisitions or asset purchases at discount prices. Additionally, issues of financial strength and creditworthiness may be a factor in some non-hedging decisions. The costs of hedging may be prohibitive for firms with poor credit quality (i.e., such firms may not be able to find a willing counterparty). Firms lacking adequate liquidity may also be unable to afford option premiums or cash margin on futures contracts.

Appendix A
Example Disclosures Illustrating Fuel Price Risk for Airlines

This appendix provides examples of fuel price risk disclosures for airlines that do not hedge (see Panel A), use fuel derivatives (see Panel B) and use fuel pass-through agreements (see Panel C). The information is collected from the 10-K reports of airlines and illustrates how exposure to jet fuel prices varies by firm based on the firm's hedging mechanisms.

Panel A: Example Disclosures From Airlines that Does Not Hedge using Fuel Derivatives
From Vanguard Airlines' 1999 10K Report
Jet fuel costs are subject to wide fluctuations as a result of disruptions in supply or other international events. The Company cannot predict the effect on the future availability and cost of jet fuel. The Boeing 737-200 jet aircraft is relatively fuel inefficient compared to newer aircraft. Accordingly, a significant increase in the price of jet fuel results in a disproportionately higher increase in the Company's fuel expenses as compared with many of its competitors who have, on average, newer and thus more fuel-efficient aircraft. **The Company has not entered into any agreements that fix the price of jet fuel over any period of time. Therefore, an increase in the cost of jet fuel will be immediately passed through to the Company by suppliers. The Company has experienced reduced margins when the Company has been unable to increase fares to compensate for such higher fuel costs.** Even at times when the Company is able to raise selected fares, the Company has experienced reduced margins on sales prior to such fare increases.

From Airtran/ValueJet's 1999 10K Report
The cost of jet fuel is an important expense for The Company. The Company estimates that a one-cent increase in fuel cost would increase the Company's fuel expenses by approximately $57,000 per month, based on the Company's current fuel consumption rate. Jet fuel costs are subject to wide fluctuations as a result of sudden disruptions in supply, such as the effect of the invasion of Kuwait by Iraq in August 1990. Due to the effect of world and economic events on the price and availability of oil, the future availability and cost of jet fuel cannot be predicted with any degree of certainty. Increases in fuel prices or a shortage of supply could have a material adverse effect on the Company's operations and operating results. **The Company has not entered into any agreement which fixes the price or guarantees delivery of fuel over any period of time. A significant increase in the price of jet fuel would result in a disproportionately higher increase in the Company's average total costs than its competitors** using more fuel efficient aircraft and whose fuel costs represent a smaller portion of total costs.

Panel B: Example Disclosures From Airlines that Use Fuel Derivatives
From American Airlines 1999 10K Report
The impact of fuel price changes on the Company and its competitors is dependent upon various factors, including hedging strategies. Although American's average cost per gallon of fuel in 1999 was flat in comparison to 1998, actual fuel prices began to increase in April 1999 and continued significantly throughout 1999 and into 2000. **However, American has a fuel hedging program in which it enters into fuel swap and option contracts to protect against increases in jet fuel prices, which has had the effect of dampening American's average cost per gallon. To reduce the impact of potential continuing fuel price increases in 2000, American had hedged approximately 48 percent of its 2000 fuel requirements as of December 31, 1999.**

From United Airlines 1999 10K Report
Changes in fuel prices are industry-wide occurrences that benefit or harm United's competitors as well as United, although fuel-hedging activities may affect the degree to which fuel-price changes affect individual companies…. **The impact of rising fuel costs is somewhat tempered by United's fuel hedging program. United pursues an options based strategy in which the upside is retained while**

the downside is eliminated. At the end of 1999, 75% of United's fuel exposure was hedged, but the goal is for fuel exposure in 2000 to be 100% hedged by the end of the first quarter.

Panel C: Example Disclosures From Airlines using Fuel Pass-Through Agreements

From Mesa Air Group's 1999 10K Report

The Company has exposure to certain market risks associated with its aircraft fuel. Aviation fuel expense is a significant expense for any air carrier and even marginal changes greatly impact a carriers profitability. Standard industry contracts do not generally provide protection against fuel price increases, nor do they insure availability of supply. **However, both the USAirways and America West fee for departure contracts allow fuel costs to be passed directly back to the codeshare partner, thereby reducing the overall exposure of Mesa to fuel price fluctuations.** In the fourth quarter of fiscal 1999, 62.2% of Mesa fuel requirements were associated with these contracts. A substantial increase in the price of jet fuel or the lack of adequate fuel supplies in the future would have a material adverse effect on Mesa's business, financial condition, and the results of operations and liquidity.

From Skywest, Inc.'s 1999 10K Report

The Company is exposed to fluctuations in the price and availability of aircraft fuel that affect the Company's earnings. **Currently, the Company has limited its exposure to fuel price increases with respect to approximately 65 percent of available seat miles produced, due to contractual arrangements with Delta and United. These major airlines reimburse the Company for the actual cost of fuel on contracted flights.**

From World Airways 1995 10K Report

Fluctuations in the price of fuel has not had a significant impact on the Company's operations in recent years. **The Company's exposure to fuel risk is limited because (i) under the terms of the Company's basic contracts, the customer is responsible for providing fuel, (ii) under the terms of its full service contracts with the U.S. Government, the Company is reimbursed for the cost of fuel it provides, and (iii) under the Company's charter contracts, the Company is reimbursed for fuel price increases in excess of 5% of the price agreed upon in the contract, subject to a 10% cap.**

References

Adam, T.R. 2002. Do firms use derivatives to reduce their dependence on external capital markets? *European Finance Review* 6:163-187.

Allayannis, G., and Mozumdar, A. 2000. Cash flow, investment, and hedging. Unpublished working paper, Darden School of Business, University of Virginia.

Allayannis, G., and Ofek, E. 2001. Exchange rate exposure, hedging, and the use of foreign currency derivatives. *Journal of International Money and Finance* 20:273-296.

Allayannis, G., and Weston, J.P. 2001. The use of foreign currency derivatives and firm market value. *Review of Financial Studies* 14:243-276.

Banham, R. 2000. Top cops of risk. *CFO.* September: 91-98.

Bartov, E., and Bodnar, G.M. 1994. Firm valuation, earnings expectations, and the exchange rate exposure effect. *Journal of Finance* 49:1755-1785.

Berkman, H., and Bradbury, M.E. 1996. Empirical evidence on the corporate use of derivatives. *Financial Management* 25 (2):5-13.

Bessembinder, H. 1991. Forward contracts and firm value: Investment incentive and contracting effects. *Journal of Financial and Quantitative Analysis* 26:519-532.

Bodnar, G.M., and Wong, M.H.F. 2000. Estimating exchange rate exposures: Some 'weighty' issues. Unpublished working paper W7497, NBER.

Chung, K.H., and Pruitt, S.W. 1994. A simple approximation of Tobin's q. *Financial Management* 23 (3):70-74.

DaDalt, P.J., Donaldson, J.R., and Garner, J.L. 2003. Will any q do? Firm characteristics and divergences in estimates of Tobin's q. *Journal of Financial Research* 26:535-551.

Damodaran, A. 2002. *Investment valuation: Tools and techniques for determining the value of any asset* (2nd ed.). John Wiley & Sons, New York.

Dolde, W. 1995. Hedging, leverage, and primitive risk. *Journal of Financial Engineering* 4:187-216.

Fazzari, S.R., Hubbard, G., and Petersen, B. 1988. Financing constraints and corporate investment. *Brookings Papers on Economic Activity* 1:141-195.

Froot, K., Scharfstein, D., and Stein, J. 1993. Risk management: Coordinating investment and financing policies. *Journal of Finance* 48:1629-1658.

Gay, G.D., and Nam, J. 1998. The underinvestment problem and corporate derivatives use. *Financial Management* 27 (4):53-69.

Géczy, C., Minton, B.A., and Schrand, C. 1997. Why firms use currency derivatives. *Journal of Finance* 52:1323-1354.

Graham, J.R., and Rogers, D.A. 2002. Do firms hedge in response to tax incentives? *Journal of Finance* 57:815-839.

Graham, J.R., and Smith, C.W., Jr. 1999. Tax incentives to hedge. *Journal of Finance* 54:2241-2262.

Guay, W., and Kothari, S.P. 2003. How much do firms hedge with derivatives? *Journal of Financial Economics* 70:423-461.

Haushalter, G.D. 2000. Financing policy, basis risk, and corporate hedging: Evidence from oil and gas producers. *Journal of Finance* 55:107-152.

Howton, S.D., and Perfect, S.B. 1998. Currency and interest-rate derivatives use in US firms. *Financial Management* 27 (4):111-121.

Jorion, P. 1990. The exchange-rate exposure of US multinationals. *Journal of Business* 63:331-346.

Kennedy, P. 1992. A guide to econometrics, 3rd edition. MIT Press, Cambridge, MA.

Kim, E.H., and Singal, V. 1993. Mergers and market power: Evidence from the airline industry. *American Economic Review* 83:549-569.

Leland, H.E. 1998. Agency costs, risk management, and capital structure. *Journal of Finance* 53:1213-1243.

Mello, A.S., and Parsons, J.E. 2000. Hedging and liquidity. *Review of Financial Studies* 13:127-153.

Mian, S.L. 1996. Evidence on corporate hedging policy. *Journal of Financial and Quantitative Analysis* 31:419-439.

Nance, D.R., Smith, C.W., Jr., and Smithson, C.W. 1993. On the determinants of corporate hedging. *Journal of Finance* 48:267-284.

Pantzalis, C., Simkins, B.J., and Laux, P. 2001. Operational hedges and the foreign exchange exposure of US multinational corporations. *Journal of International Business Studies* 32:793-812.

Perfect, S.B., and Wiles, K.W. 1994. Alternative constructions of Tobin's q: An empirical comparison. *Journal of Empirical Finance* 1:313-341.

Petersen, M.A., and Thiagarajan, S.R. 2000. Risk measurement and hedging: With and without derivatives. *Financial Management* 29 (4):5-30.

Pulvino, T.C. 1998. Do asset fire sales exist? An empirical investigation of commercial aircraft transactions. *Journal of Finance* 53:939-978.

Pulvino, T.C. 1999. Effects of bankruptcy court protection on asset sales. *Journal of Financial Economics* 52:151-186.

Rogers, D.A. 2002. Does executive portfolio structure affect risk management? CEO risk-taking incentives and corporate derivatives usage. *Journal of Banking and Finance* 26:271-295.

Schrand, C., and Unal, H. 1998. Hedging and coordinated risk management: Evidence from thrift conversions. *Journal of Finance* 53:979-1013.

Smith, C.W., Jr., and Stulz, R.M. 1985. The determinants of firms' hedging policies. *Journal of Financial and Quantitative Analysis* 20:391-405.

Stulz, R.M. 1996. Rethinking risk management. *Journal of Applied Corporate Finance* 9 (3):8-24.

Tufano, P. 1996. Who manages risk? An empirical examination of risk management practices in the gold mining industry. *Journal of Finance* 51:1097-1137.

Tufano, P. 1998. Agency costs of corporate risk management. *Financial Management* 27 (1):67-77.

Weiss, L.A., and Wruck, K.H. 1998. Information problems, conflicts of interest, and asset stripping: Chapter 11's failure in the case of Eastern Airlines. *Journal of Financial Economics* 48:55-97.

Table 1
Jet Fuel Costs, Cash Flow and Investment Spending – US Airlines (1979-2000)

Table 1 shows annual figures of industry jet fuel costs, cash flow (defined as net income plus depreciation as a percentage of asset book value) and capital expenditures (as a percentage of asset book value) in the first three columns. The next three columns show cross-sectional averages, medians, and standard deviations of individual airline capital expenditure percentages for each year. The difference between "industry" and "average" capital expenditures is that the "industry" figure is the ratio of the sums (across firms) of capital expenditures and assets, while "average" is a simple average of the ratio of capital expenditures divided by assets. The number of observations utilized for the summary statistics is shown in the final column.

Year	Jet Fuel Costs ($/gal) Industry	Cash Flow (% of assets) Industry	Capital Expenditures (% of assets) Industry	Summary Statistics Across Companies Average	Median	Std dev	# of obs
1979 $	0.575	9.08%	18.4%	23.4%	21.4%	9.5%	22
1980 $	0.905	6.96%	16.3%	22.5%	19.3%	12.7%	23
1981 $	1.048	5.74%	14.8%	27.6%	19.8%	20.2%	25
1982 $	1.008	3.94%	13.7%	17.8%	14.2%	15.8%	31
1983 $	0.890	6.10%	14.8%	17.7%	15.1%	14.7%	32
1984 $	0.853	9.25%	12.3%	19.6%	16.4%	15.5%	33
1985 $	0.803	8.63%	14.7%	17.0%	15.4%	12.4%	32
1986 $	0.559	5.94%	14.5%	19.6%	15.5%	16.3%	27
1987 $	0.558	5.97%	12.4%	18.5%	13.8%	15.8%	25
1988 $	0.534	8.19%	12.0%	13.4%	12.7%	7.2%	26
1989 $	0.602	3.00%	13.1%	18.6%	18.5%	11.9%	22
1990 $	0.778	-2.43%	16.5%	16.7%	16.4%	10.7%	22
1991 $	0.700	2.25%	16.2%	12.0%	11.1%	7.9%	20
1992 $	0.655	0.62%	15.6%	11.7%	11.4%	7.5%	23
1993 $	0.602	2.75%	9.1%	12.1%	11.2%	10.1%	24
1994 $	0.548	3.95%	6.8%	11.9%	8.9%	9.9%	28
1995 $	0.558	7.98%	6.6%	11.6%	8.6%	9.9%	29
1996 $	0.652	9.27%	8.1%	11.6%	7.8%	9.2%	29
1997 $	0.630	11.19%	11.2%	11.5%	9.2%	7.4%	27
1998 $	0.498	10.05%	14.0%	14.5%	12.6%	9.7%	27
1999 $	0.519	9.17%	15.5%	16.7%	17.0%	9.9%	23
2000 $	0.775	7.50%	14.2%	13.4%	14.7%	6.7%	22
Time Series:							
Average $	0.693	6.14%	13.2%	16.3%	14.1%	11.4%	
Median $	0.641	6.53%	14.1%	16.7%	14.5%	10.0%	
Std dev $	0.164	3.41%	3.2%	4.5%	3.8%	3.6%	

Table 2
Credit Ratings – US Airlines (1988 – 2000)

Table 2 shows S&P ratings for senior debt as reported by Compustat over the period of January 1988 – December 2000. The first column shows the debt rating at the beginning of 1988 (or the first rating reported, if occurring after January 1988). The second, third, and fourth columns show the median, high, and low rating levels achieved during the period. Finally, the last column shows the rating as of the end of December 2000. The lower portion of the table summarizes rating changes occurring each year.

Company	S&P Sr Debt Rating (1/88)	Median Rating	High Rating	Low Rating	End of 2000 Rating
Airtran Holdings	BB-*	B-	BB-	CCC+	B-
Alaska Air Group	BB+	BB+	BBB-	BB+	BB+
America West	B	B+	B+	bankrupt	B+
AMR	A	BBB-	A	BB+	BBB-
Amtran	B**	B+	B+	B	B+
Atlantic Coast Airlines	B***	B	B	B	B
Continental Airlines	B	B	BB	bankrupt	BB
Delta Air Lines	A-	BBB-	A	BB	BBB-
Midway Airlines	B-****	B-	B-	B-	B-
Northwest Airlines	A	BB	A	BB-	BB
Southwest Airlines	A-	A-	A-	A-	A-
Tower Air	CCC+*****	CCC+	CCC+	bankrupt	bankrupt
Trans World Airlines	B-	CCC	B-	bankrupt	purchased by AMR
UAL	BBB	BB+	BBB	BB	BB+
US Airways Group	BBB	B+	BBB	B-	B

* First rating in April 1996
** First rating in July 1997
*** First rating in September 1997
**** First rating in September 1998
***** First rating in July 1998

Years of Rating Changes:

1988 UAL (downgrade)
    Delta (upgrade)

1989 UAL (upgrade)
    Alaska (upgrade)

1990 AMR (downgrade)
    Continental (downgrade)
    UAL (downgrade)
    US Airways (downgrade)

1991 AMR (downgrade)
    Delta (downgrade) - twice
    TWA (downgrade)
    UAL (upgrade)
    US Airways (downgrade) - twice

1992 Alaska (downgrade)
    AMR (downgrade)
    Delta (downgrade) - twice
    UAL (downgrade)
    US Airways (downgrade)

1993 AMR (downgrade)
    Delta (downgrade)
    UAL (downgrade)

1994 TWA (downgrade)
    US Air (downgrade) - twice

1995 Northwest (upgrade)

1996 Airtran (downgrade)
    Continental (upgrade)
    Delta (upgrade)

1997 Airtran (upgrade)
    AMR (upgrade)
    Continental (upgrade)
    Delta (upgrade)
    UAL (upgrade)

1998 Amtran (upgrade)
    Continental (upgrade)
    US Airways (upgrade)

2000 US Airways (downgrade)

Table 3
Descriptive Data – US Airlines

Table 3 lists the 27 US airlines (defined as firms with SIC codes 4512 and 4513) with available data on Compustat. Also shown are data on market share, fuel cost, fuel usage, and hedging data for the period 1994-2000.

Panel A: Market Share Based on Available Seat Miles

Airline carrier classifications are based on the Air Transport Association of America definitions. Major carriers are defined as an airline with annual revenue of more than $1 billion, and national carriers are airlines with annual revenues between $100 million and $1 billion. Regional carriers are airlines with annual revenues of less than $100 million whose service generally is limited to a particular geographic region. ASM stands for available seat miles and represents one seat flown one mile. For example, an airline with 100 passenger seats, flown a distance of 100 miles, represents 10,000 available seat miles. Average revenues are calculated as the average over 1994-2000 and market share is calculated as the percentage of total ASM for the period 1994-2000.

Airline	Average Revenues (millions $)	Total ASM (1994-2000)	Market Share Based on ASM
Major Carriers (10 airlines)			
UAL Corp	16,796	1,168,894.0	19.611%
AMR Corp	16,913	1,126,177.0	18.895%
Delta Air Lines	13,528	966,188.0	16.210%
Northwest Airlines	9,750	657,477.6	11.031%
Continental Airlines	7,356	498,731.0	8.368%
US Airways Group	8,240	418,607.0	7.023%
Southwest Airlines	3,891	313,827.9	5.265%
Trans World Airlines (TWA)	3,362	224,165.0	3.761%
America West Holdings	1,879	160,005.0	2.685%
Alaska Air Group	1,746	119,565.0	2.006%
National Carriers (15 airlines)			
Amtran	880	94,232.6	1.581%
Hawaiian Airlines	423	38,455.1	0.645%
Airtran Holdings	360	27,787.1	0.466%
Tower Air	444	23,286.3	0.391%
Midwest Express Holdings	347	17,603.5	0.295%
Mesa Air Group	452	16,966.4	0.285%
Comair Holdings	517	15,113.9	0.254%
Frontier Airlines	151	14,992.8	0.252%
SkyWest	291	12,147.6	0.204%
Mesaba Holdings	235	12,054.7	0.202%
Midway Airlines	200	9,775.3	0.164%
Atlantic Coast Airlines	253	8,642.7	0.145%
Great Lakes Aviation	103	3,701.6	0.062%
Western Pacific Airlines	105	3,485.8	0.058%
World Airways	263	N/A	N/A
Regional/Commuters (2 airlines)			
Vanguard Airlines	91	6,912.9	0.116%
CCAir	71	1,504.4	0.025%
Total		*5,960,300.2*	*100.00%*

Table 3 – *continued*:
Panel B: Fuel Usage, Derivatives Hedging and Operational Hedging Disclosures

The first column shows average percentage of operating costs that are spent on fuel over 1994-2000. The second column shows average fuel cost per available seat mile (ASM). The third column shows average annual gallons consumed. The derivative hedging disclosures present data gathered from firm 10-K filings for the years 1994-2000. Years fuel hedged column lists the years over 1994-2000 that the firm hedged fuel prices and the maximum maturity of hedge lists the maximum time period the firm disclosed for hedging. Also shown is the percentage of next year's fuel consumption hedged at fiscal year-end for years in which hedging is disclosed. Pass-through agreement shows a value of 1 if the firm's discussion in its 10-K discloses a fuel pass-through agreement. Similarly, charter indicates that the firm's discussion discloses charter operations. N/A means the amounts were not disclosed. Note: CC Air was acquired by Mesa Air in 2000; Comair Holdings was acquired by Delta Air Lines in January, 2000; TWA was acquired by American Airlines in 2001; and 1996 was the last year data available for Western Pacific Airlines.

Company	Avg. Fuel % of Expenses	Avg. Fuel Cost per ASM	Avg. Annual Gallons of Jet Fuel Used (millions)	Years Fuel Hedged	Max. Maturity of Hedge (years)	Avg. % of Next Year Hedged	Fuel Pass-through Agreement	Charter
Airtran Holdings	18.30%	$0.0160	96.3	1999-2000	1.0	26%	0	0
Alaska Air Group	14.20%	$0.0137	323.2	1994-96, 2000	1.0	26%	0	0
America West Holdings	12.60%	$0.0099	364.6	1997-2000	<1.0	19%	0	0
AMR Corp	11.00%	$0.0112	2871.9	1994-2000	3.0	28%	0	0
Amtran	18.80%	$0.0118	N/A	1998-2000	0.75	9%	1	1
Atlantic Coast Airlines	10.70%	$0.0205	32.1	1997-2000	0.75	25%	1	0
CCAir	8.70%	$0.0197	7.9	None			0	1
Comair Holdings	10.20%	$0.0168	80.7	None			0	1
Continental Airlines	12.50%	$0.0120	1386.1	1996-2000	0.5	24%	0	0
Delta Air Lines	12.00%	$0.0109	2636.0	1996-2000	3.0	68%	0	0
Frontier Airlines	15.20%	$0.0132	30.0	None			0	1
Great Lakes Aviation	15.40%	$0.0300	17.4	None			0	1
Hawaiian Airlines	17.30%	$0.0135	106.0	1997-2000	1.1	12%	0	1
Mesa Air Group	11.30%	$0.0241	85.7	None			1	1
Mesaba Holdings	9.70%	$0.0185	24.9	None			1	0
Midway Airlines	12.50%	$0.0156	34.7	None			0	0
Midwest Express Holdings	16.00%	$0.0197	70.2	1997-2000	0.25	2%	0	1
Northwest Airlines	13.40%	$0.0128	1944.2	1997-2000	1.00	16%	0	1
SkyWest	11.00%	$0.0190	33.4	None			0	0
Southwest Airlines	13.30%	$0.0098	741.9	1994-2000	3.00	41%	0	0
Tower Air	18.40%	$0.0175	120.1	1998	N/A	0%	1	1
TransWorld Airlines (TWA)	13.00%	$0.0122	763.5	1998-1999	0.5	0%	0	0
UAL Corp	12.20%	$0.0115	2937.3	1995-2000	1.0	19%	0	0
US Airways Group	9.50%	$0.0126	1155.0	1994-97,2000	1.0	6%	0	0
Vanguard Airlines	17.20%	$0.0157	24.6	None			0	1
Western Pacific Airlines	15.00%	$0.0108	N/A	None			0*	0*
World Airways	7.90%	N/A	N/A	None			1	1
Average	*13.23*	*0.0153*	*662.0*	*Not applicable*	*Not applicable*	*19.3%*	*0.23*	*0.46*

Table 4
Tobin's Q – Descriptive Statistics

Table 4 presents summary statistics for Tobin's Q. The values for Tobin's Q are calculated using the method suggested by Chung and Pruitt (1994).

Panel A: Average and median values computed over 1994-2000 are shown for each airline. The values in the second set of columns adds the present value of future operating lease obligation as debt in the numerator and denominator of the Q computation.

	Unadjusted Q		Adjusted Q	
	Average	*Median*	*Average*	*Median*
Major Airlines:				
Alaska Air Group	0.6522	0.6663	0.7877	0.7982
America West	0.6924	0.7341	0.8375	0.8608
AMR Corp	0.6888	0.7078	0.7739	0.7902
Continental Airlines	0.7588	0.7682	0.8523	0.8588
Delta Air Lines	0.7117	0.6963	0.8155	0.8095
Northwest Airlines	1.0278	0.9042	1.0010	0.9328
Southwest Airlines	1.5753	1.4335	1.4219	1.2921
Trans World Airlines	0.6917	0.7171	0.7828	0.8025
UAL	0.6662	0.6599	0.8034	0.8013
US Airways Group	0.7822	0.7787	0.8658	0.8642
Average - Major Airlines (1994-2000)	0.8266		0.8976	
Median - Major Airlines (1994-2000)	0.7464		0.8518	
Std Dev - Major Airlines (1994-2000)	0.3485		0.2453	
National & Regional Airlines:				
Airtran Holdings	1.6178	1.1865	1.5224	1.1487
Amtran	0.6656	0.6215	0.8014	0.7799
Atlantic Coast Airlines	1.7952	1.9435	1.3831	1.3934
CCAir	1.3012	0.8063	1.0676	0.9437
Comair	2.1100	2.3488	1.5552	1.6083
Frontier Airlines	1.0950	1.0662	1.0213	1.0243
Great Lakes Aviation	0.7674	0.7721	0.8722	0.8790
Hawaiian Airlines	0.6360	0.6190	0.7345	0.7280
Mesa Air Group	0.6762	0.6952	0.8207	0.8290
Mesaba	1.5233	1.1251	1.2889	1.0749
Midway Airlines	0.7313	0.6626	0.8568	0.8173
Midwest Express	1.7994	1.8751	1.4538	1.5287
Skywest	1.0252	0.7923	1.0211	0.8968
Tower Air	0.8137	0.7568	0.7637	0.7058
Vanguard Airlines	1.5653	1.5474	1.1449	1.1080
World Airways	0.9281	0.8590	0.9968	0.9787
Average - Natl & Regional (1994-2000)	1.1854		1.0834	
Median - Natl & Regional (1994-2000)	0.8639		0.9439	
Std Dev - Natl & Regional (1994-2000)	0.6957		0.4087	

Panel B: Average and median values of Tobin's Q are shown for each year.

	1994	1995	1996	1997	1998	1999	2000
Major Airlines:							
Average - Unadjusted Q	0.7374	0.8075	0.7830	0.8753	0.8537	0.8994	0.8304
Average - Adjusted Q	0.8393	0.8746	0.8715	0.9201	0.9155	0.9280	0.9434
Median - Unadjusted Q	0.7222	0.7476	0.7605	0.8088	0.7506	0.7459	0.6282
Median - Adjusted Q	0.8101	0.8577	0.8589	0.8954	0.8621	0.8568	0.7570
National & Regional:							
Average - Unadjusted Q	0.8666	1.3708	1.0313	1.2414	1.4313	1.2377	0.9435
Average - Adjusted Q	0.9376	1.2148	0.9606	1.1247	1.1528	1.1293	0.9893
Median - Unadjusted Q	0.8063	1.2290	0.8043	0.9440	1.0900	0.8493	0.7166
Median - Adjusted Q	0.929	1.040	0.920	0.991	1.034	0.953	0.874

Table 5
Estimates of the Relationship Between Firm Value and Hedging Behavior by Airlines

Models 1 through 3 are estimated using pooled OLS with robust standard errors, while models 4 through 6 are estimated using GLS with a heteroskedastically consistent covariance matrix. The dependent variable is the natural logarithm of Tobin's Q. All regressions include year dummy variables indicating 1996-2000. T-statistics are computed using robust standard errors for the pooled OLS regressions and are shown in parentheses beneath the parameter estimates. Z-statistics are shown in parentheses beneath the parameter estimates for the GLS regressions. Statistical significance at the 10 percent, 5 percent, and 1 percent levels is indicated by *, **, ***, respectively.

	Model 1 (n = 157)	Model 2 (n = 154)	Model 3 (n = 154)	Model 4 (n = 157)	Model 5 (n = 154)	Model 6 (n = 154)
Regression model	Pooled OLS	Pooled OLS	Pooled OLS	FGLS	FGLS	FGLS
Constant	0.4476*** (3.10)	0.4478 (3.23)	0.4325*** (3.01)	0.3343*** (3.38)	0.2860*** (2.84)	0.3583*** (3.60)
ln(Assets)	-0.1145*** (-5.73)	-0.1104*** (-6.25)	-0.1111*** (-5.55)	-0.0891*** (-7.39)	-0.0799*** (-6.26)	-0.0930*** (-7.60)
Dividend dummy	0.2216*** (2.94)	0.2037** (2.55)	0.2235** (2.70)	0.1113*** (3.03)	0.1802*** (3.71)	0.1605*** (4.03)
LT debt-to-assets	-0.0492 (-0.23)	-0.0714 (-0.32)	-0.0994 (-0.45)	-0.0302 (-0.23)	-0.1024 (-0.72)	-0.1514 (-1.12)
Return on assets	0.0370 (1.52)	0.0040 (1.63)	0.0040 (1.60)	0.0056*** (3.23)	0.0060*** (3.40)	0.0058*** (3.36)
Cap exp to sales	0.1459 (0.46)	0.4912 (1.41)	0.5315 (1.52)	-0.1821 (-0.73)	0.1778 (0.67)	0.1724 (0.68)
Dummy indicating jet fuel hedging activity	0.1599* (1.96)			0.1608*** (3.42)		
% of next year's fuel requirements hedged		0.4745* (1.94)			0.2837* (1.92)	
Dummy indicating % hedged is greater than zero			0.1494* (1.74)			0.1515*** (3.46)
R²	0.2631	0.2636	0.2556			
F Statistic	4.58***	5.17***	4.55***			
Log likelihood				-13.90	-29.09	-19.87
Wald χ²				109.15***	77.81***	120.01***

Table 6
Estimates of the Relationship Between Changes in Firm Value and Changes in Hedging Behavior by Airlines

Models 1 and 2 are estimated using pooled OLS with robust standard errors, while models 3 and 4 are estimated using GLS with a heteroskedastically consistent covariance matrix. The dependent variable is the change in the natural logarithm of Tobin's Q. Year dummy variables indicating 1997-2000 are included in all regressions. T-statistics (z-statistics for the GLS estimates) are shown in parentheses beneath the parameter estimates. Statistical significance at the 10 percent, 5 percent, and 1 percent levels is indicated by *, **, ***, respectively.

	Model 1 (n = 123)	Model 2 (n = 123)	Model 3 (n = 123)	Model 4 (n = 123)
Regression model	Pooled OLS	Pooled OLS	FGLS	FGLS
Constant	0.0503 (0.85)	0.0583 (0.99)	0.07403** (2.47)	0.0798*** (2.69)
Δ ln(Assets)	-0.2425 (-1.51)	-0.2642 (-1.64)	-0.2455*** (-3.08)	-0.2502*** (-3.04)
Δ Dividend dummy	0.07478 (1.52)	0.0769 (1.59)	0.0795** (2.38)	0.08244*** (2.63)
Δ LT debt-to-assets	0.5407* (1.87)	0.5082* (1.74)	0.5972*** (4.07)	0.5488*** (3.61)
Δ Return on assets	0.0104*** (6.72)	0.0104*** (6.77)	0.0096*** (6.46)	0.0094*** (6.39)
Δ Cap exp to sales	0.0000 (0.26)	0.0000 (0.37)	0.0000 (0.56)	0.0000 (0.61)
Δ % fuel hedged	0.1774 (1.31)		0.1796 (1.54)	
Δ Dummy variable indicating % hedged		0.1368*** (3.14)		0.1233*** (3.08)
R^2	0.4016	0.4148		
F Statistic	8.80***	9.60***		
Log likelihood			12.64	14.95
Wald χ^2			109.24***	118.14***

Table 7
Relation of Firm Value with the Interaction of Hedging and Capital Expenditures

Table 7 shows the results of regressions comparable to models 3 and 6 from Table 7. In both specifications, a variable has been added that is the product of the capital expenditures and hedging variables. The dependent variable is the change in the natural logarithm of Tobin's Q. Year dummy variables indicating 1996-2000 are included in both regressions. T-statistics (z-statistics for the GLS estimates) are shown in parentheses beneath the parameter estimates. Statistical significance at the 10 percent, 5 percent, and 1 percent levels is indicated by *, **, ***, respectively.

|	Model 1 (n = 154)	Model 2 (n = 154)
Regression model	Pooled OLS	FGLS
Constant	0.4553*** (3.24)	0.3684*** (3.51)
ln(Assets)	-0.1086*** (-5.43)	-0.0920*** (-6.68)
Dividend dummy	0.2027** (2.47)	0.1745*** (3.60)
LT debt-to-assets	-0.1084 (-0.48)	-0.1319 (-0.95)
Return on assets	0.0043* (1.71)	0.0062*** (3.46)
Cap exp to sales	0.2743 (0.70)	-0.0766 (-0.26)
Dummy variable indicating % hedged	-0.0183 (-0.14)	0.0417 (0.56)
(Cap exp to sales) x Hedging dummy	1.3323* (1.76)	0.9816* (1.83)
R^2	0.2691	
F Statistic	4.94***	
Log likelihood		-23.41
Wald χ^2		86.53***

Table 8
Instrumental Variables Regression: The Effect of Hedging on Value via Capital Expenditures

Table 8 shows results of instrumental variables regressions. Coefficients are listed first with p-values listed below each coefficient. In the first stage, capital expenditures-to-sales is regressed on the listed independent variables and year indicators (not reported). The predicted value of capital expenditures-to-sales is included as an independent variable in the second-stage regression of the natural logarithm of Q on the listed independent variables. The first hedging premium reported is the product of the coefficient on capital expenditures in the second-stage regression and the sum of the two coefficients on the hedging variables in the first-stage regression. The second hedging premium adds the coefficient on the hedging variable in the second-stage regression to the first hedging premium. In model 1, $0.0951 = (0.0110 + 0.0045) \times 6.1328$, and $0.1819 = 0.0951 + 0.0868$.

First stage: Dependent variable = Capital expenditures / sales			
	Model 1	Model 2	Model 3
	(n = 126)	(n = 119)	(n = 119)
Independent variables:			
ln(Assets)	0.0044	0.0119	0.0150
	0.395	0.039	0.015
Dividend dummy	0.0145	0.0031	0.0058
	0.388	0.888	0.795
LT debt-to-assets	0.0190	0.0313	0.0275
	0.635	0.529	0.580
Return on assets	-0.0022	-0.0005	-0.0006
	0.009	0.578	0.529
Cash flow-to-sales	0.6319	0.1526	0.1664
	0.002	0.425	0.382
Q (lagged)	0.0128	0.0717	0.0744
	0.507	0.001	0.001
Dummy indicating jet fuel hedging activity	0.0110		
	0.633		
Dummy indicating jet fuel hedging activity (lag)	0.0045		
	0.846		
% of next year's fuel requirements hedged		0.0110	
		0.884	
% of next year's fuel requirements hedged (lag)		0.0599	
		0.434	
Dummy indicating % hedged > 0			0.0240
			0.396
Dummy indicating % hedged > 0 (lag)			-0.0289
			0.316
Second stage: Dependent variable = Q (log)			
Capital expenditures/sales (predicted)	6.1328	8.5520	8.3520
	0.054	0.070	0.061
Total assets (log)	-0.1767	-0.1923	-0.1953
	0.002	0.015	0.021
Dividend dummy	0.0819	0.1079	0.1176
	0.699	0.734	0.724
Long-term debt/total assets	0.3554	0.1857	0.1867
	0.339	0.746	0.743
ROA	0.0051	0.0056	0.0056
	0.309	0.359	0.364
Dummy indicating jet fuel hedging activity	0.0868		
	0.638		
% of next year's fuel requirements hedged		-0.0559	
		0.933	
Dummy indicating % hedged > 0			0.0271
			0.916
Predicted hedging premiums:			
Using effect of hedging on capital expenditures	0.0951	0.6065	-0.0407
Total	0.1819	0.5506	-0.0136

Figure 1: Monthly Jet Fuel Costs – US Airline Industry

Panel A: This figure shows the average cost per gallon paid per month by US airlines based on data compiled by the Air Transport Association from January 1988 – November 2001.
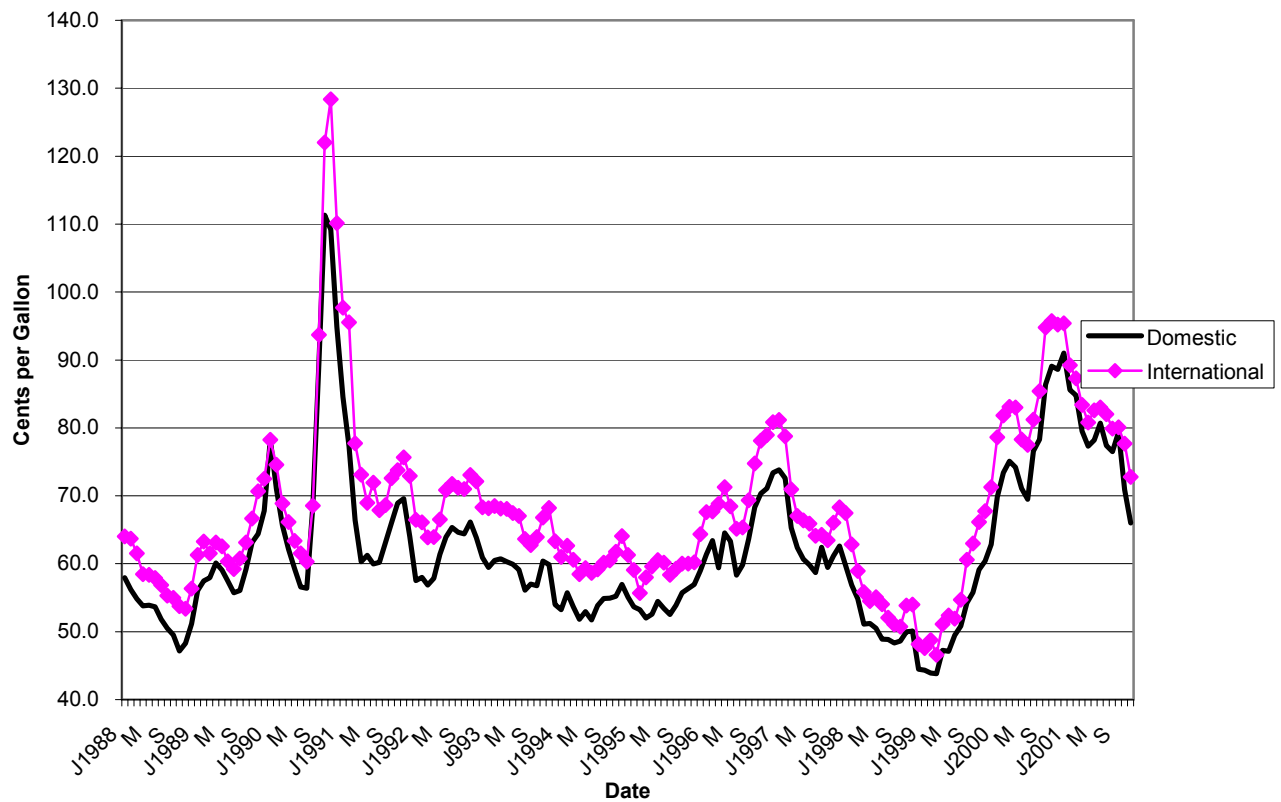
Panel B: This figure shows the regional variability of jet fuel prices using OPIS Regional Jet Fuel Prices for Chicago, Gulf Coast, Los Angeles, N.Y. Harbor, and San Francisco. As shown, regional price spikes can vary significantly from averages.
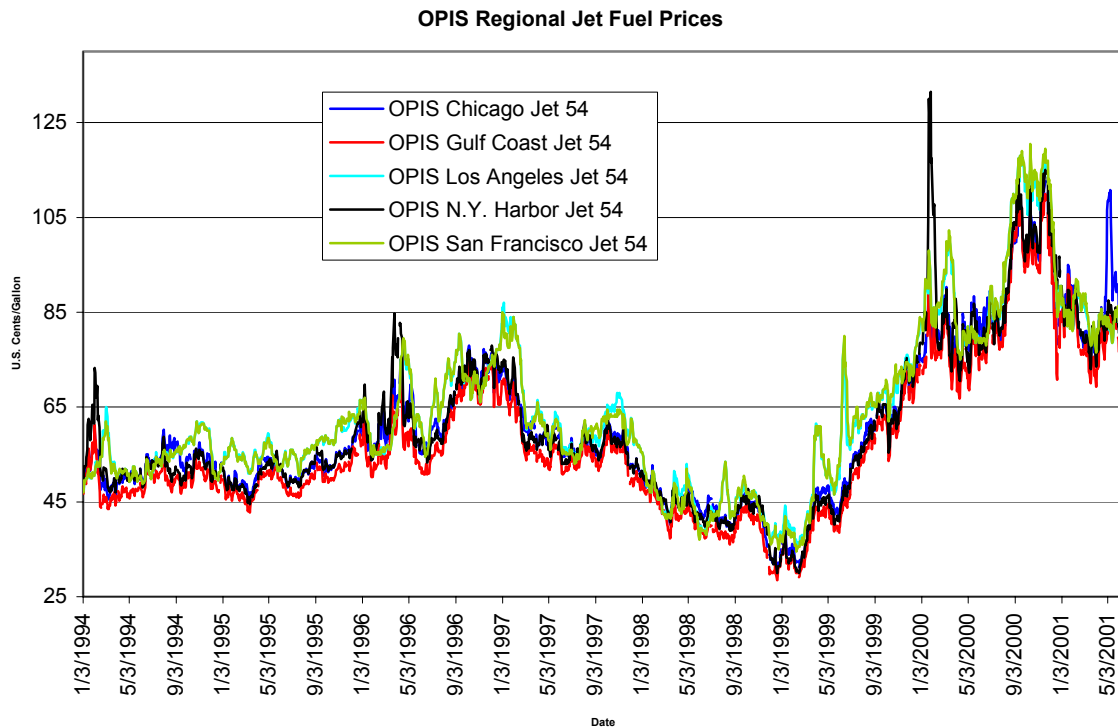
OPIS Regional Jet Fuel Prices

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Figure 2: **The Effect of Jet Fuel Costs on Capital Expenditures and Cash Flow**

These figures show relations of jet fuel costs (compiled by the Air Transport Association) with aggregate US airline industry capital expenditures and net cash flows. The data are measured annually during 1979-2000. Both panels show the actual annual paired data as well as the least squares regression line showing the linear relations of jet fuel costs with investment and cash flow measures.

Panel A: Jet Fuel Costs vs. Capital Expenditures
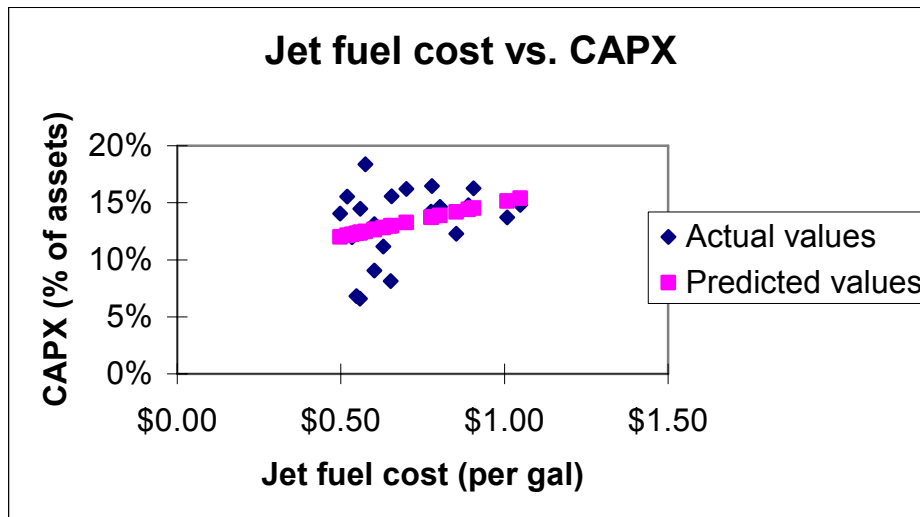
Panel B: Jet Fuel Costs vs. Net Cash Flow