Does Hedging Affect Firm Value? Evidence from the US Airline Industry

David A. Carter, Daniel A. Rogers, and Betty J. Simkins*

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 1992-2003 to examine whether such hedging is a source of value for these companies. We illustrate that the investment and financing climate in the airline industry conforms well to the theoretical 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 variables in our regression analysis suggest that the "hedging premium" is greater than the 5% documented in Allayannis and Weston (2001), and might be as large as 10%. We find that the positive relation between hedging and value increases in capital investment, and that most of the hedging premium is attributable to the interaction of hedging with investment. This result is consistent with the assertion that the principal benefit of jet fuel hedging by airlines comes from reduction of underinvestment costs.

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. On the other hand, Jin and Jorion (2004) find no relation between hedging and firm value for oil and gas producers.

This article contributes to the body of corporate risk management research in two important ways. First, given the conflicting results on the relation between hedging and firm value, we provide additional evidence regarding this question by studying the hedging of jet fuel price risk exposure by US airlines. The airline industry offers a unique perspective from which to analyze the value of firms' hedging activities because the industry is largely homogeneous and competitive. Further, we focus on the hedging of a single, homogeneous and volatile input commodity, jet fuel. Second, and perhaps more important, our analysis provides a better understanding of the source of potential value from hedging by airlines. To our knowledge, we are the first to find empirical evidence pointing to the source of value from hedging operations.

We find that the airline industry exhibits two characteristics consistent with the general assumptions and framework developed in Froot, Scharfstein, and Stein (1993). First, the airline

[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.

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David A. Carter and Betty J. Simkins are Associate Professors of Finance at Oklahoma State University in Stillwater, OK., Daniel A. Rogers is an Assistant Professor of Finance at the Portland State University in Portland, OR.

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. For example, Pulvino (1998, 1999) finds that 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. 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. Simply put, the airline industry provides an excellent sample setting because its environment conforms well to this theory of hedging.

The results show that airline firm value is positively related to hedging of future jet fuel requirements. Additionally, changes in hedging are positively associated with changes in firm value. As in Allayannis and Weston (2001), 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 likely in the range of 5% – 10%.

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 further suggests that investors view such investment as positive net present value projects. We find that the interaction between hedging and capital expenditures captures a large majority of the hedging premium. We also examine a two-stage system in which hedging impacts value through its effect on capital expenditures. The results of this procedure also suggest that the hedging premium is largely attributable to 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 1992-2003 is approximately 27%. As a point of comparison, Guay and Kothari find that the annualized volatility of major currencies is only 11% (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 hedging firm in our sample is 21.7% of capital expenditures. Overall, airline exposure to jet fuel price risk is economically significant, and considerable cash can be realized by hedging in the event of an extreme price increase.

The article proceeds as follows. Section I provides a brief review of relevant hedging literature. Section II discusses the airline industry environment with respect to risk exposures, particularly jet fuel price risk. This section also explores the relation between jet fuel costs, cash flow, and investment in the industry. Additionally, we provide analysis of the financing environment. Section III explores the determinants of jet fuel hedging by individual airlines. The value of hedging is analyzed in Section IV, and we investigate whether the hedging premium is associated with the investment opportunities framework. Section V concludes the article.

I. Literature Review: Hedging and Firm Value

Most of the theoretical research in corporate risk management argues that firms can increase value by hedging. In a seminal article, Smith and Stulz (1985) argue that, by reducing the probability of bankruptcy, hedging can increase firm value and this effect is larger for firms with higher costs of financial distress. In the same article, they propose that firms facing an income tax liability function that is convex in taxable income can reduce expected tax payments by hedging taxable income.

As noted in Stulz (1996), financial distress costs include those related to failure to invest in valuable projects because of deadweight costs of debt. Froot et al. (1993) extend the Smith and Stulz (1985) analysis by illustrating 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. Hedging generates additional cash in these states, thus circumventing the underinvestment problem.[2] An important feature of the Froot et al. 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 as investment opportunities are less positively 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.

Interestingly, there is little empirical evidence to date that hedging assists in value creation. Two recent studies make direct 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. Jin and Jorion (2004) argue that the positive value effect of hedging shown in the cross-sectional sample used by Allayannis and Weston (2001) might be hard to interpret because of issues that are difficult to adequately control such as endogeneity of value and hedging or variation in risk exposures across the sample firms. In their study, Jin and Jorion (2004) show that hedging has no value effect for a sample of oil and gas firms. However, Jin and Jorion (2004) might have biased their results against finding a relation between hedging and firm value by selecting a sample in which, by their own admission, investors might prefer firms not to hedge (p. 3). In contrast, we analyze hedging by firms that are consumers of oil. Investors are less likely to use airline stocks as mechanisms to speculate on oil prices.

II. US Airline Industry Environment

The US airline industry offers an excellent setting for examining the effect of hedging on firm value. First, airlines are exposed to substantial, but hedgeable, risk exposures. One particularly notable risk facing airlines is their exposure to rising jet fuel prices. Second, the

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

investment and financing environment in the industry demonstrates similarities to the setting posed by Froot et al. (1993) in motivating the benefits of hedging. We discuss these two points in this section of the article.

A. Risk Exposures and Hedging Mechanisms

Airlines, like many industrial companies, are potentially exposed to risks resulting from adverse movements in interest rates, foreign currency prices, and commodity prices, particularly jet fuel prices. Airlines' fuel price exposures are particularly transparent because oil is a widely traded global commodity, and the poor economic condition of airlines (partly as a result of higher fuel prices) has frequently been in the news since the terrorist attacks of September 11, 2001. Figure 1 shows average monthly spot jet fuel prices at three major US trading hubs (New York Harbor, Gulf Coast, and Los Angeles) during January 1992 – December 2003. Averaging across the three locations, the mean price of jet fuel is about 63.4 cents per gallon. Until about mid-1996, jet fuel prices were not particularly volatile, but clearly that has not been the case since late 1997. The standard deviation of average monthly fuel prices during 1992-2003 is about 15.7 cents per gallon.

We start our analysis by identifying publicly held US passenger airline companies with information available on the Compustat database during 1992-2003 (SIC code is 4512 or 4513). We use the 10-K filings of these firms to obtain data regarding management of interest rate, foreign currency, and jet fuel risk exposures. Twenty-nine airlines disclose adequate levels of data for our analysis. We eliminate one airline (Western Pacific) because its filings contain limited data covering only two years of the sample period.

We find that airlines manage all three of these risks. From 259 firm-year observations, we find 65 (58) disclosures of derivative usage specifically to manage interest rate (foreign currency) risk. Meanwhile, 88 firm-year observations include disclosures that some of next year's jet fuel requirements have been explicitly hedged as of fiscal year-end. Many of the airlines that do not disclose hedging future jet fuel purchases discuss using fuel risk management tactics such as fuel pass-through agreements entered into with major airline partners or charter arrangements that allow for fuel costs to be passed along to the organization chartering the flight. Examples of airline disclosures about various mechanisms for managing fuel price risk are shown in the Appendix.

Overall, airline disclosures suggest fuel price risk is of significant importance. Fuel price risk is ubiquitous across all airlines, as opposed to foreign currency price risk that applies only to the relatively small set of airlines that operate in foreign markets. For example, foreign sales as reported by Compustat are non-zero for only nine of the companies in our sample. Interest rate risk would seem important in a highly levered industry, but interest rate derivatives usage among our sample firms suggests that interest rate risk is of a lower magnitude than jet fuel price risk. As such, we focus the attention of our analysis on jet fuel price risk. Nevertheless, our subsequent analyses incorporates interest rate and foreign currency decisions separately from jet fuel hedging decisions.[3]

Table I summarizes jet fuel costs and hedging policies of the sample airlines across available firm-years. For the full sample of firm-year observations, fuel costs average about 13.6% of operating expenses. The percentages range from 8.5% (Mesaba Holdings) to

[3]Jet fuel price risk price exhibits little correlation with foreign currency price risk or interest rate risk. We calculate correlation coefficients among monthly jet fuel returns, major currency index returns, and the yield relative (see Flannery and James, 1984) of the 7-year constant maturity Treasury bond during 1992-2003. The correlation between jet fuel returns and the currency index is approximately –0.10 (p-value = 0.23). The correlation between jet fuel returns and the yield relative is about 0.04 (p-value = 0.60).

Figure 1. Average Monthly Jet Fuel Prices

Figure 1 shows the average monthly spot price per gallon for kerosene-type jet fuel in three locations across the United States during January 1992 – December 2003. Spot prices are based on f.o.b. (free on board) for each specified location. The Energy Information Administration (www.eia.doe.gov) provides the data and uses the symbols RJETNYH, RJETUSG, and RJETLA for the spot price series for New York Harbor, Gulf Coast, and Los Angeles delivery points, respectively.

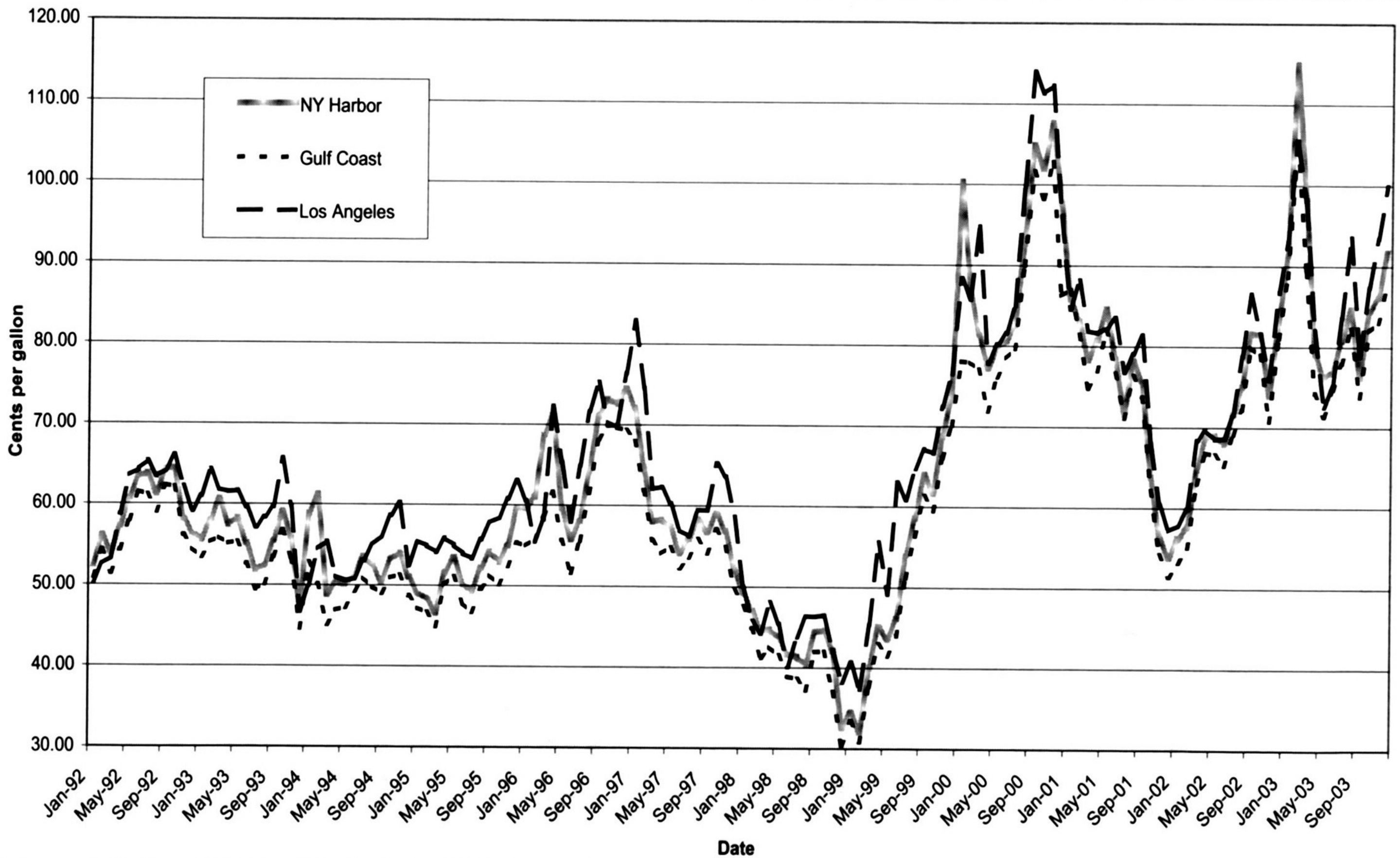

Table I. Fuel Usage, Derivatives Hedging, and Operational Hedging Disclosures

This table presents information on jet fuel usage and mechanisms used by airlines to manage fuel costs, including hedging, fuel pass-through agreements, and the use of charter operations. The derivative hedging disclosures present data gathered from firm 10-K filings. Column [1] reports the average percentage of operating costs that are spent on fuel during years for which data are disclosed. Column [2] lists the years during 1992-2003 that the firm hedged future fuel requirements. Column [3] presents the maximum time period the firm disclosed for hedging. The percentage of next year's fuel consumption hedged at fiscal year-end for years in which hedging is disclosed is reported in Column [4]. Column [5] reports whether the airline discloses a fuel pass-through agreement in its 10-K filings (the existence of a pass-through agreement is reported as a one, zero otherwise). Similarly, Column [6] indicates that the airline discloses the existence of charter operations (the existence of charter operations is reported as a one, zero otherwise). Note: CC Air was acquired by Mesa Air in 2000; Comair Holdings was acquired by Delta Air Lines in January, 2000; Hawaiian Airlines changed name to Hawaiian Holdings in 2002; Midway Airlines' final year of operation was 2000; Tower Air went bankrupt in 2001; TWA was acquired by American Airlines in 2001; and Vanguard Airlines' final year of operation was 2001.

	[1]	[2]	[3]	[4]	[5]	[6]
Airline	**Jet Fuel as a Percentage of Operating Expenses (Average Over Sample Period)**	**Years Jet Fuel Hedged**	**Maximum Maturity of Hedge (Years)**	**Average Percentage of Next Year Hedged**	**Fuel Pass-through Agreement**	**Charter Operations**
Airtran Holdings	18.84%	1999-2003	1.0	14%	0	0
Alaska Air Group	13.92%	1992-96, 2000-03	3.0	22%	0	0
America West Holdings	13.30%	1997-2003	<1.0	11%	0	0
AMR Corp	11.97%	1992-2003	3.0	28%	0	0
Amtran	18.44%	1998-2001	0.75	3%	1	1
Atlantic Coast Airlines	12.73%	1997-2000	1.0	5%	1	0
CCAir	8.69%	None			0	1
Comair Holdings	10.19%	None			0	1
Continental Airlines	15.14%	1992-93, 1996-2002	1.0	18%	0	0
Delta Air Lines	12.20%	1996-2003	3.0	34%	0	0
Express Jet Holdings	11.62%	None			1	0
Frontier Airlines	15.58%	2002-03	2.0	2%	0	1
Great Lakes Aviation	15.28%	None			0	1
Hawaiian Airlines	17.11%	1997-2002	2.0	8%	0	1
Jetblue Airways	16.07%	2002-03	1.25	43%	0	0
Mesa Air Group	15.09%	None			1	1
Mesaba Holdings	8.45%	None			1	0
Midway Airlines	12.52%	None			0	0
Midwest Express Holdings	16.53%	1997-2002	0.75	4%	0	1
Northwest Airlines	13.57%	1997-2002	1.0	11%	0	1
SkyWest	12.20%	None			1	0
Southwest Airlines	14.51%	1992-2003	6.0	43%	0	0
Tower Air	18.36%	1998	N/A	0%	1	1
TransWorld Airlines (TWA)	13.00%	1998-1999	2.0	1%	0	0
UAL Corp	12.30%	1995-2003	1.0	19%	0	0
US Airways Group	9.69%	1994-97, 2000-03	2.0	12%	0	0
Vanguard Airlines	17.61%	None			0	1
World Airways	9.97%	None			1	1
Average	*13.75%*			*15%*	*0.28*	*0.41*

18.8% (Airtran Holdings).

The next set of three columns in Table I reports information regarding hedging of future jet fuel requirements. We show the calendar years in which fuel 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.[4]

Major airlines (defined as carriers with annual revenues in excess of $1 billion) more commonly hedge future jet fuel purchases than do smaller ones. While all major airlines hedged during part of the period 1992-2003, only AMR and Southwest Airlines always had hedges in place at the end of every year for which we have data. Eighteen of the 28 firms reported hedging jet fuel in at least one year. Of hedging firms, the average hedged percentage (on an equally-weighted basis) of next year's fuel consumption is approximately 15%.[5] We observe wide variation in the amount of fuel hedged, even among hedgers. Recently, Southwest Airlines has often hedged close to 80% of its coming year's fuel requirements. In the late 1990s, UAL typically had hedges in place for most of their next year's expected consumption. However, it is not uncommon to observe airlines that hedge very little or none of its future fuel purchases. This type of cross-sectional variation within an industry setting is generally consistent with recent theoretical models such as Adam, Dasgupta, and Titman (2004) and Mello and Ruckes (2004). Most hedging airlines also report the maximum maturity of jet fuel hedges. In recent years, airlines have been increasing the maximum lengths of hedging horizons. Southwest has gained some notoriety in the press recently for extending its fuel hedges to a maximum maturity of six years.[6]

Within the industry, some airlines use avenues other than hedging future fuel purchases to manage fuel price risk. 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. Table I 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 I indicates airlines classified as having charter operations.[7] One point worth noting about fuel pass-through and charter agreements is that these mechanisms do not lock in a price (or price cap) for future jet fuel, as is the case when airlines hedge future fuel purchases. Rather, users of these mechanisms experience higher fuel costs as fuel prices increase, but allow airlines to pass the higher fuel cost to another party (i.e., the partner airline or the chartering customer). If the demand for air travel is price-elastic, then fuel pass-through and chartering arrangements are not equivalent to hedging future fuel purchases. The former two mechanisms will be associated with lower passenger demand if fuel prices rise, while the latter strategy allows

[4]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. For some firm-years prior to 1997, we are able to estimate the percentage of fuel requirements hedged by using notional value disclosures and gallons of fuel consumed.

[5]Other averages are as follows: 10.9% across all non-missing firm-year observations; 16.4% across all firms with at least one year of disclosure about hedging and weighted by number of observations; and 29.4% across only positive firm-year observations.

[6]Warren (2005) notes that Southwest's more aggressive approach to hedging future jet fuel purchases might prove costly if oil prices fall in the future.

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

airlines to maintain current fares in spite of higher fuel prices. In subsequent analyses, we differentiate fuel hedging from these other fuel risk management mechanisms.

Thus far, we have discussed the fact that airlines appear to view volatile jet fuel prices as a source of risk exposure. Next, we explore two possible ways of measuring airline exposure to jet fuel prices. First, we estimate a monthly market model using an equally-weighted airline industry return that includes a jet fuel return factor. This type of methodology is standard in other research examining risk exposures.[8] We conduct the following monthly time-series regression:

$$R_t = \alpha + \beta R_{mt} + \gamma R_{Jt} + e_t, \qquad (1)$$

where R_t is the equally-weighted rate of return on the sample airlines in month t (as gathered from CRSP), R_{mt} is the return on the CRSP equally-weighted market portfolio, R_{Jt} is the percentage change in Gulf Coast spot jet fuel prices (gathered from the Energy Information Administration), and ε_t is the idiosyncratic error term.[9] The estimated coefficient, γ, is a measure of the sensitivity of the industry'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 airline industry stock prices are negatively related to jet fuel prices. The jet fuel exposure coefficient from Equation (1) is –0.11, and it is statistically significant at the 5% level. The coefficient also implies economic significance of jet fuel price changes. Recall that the standard deviation of jet fuel prices shown in Figure 1 is 15.7 cents per gallon with a mean of 63.4 cents. Thus, a one standard deviation change in jet fuel price represents approximately a 25% change from the mean price. Using a 25% price change in the context of the regression results suggests a one standard deviation movement in jet fuel price results in a 2.75% change (monthly) in airline industry stock prices.

As a second measure of exposure, we use an approach suggested by Guay and Kothari (2003). They measure cash flow sensitivity to price risk by using a three standard deviation price change to illustrate the effects of an extreme move in underlying asset prices (i.e., interest rates, currencies, and commodities). In the case of jet fuel, a 45-cent (per gallon) change represents approximately three standard deviations. 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 firm-years from 1994-2003, the median of this value is 91%. Alternatively, this measure may be interpreted as the relative cash flow from the hedge resulting if the firm has hedged 100% of its fuel consumption. The median percentage of next year's fuel consumption hedged is 24% (for firms that hedge). Multiplying the prior amounts by 24% suggests that "normal" amounts of hedging would generate cash flow equal to 21.7% of capital expenditures in the event of an extreme price move. By contrast, Guay and Kothari find that the median firm in their sample would generate cash flow amounting to only 9% of investing cash flow. While the 21.7% vs. 9% figures mentioned above are not directly comparable, we note that capital expenditures are greater than or equal to investing net cash flow for over half of our sample. Thus, our comparison understates the greater importance of

[8]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.

[9]When examining currency exposures, Bodnar and Wong (2003) 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.

jet fuel hedging relative to the firms in Guay and Kothari's sample. Clearly, jet fuel hedging by airlines is economically meaningful in terms of their measure.

B. Jet Fuel Prices, Investment, Cash Flow, and Financing Environment

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

There are two major ways in which hedging can assist in an airline's ability to invest. First, airlines typically negotiate large purchase orders with aircraft manufacturers years in advance of delivery of some of the aircraft. Purchase orders are disclosed as firm commitments in the financial statement footnotes. However, the orders appear to include deferral/cancellation options as most carriers exercised such options following the terrorist 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 disclosed that its purchase of TWA during 2001 was funded with existing cash and assumption of TWA debt.[10]

To analyze whether the airline industry is characterized by the investment environment discussed in Froot et al. (1993), we examine aggregate airline industry data on jet fuel costs, investment expenditures, and cash flow from 1979-2003. 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. 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 II illustrates the annual patterns of jet fuel costs, cash flow, and investment spending for US airlines during 1979-2003.[11] The first column shows the level of industry jet fuel 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 among US airlines during 1979-2003 is about 71 cents per gallon.

The second column of Table II shows net income plus depreciation (scaled by book value of assets). Industry cash flow has also shown significant variation over time. The mean value is about 5.4%, but has been negative during weak economic climates in 1990 and 2001-2002. Notably, these are also years in which fuel costs are above average. The highest cash flows occurred in 1997 and 1998 as fuel prices were moving lower (see Figure 1). Industry

[10]The discussion suggests that hedging should allow for firms to increase market share. We examine this by calculating market share of available seat miles (ASM) for each firm-year by dividing each firm's disclosed ASM by the total US industry's ASM total (as disclosed by the Air Transport Association). We calculate the correlation coefficient between the percentage of fuel requirements hedged and the change in market share. The correlation is positive (approximately 14%), and is statistically significant at the 5% level.

[11]Table II shows per gallon jet fuel costs in nominal terms. Much of the analysis in this section uses both nominal and inflation-adjusted fuel costs.

Table II. Jet Fuel Costs, Cash Flow, Capital Expenditures, and Leverage – US Airlines (1979-2003)

This table shows annual average jet fuel costs, cash flow (defined as net income plus depreciation as a percentage of asset book value), capital expenditures (as a percentage of asset book value), and debt as a percentage of total assets. We report capital expenditures, as a percentage of assets, in two different ways: first, in the column labeled "Industry", we show total industry capital expenditures divided by total industry assets; second, under "By Airline", we report averages, medians, and standard deviations for the cross-section of airlines in the given year.

			Capital Expenditures (% of Assets)				
				By Airline			
Year	Jet Fuel Costs ($/Gal)	Cash Flow (% of Assets)	Industry	Average	Median	Std Dev	Debt (% of Assets)
1979	$ 0.577	9.08%	18.4%	23.4%	21.4%	9.5%	43.4%
1980	$ 0.892	6.96%	16.3%	22.5%	19.3%	12.7%	44.9%
1981	$ 1.047	5.74%	14.8%	27.6%	19.8%	20.2%	42.8%
1982	$ 0.989	3.94%	13.7%	17.8%	14.2%	15.8%	47.4%
1983	$ 0.896	6.10%	14.8%	17.7%	15.1%	14.7%	44.8%
1984	$ 0.855	9.25%	12.3%	19.6%	16.4%	15.5%	43.8%
1985	$ 0.809	8.63%	14.7%	17.0%	15.4%	12.4%	42.2%
1986	$ 0.558	5.94%	14.5%	19.6%	15.5%	16.3%	41.1%
1987	$ 0.559	5.97%	12.4%	18.5%	13.8%	15.8%	40.2%
1988	$ 0.535	8.19%	12.0%	13.4%	12.7%	7.2%	40.3%
1989	$ 0.605	3.00%	13.1%	18.6%	18.5%	11.9%	32.3%
1990	$ 0.783	-2.43%	16.5%	16.7%	16.4%	10.7%	32.2%
1991	$ 0.691	2.25%	16.2%	12.0%	11.1%	7.9%	28.9%
1992	$ 0.637	0.62%	15.6%	11.7%	11.4%	7.5%	33.7%
1993	$ 0.606	2.75%	9.1%	12.1%	11.2%	10.1%	31.4%
1994	$ 0.558	3.95%	6.8%	11.9%	8.9%	9.9%	29.9%
1995	$ 0.558	7.98%	6.6%	11.6%	8.6%	9.9%	25.7%
1996	$ 0.664	9.27%	8.1%	11.6%	7.8%	9.2%	29.9%
1997	$ 0.645	11.19%	11.2%	11.5%	9.2%	7.4%	31.0%
1998	$ 0.513	10.05%	14.0%	14.5%	12.6%	9.7%	30.1%
1999	$ 0.531	9.17%	15.5%	16.7%	17.0%	9.9%	30.6%
2000	$ 0.806	7.43%	14.4%	16.4%	15.7%	13.3%	37.0%
2001	$ 0.777	-0.94%	11.3%	13.9%	11.1%	10.6%	39.3%
2002	$ 0.714	-3.17%	6.1%	9.5%	6.2%	11.9%	37.3%
2003	$ 0.849	2.88%	5.0%	9.6%	7.9%	11.9%	39.2%
Average	$ 0.706	5.35%	12.5%	15.8%	13.5%	11.7%	36.8%
Median	$ 0.664	5.97%	13.7%	16.4%	13.8%	10.7%	37.3%
Std Dev	$ 0.155	3.96%	3.7%	4.6%	4.1%	3.3%	6.2%

fuel costs in 1998 were at the lowest level seen during the period examined. The Pearson correlation between jet fuel costs and cash flow is about –0.185. This correlation becomes much more negative (-0.526) if we exclude the 1979–1985 period during which the industry was in the process of transitioning into a more deregulated environment. Inflation-adjusted fuel costs also exhibit a negative correlation with cash flow (-0.487).

The third column of Table II shows industry capital expenditures as a percentage of book value of assets.[12] Capital expenditures range from a low of 6.6% in 1995 to a maximum of 18.4% in 1979. The next three columns in Table II present 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 1980s and into the early 1990s, followed by low investment through 1996. The late 1990s exhibited relatively high levels of investment, followed by below-average investment spending in 2001-2003. Capital expenditures appear to be negatively correlated with firm size because the industry capital spending ratios (a weighted average) are typically below the simple averages and medians. Pearson correlations between jet fuel costs and capital expenditures are positive during the 1979-2003 time period (0.144 for industry capital expenditures). The correlation declines to -0.116 if we exclude the 1979-1985 observations, but inflation-adjusted fuel costs exhibit positive correlations with industry capital expenditures in both the full time frame (0.464) and the shorter time frame (0.362).

The simple analyses discussed earlier provide univariate evidence that the airline industry exhibits an investment and cash flow environment that is generally consistent with the assumptions of Froot et al. (1993). Next, we consider an extended investment cash-flow sensitivity framework to further explore the relation between jet fuel costs and capital expenditures. The dependent variable is capital expenditures scaled by lagged assets, and the independent variables are: 1) inflation-adjusted jet fuel costs per gallon, 2) cash flow scaled by lagged assets, and 3) lagged Tobin's Q. This regression allows us to control for cash flow and investment productivity effects on capital expenditures, in addition to the possible effect of jet fuel costs. In untabulated results, we find a positive and statistically significant (p-value is 0.04) coefficient on the jet fuel costs variable. Thus, the evidence suggests that the airline industry offers greater investment opportunities when jet fuel prices are higher.

An additional feature 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) imply 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).

The airline industry is capital intensive and the primary assets (aircraft) hold considerable collateral value for lenders. Not surprisingly, firms in the industry often have significant amounts of debt in their capital structures. The final column of Table II shows the average

[12]According to the Director of Corporate Finance at Southwest Airlines, aircraft spending constitutes roughly 90% of total capital expenditures, while maintenance expenditures are rarely capitalized.

debt ratio across airlines for each year from 1979-2003. Average debt ratios were above 40% through 1988. Debt levels appear considerably lower throughout the 1990s. Weak industry conditions in recent years are likely a contributing factor to average debt levels approaching 40% during the final several years of our sample period.

Airlines are not limited to buying aircraft. Firms in the industry often lease aircraft. If a lease qualifies as an operating lease for accounting purposes, then the asset and the underlying capital are not reported on the firm's balance sheet. Thus, reported debt and assets are systematically understated for airlines that make greater use of operating leases. To obtain a sense of leasing practices across airlines and over time, we search 10-K filing disclosures regarding percentage of aircraft fleets that are leased for fiscal years 1996, 2000, and 2003. In untabulated results, we find considerable variation in leasing practices across airlines and over time. Across all airlines, the leased percentage averages between 60% – 70% during each of the three years examined. While no leasing is a rarity among our sample firms, we do find a number of instances in which less than 30% of the fleet is leased. Meanwhile, some airlines lease their entire fleets. We also observe significant changes in the leasing percentages of individual firms. Because of the variation in leasing percentages, we explore the effect of adjusting key variables (i.e., assets, debt, capital expenditures, etc.) to account for operating leases in subsequent analyses.

To better understand the cost of airline debt, we gather the S&P ratings for senior debt of the 15 sample airlines with ratings reported in the Compustat database. Panel A of Table III shows the level of credit ratings as of January 1988, the median rating for each airline, the highest and lowest ratings experienced, and the rating as of May 2004. As of May 2004, only one airline (Southwest) had an investment grade credit rating. At the beginning of 1988, six airlines possessed investment grade ratings. Over the time frame examined, nine airlines experienced a decline in credit rating, three filed Chapter 11 bankruptcy, and one was purchased after filing bankruptcy. One airline had no net change in credit rating over the period studied, and one experienced an increase in its credit rating.

Panel B of Table III summarizes rating changes by year. The 1990-1994 period began with relatively high jet fuel prices and a recession, and exhibited low cash flows. During this time frame, credit ratings often declined. Twenty-four credit downgrades occurred versus only one upgrade. Continental, Trans World Airlines, and America West all filed Chapter 11 bankruptcy during this period as well. A similar industry environment has emerged since 2000, and 30 credit rating downgrades have occurred. Only three upgrades happened during this same time frame.

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, and again in 2000, as the industry slumps 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 1990s.

Overall, the observations discussed above imply that airlines face lackluster credit markets during much of our sample period. As we have seen in the wake of the terrorist attacks, external shocks can have devastating impact on the industry's cash flows. Interestingly, the last major cash flow shock of the 1990s occurred during a period when major airlines had better credit ratings. In the more recent 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

Table III. Credit Ratings – US Airlines (Jan 1988 – May 2004)

This table shows S&P ratings for senior debt as reported by Compustat over the period of January 1988 – May 2004. 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 May 2004. The lower portion of the table summarizes the numbers of credit rating upgrades and downgrades by year.

Airline	S&P Sr Debt Rating (1/88)	Median Rating	High Rating	Low Rating	May 2004 Rating
Panel A. Airline Debt Ratings					
Airtran Holdings*		B-	BB-	CCC+	B-
Alaska Air Group	BB+	BB+	BBB-	BB-	BB-
America West	B	B+	B+	Bankrupt	B-
AMR	A	BBB-	A	CCC	B-
Amtran*		B	B+	CCC	CCC
Atlantic Coast Airlines*		B	B	B-	B-
Continental Airlines	B	B+	BB	Bankrupt	B
Delta Air Lines	A-	BBB-	A	B-	B-
Midway Airlines*		B-	B-	Bankrupt	Bankrupt
Northwest Airlines	A	BB	A	B+	B+
Southwest Airlines	A-	A-	A	A-	A
Tower Air*		CCC	CCC+	Bankrupt	Bankrupt
Trans World Airlines	B-	CCC	B-	Bankrupt	Purchased by AMR
UAL	BBB	BB+	BBB	Bankrupt	Bankrupt
US Airways Group	BBB	B+	BBB	Bankrupt	CCC+

Panel B. Rating Upgrades and Downgrades

Year	Upgrades	Downgrades
1988	3	1
1989	2	1
1990	0	5
1991	1	7
1992	0	6
1993	0	3
1994	0	3
1995	1	0
1996	2	1
1997	5	0
1998	3	0
1999	0	0
2000	0	1
2001	1	12
2002	1	6
2003	1	7
2004 (thru May)	0	4

*Denotes that no rating is available for January 1988. Airtran, Amtran, Atlantic Coast, Midway, and Tower are first rated in April 1996, July 1997, September 1997, September 1998, and July 1998, respectively.

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.

III. What Explains Jet Fuel Hedging by Airlines?

Much of the empirical research in corporate risk management seeks to identify the factors that explain hedging. While the focus of our study is primarily to understand the value effects of hedging, it remains instructive to identify the explanatory factors of fuel hedging in the airline industry. In particular, our discussion in Section II suggests that the Froot et al. (1993) underinvestment framework should be particularly applicable to our sample.[13] In this section, we analyze what factors are important in explaining jet fuel hedging by airlines.

A. Empirical Models

The theories of corporate risk management may be classified into three categories. First, financial constraint theories argue that measures of financial constraints should be useful in explaining hedging. By relaxing these constraints, hedging allows for higher value by reducing expected costs of underinvestment (e.g., Froot et al., 1993) or by reducing expected financial distress costs (e.g., Smith and Stulz, 1985). Second, tax arguments suggest that hedging is valuable because of greater tax benefits resulting from increased leverage (e.g., Leland, 1998), or because of lower tax liabilities resulting from the convexity of corporate tax functions (e.g., Smith and Stulz, 1985). Finally, risk-averse managers are naturally inclined to seek ways to reduce firm risk. The nature of management's holdings of corporate securities can increase or reinforce their risk aversion (e.g., Smith and Stulz, 1985).

Incorporating theories of corporate risk management, we build empirical models to explain jet fuel hedging by the sample airlines. Table V shows results of three random effects models. The results shown reflect only variables exhibiting at least weak degrees of statistical significance in explaining jet fuel hedging. Before discussing the results, we first discuss the variables used (including those not included in the models presented). Table IV shows summary statistics for the variables discussed in subsequent paragraphs.

The dependent variable in each of the first two models of Table V is the percent of next year's fuel requirements hedged as of the end of the fiscal year. As shown earlier in Table I, there is considerable variation in these hedge ratios, and a number of airlines do not hedge future fuel purchases at any time during our study. In Model 3 of Table V, we contrast the results of Models 1 and 2 by using a simple binary measure of hedging that equals one if the percent hedged is positive, or zero otherwise.

The first four independent variables shown in Model 1 of Table V have implications for financial constraints hypotheses. The capital expenditures-to-sales ratio and Tobin's Q are used to proxy for the amount and productivity of investment opportunities, respectively. In the underinvestment costs framework, both of these variables should be positively related to hedging. The debt ratio serves as a standard measure of financial constraints, and is

[13] Several articles investigate whether corporate risk management practices are consistent with predictions of the Froot et al. (1993) theory. These include Adam (2002), Allayannis and Mozumdar (2000), Deshmukh and Vogt (2005), and Gay and Nam (1998). All of these articles find evidence suggesting that this theoretical framework explains corporate hedging behavior. Nevertheless, none of the articles mentioned analyze the value implications of hedging.

Table IV. Summary Statistics of Variables Used in Regression Models

This table presents summary statistics for the variables used in the regression models. The data are gathered from firm 10-K filings and Compustat.

Variable	Mean	Median	Std Dev	Min	Max
% of next year's fuel requirements hedged	0.109	0.000	0.200	0	0.878
Positive % fuel hedged indicator	0.370	0.000	0.484	0	1
Capital expenditures-to-sales	0.117	0.083	0.127	0	1.030
Tobin's Q	0.955	0.749	0.576	0.039	3.963
LT debt-to-assets	0.266	0.262	0.178	0.000	1.000
ln(Assets)	6.843	6.513	1.990	2.621	10.399
Capital expenditures-to-sales (lease-adjusted)	0.273	0.255	0.350	-0.828	1.775
Tobin's Q (lease-adjusted)	0.962	0.864	0.342	0.265	3.530
LT debt-to-assets (lease-adjusted)	0.577	0.583	0.181	0	1
ln(Assets) (lease-adjusted)	7.498	7.349	1.796	3.728	10.609
Cash flow-to-sales	0.049	0.073	0.099	-0.353	0.359
Cash-to-sales	0.152	0.120	0.122	0.000	0.683
Credit rating*	22.278	20.000	7.790	8.000	30.000
Z-score	2.035	1.727	1.868	-6.167	7.666
Tax loss carryforwards-to-assets	0.110	0.000	0.386	0.000	3.635
Dividend indicator	0.297	0.000	0.458	0	1
Executive options-to-shares outstanding	0.046	0.034	0.061	0.000	0.570
Executive shares-to-shares outstanding	0.071	0.009	0.175	0.000	0.787
CEO options-to-shares outstanding	0.022	0.014	0.030	0.000	0.305
Executive shares-to-shares outstanding	0.035	0.003	0.123	0.000	0.772
Fuel pass-through indicator	0.222	0.000	0.416	0	1
Charter indicator	0.455	0.000	0.499	0	1
Foreign currency derivatives indicator	0.230	0.000	0.422	0	1
Interest rate derivatives indicator	0.258	0.000	0.438	0	1

*The reported statistics for the credit rating is based on the numerical values assigned by Compustat. A larger value represents a lower credit score, e.g., a value of 2 corresponds to a AAA rating assigned by Standard & Poor's, while a value of 27 corresponds to a D rating.

generally predicted to show a positive relation with hedging if firms facing higher probabilities of distress hedge more. Finally, firm size (as measured by the natural logarithm of total assets) potentially serves as an inverse measure of bankruptcy costs. If so, firm size should be negatively related to hedging.[14]

In Section II, we discussed leasing practices of airlines. Aircraft are often leased using operating leases, and the values of these aircraft are not reflected on airline balance sheets. Thus, the reported values of the first four independent variables in Table V are systematically misstated depending upon the usage of operating leases. We use an adjustment process explained in Damodaran (2002) 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, the long-term debt-to-assets ratio, and total assets. We revise capital expenditures by adding the difference between the present values of the operating lease obligations to the reported capital expenditures. In Model 2, we use lease-adjusted values of the first four independent variables.

The next three variables shown, cash flow-to-sales ratio, cash-to-sales ratio, and credit rating, also might proxy for financial constraints. Airlines that generate greater cash flow should have less binding financial constraints, so they might have fewer incentives to hedge. Alternatively, better-performing firms may want to hedge to lock in the effects of their higher profitability as in Breeden and Viswanathan (1998).

Cash holdings are an important form of financial slack for firms that view external financing as more costly than internal financing (e.g., Myers and Majluf, 1984). Thus, cash provides a financial buffer, so we predict a negative relation with hedging. One additional financial constraint variable employed, but dropped from the final tests, is an indicator variable for firm-years in which dividends are paid. The dividend dummy exhibits no statistically significant relation with jet fuel hedging.

The probability of bankruptcy serves as an important financial constraint. We utilize S&P credit ratings and Altman's Z-score as potential measures of bankruptcy probability. In subsequent analyses, we find that the Z-score exhibits no statistically significant relation with jet fuel hedging. The S&P credit rating used is the Compustat numeric scale from 2 to 28 (with lower numbers reflecting higher credit ratings). We code any missing firm-year observations with values of 30.

Graham and Rogers (2002) empirically examine the tax incentives to hedge for a broad cross-section of firms, and find that the tax benefits of additional leverage that can be undertaken are an important source of value from hedging. Their analysis suggests that we should observe a positive relation between leverage and hedging if tax arguments are important. In the same article, they find no evidence that tax function convexity explains hedging behavior. While we do not have access to a direct measure of tax function convexity, we use tax loss carryforwards as a proxy. If tax convexity is important in explaining hedging, we expect a positive relation between carry-forwards and hedging. We find no statistical evidence of any relation, and drop this variable from the analysis.

Tufano (1996) illustrates that managerial incentives are an important factor in explaining gold price hedging by mining firms. We incorporate managerial incentives by gathering option and share holding data for the executives listed in the Execucomp database and from proxy statements. We divide executive share and option holdings by the number of shares outstanding for each firm-year. We also do this for the CEO only. We find that neither option

[14]Nance et al. (1993) point out that corporate risk management might be positively related to firm size because economies of scale may apply to operational and transactions costs of hedging. Most empirical studies of hedging document positive relations with firm size.

Table V. Determinants of Jet Fuel Hedging by Airlines

This table reports the results of regressions explaining the hedging of future jet fuel purchases by sample airlines during the period 1992 – 2003. In Models 1 and 2, the dependent variable is the percentage of the next year's fuel requirements hedged as of the end of the fiscal year. In Model 3, the dependent variable is an indicator equaling one if the percentage hedged is greater than zero, and zero otherwise. Year dummies are included in each of the regressions, but are not reported. p-values are reported below the coefficients (in parentheses). Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, ***, respectively.

	Model 1 Random Effects Tobit	Model 2 Random Effects Tobit	Model 3 Random Effects Logit
Constant	-0.0773	0.0234	-3.6849
	(0.817)	(0.941)	(0.414)
Capital expenditures-to-sales	0.3073		3.6567
	(0.102)		(0.164)
Tobin's Q	0.1367 **		0.5934
	(0.017)		(0.413)
LT debt-to-assets	-0.0848		0.9672
	(0.579)		(0.619)
ln(Assets)	0.0532 *		0.5778
	(0.056)		(0.141)
Capital expenditures-to-sales (adjusted for leases)		0.1001	
		(0.262)	
Tobin's Q (adjusted for leases)		0.2249 ***	
		(0.007)	
LT debt-to-assets (adjusted for leases)		-0.2729 **	
		(0.043)	
ln(Assets) (adjusted for leases)		0.0492 **	
		(0.032)	
Cash flow-to-sales	0.7896 **	0.4812	7.4863 *
	(0.034)	(0.184)	(0.099)
Cash-to-sales	-0.4939	-0.4056	-5.5166
	(0.109)	(0.179)	(0.142)
Credit rating	-0.0226 ***	-0.0214 ***	-0.1281
	(0.000)	(0.000)	(0.109)
Fuel pass-through indicator	-0.3854 ***	-0.3894 ***	-2.8554 **
	(0.001)	(0.000)	(0.023)
Interest rate derivatives indicator	0.1128 *	0.0766	1.6315 **
	(0.065)	(0.111)	(0.047)
Executive shareholdings-to-shares outstanding	0.5684 ***	0.4852 ***	5.1093 **
	(0.007)	(0.007)	(0.041)
Number of observations	215	206	215
	(127 censored)	(120 censored)	
Log likelihood	-29.56	-30.80	-76.03

holdings at the executive or CEO level provide explanatory power in the hedging models, nor does CEO shareholdings. Executive shareholdings are the only remaining managerial incentive variable shown in the model.

We also check the relations of alternative hedging mechanisms in the regressions. Specifically, we include dummy variables to indicate if airlines hold foreign currency derivatives, if they hold interest rate derivatives, if they use fuel pass-through agreements, and if they disclose that chartering is a significant portion of their overall businesses. Neither the charter nor the foreign currency indicators exhibit any explanatory power in the models of jet fuel hedging, so these variables are dropped from the analyses.

B. Results

The results shown in Table V largely suggest that the percent of future jet fuel requirements hedged are explained by firm characteristics that are consistent with the underinvestment costs framework of Froot et al. (1993). Models 1 and 2 of Table V show that Tobin's Q is positively associated with the amount of jet fuel hedged. This result implies that airlines with more productive investment opportunities hedge more, and this is a key prediction from the underinvestment hypothesis. Capital expenditures exhibit a positive relation with the amount of hedging, although the coefficients are not statistically significant at standard levels.

Firm leverage, after being adjusted to account for future operating lease obligations, is negatively related to the amount of jet fuel hedged. Additionally, the credit rating variable is negatively related to the amount of jet fuel hedged, thus implying that firms with higher credit ratings hedge more. This set of results could be argued to imply that hedging is conducted by airlines with fewer financial constraints.[15] This argument is true if all airlines face similar costs of distress (if distress occurs). However, if airlines with greater distress costs optimally choose lower debt ratios and are assigned higher credit ratings, then the observed results appear more consistent. Recall that underinvestment costs are a subset of total distress costs. Firms with greater productivities and amounts of investment opportunities stand to lose more value if distress occurs. Thus, the leverage and credit rating results are complementary to the Q and capital expenditures results discussed above. The ratio of cash flow to sales exhibits a positive relation with amount of jet fuel hedged in Model 1. This result is generally inconsistent with a financial constraints argument. On the other hand, we observe a negative (but not statistically significant) relation between cash holdings and amount hedged. Firm size shows a positive relation with jet fuel hedging. If smaller firms face larger proportional distress costs, then this result is inconsistent with a distress argument. The hedging versus size result also suggests that larger airlines do not subscribe to a "too big to fail" hypothesis in setting risk management policies. Rather, the positive relation is consistent with an argument that economies of scale and/or scope might apply to hedging future jet fuel purchases.

Model 3 of Table V utilizes a binary variable to indicate positive amounts of jet fuel hedging. To maintain consistency with Models 1 and 2, we employ a random effects model. The signs on the coefficients are consistent between the models, but the logit model is

[15]Fazzari, Hubbard, and Petersen (1988) argue that the sensitivity of investment to cash flow is a measure of financial constraints for individual firms. We compute investment-cash flow sensitivity coefficients for each airline using annual and quarterly data. We find that airlines with average hedge ratios of over 10% across all available years exhibit higher average investment-cash flow sensitivity coefficients than do airlines that hedge little or not at all. The statistical significance is weak because of the small number of airlines. P-value values are 0.126 and 0.078 for the annual and quarterly data, respectively.

unable to identify most of the relations found when using the continuous hedging variable. The logit model, as in the Tobit models, shows that jet fuel hedging is negatively associated with the existence of fuel pass-through agreements and positively related to executive shareholdings.[16]

IV. Do Investors Value Jet Fuel Hedging?

We investigate whether airlines' jet fuel hedging activities affect firm value by estimating the empirical relationships between Tobin's Q (our proxy for firm value) and jet fuel hedging. We construct our models to resemble those used by Allayannis and Weston (2001). In addition to fuel hedging variables, the list of explanatory variables used in Table VI includes firm size, a dividend indicator, long-term debt-to-assets, cash flow-to-sales ratio, capital expenditures-to-sales ratio, advertising-to-sales ratio, S&P credit rating score, and Altman's Z-score.[17] We also include indicator variables to proxy for the possible effect on value of other risk management techniques, such as fuel pass-through agreements, charter operations, interest rate derivatives, and foreign currency derivatives. Finally, we include a liquidity measure, the ratio of cash to sales, in the regressions. Carter and Simkins (2004) find that airlines with greater liquidity demonstrate less sensitivity to the market price effect of the 9/11 attacks.[18]

A. Measurement of Firm Value

We measure firm value using the simple approximation of Tobin's Q, developed by Chung and Pruitt (1994).[19] 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

[16]In untabulated results, we also include two other operational measures to analyze jet fuel hedging. Airlines with older, less fuel-efficient aircraft might be more likely to hedge jet fuel purchases. We include average aircraft age (gathered from 10-K disclosures) to proxy for this argument. We also gather the percentage of labor costs as a percentage of operating expenses (also from 10-K filings), and hypothesize that airlines with higher labor costs might require more active management of fuel costs. Because of data limitation, including these variables reduces the number of observations to 153 in Models 1 and 3 and 150 in Model 2. In results consistent with the hypothesis that airlines flying older airplanes have greater incentives to hedge fuel costs, aircraft age shows a positive and statistically significant relation with jet fuel hedging in all three models when age and labor cost percentage are included. However, the coefficient on aircraft age is not significant if the labor cost percentage variable is excluded.

[17]We use the cash flow-to-sales ratio as a proxy for ROA used by Allayannis and Weston (2001). The correlation of these two variables is about 85%. We find that cash flow-to-sales effectively captures the expected positive relation between profitability and firm value, while the ROA variable does not exhibit this relation. The inclusion of post-9/11/2001 data reduces the ability of ROA to explain firm value.

[18]Hedging might also be associated with higher firm value because hedging firms are better able to meet analysts' earning forecasts, as suggested in Brown (2001). DaDalt, Gay, and Nam (2002) find that hedging allows firms to better meet analyst forecasts. Using 169 annual analyst earnings forecasts during 1994-2002, we find that the firm-years in which firms hedged jet fuel display smaller forecast errors relative to non-hedging firm-years. The differences are not statistically significant if we include 2001 data, but become so when 2001 observations are removed.

[19]The Tobin's 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 *Moody's Industrial Manual* to obtain the yields on preferred stock for medium-grade industrials.

Table VI. Estimates of the Relation Between Firm Value and Hedging Behavior

This table reports the results of regressions of firm value, as measured by the natural logarithm of Tobin's Q, on measures of hedging behavior and other firm characteristics. Models 1 and 2 are estimated with OLS using robust standard errors that account for the clustered sample. Model 3 is estimated as a firm fixed effects model, while Model 4 uses time-series feasible generalized least squares with heteroskedastically consistent standard errors. Year dummy variables are included in all regressions, but are not reported. p-values are reported in parentheses below the coefficients. Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, ***, respectively.

Variable	Model 1 Pooled OLS (n = 229)	Model 2 Pooled OLS (n = 228)	Model 3 Fixed Effects (n = 228)	Model 4 FGLS (n = 228)
Constant	-0.0272	-0.0852	1.1668	-0.5574
	(0.970)	(0.908)	(0.163)	(0.179)
ln(Assets)	-0.1716***	-0.1735 ***	-0.1468	-0.1151 ***
	(0.004)	(0.003)	(0.126)	(0.000)
Dividend Indicator	0.2120 **	0.1927 *	0.1402	0.1721 ***
	(0.040)	(0.056)	(0.210)	(0.001)
LT Debt-to-Assets	0.6936 *	0.7095 *	0.4952 **	0.8187 ***
	(0.075)	(0.074)	(0.029)	(0.000)
Cash Flow-to-Sales	1.4074 *	1.3613	1.1890 **	0.4206
	(0.099)	(0.108)	(0.016)	(0.244)
Cap Exp to Sales	0.2252	0.1825	-0.1489	0.1772
	(0.487)	(0.578)	(0.635)	(0.378)
Z-score	0.1014	0.0982	0.1058 ***	0.1800 ***
	(0.185)	(0.200)	(0.003)	(0.000)
Credit Rating	-0.0063	-0.0046	-0.0169	-0.0042
	(0.620)	(0.726)	(0.109)	(0.488)
Advertising-to-Sales	12.1061***	11.5784 ***	-3.0200	10.8120 ***
	(0.001)	(0.001)	(0.591)	(0.000)
Cash-to-Sales	-0.3432	-0.2764	-0.2291	-0.3086
	(0.485)	(0.589)	(0.578)	(0.218)
Positive % Fuel Hedged Indicator	0.0442			
	(0.665)			
% of Next Year's Fuel Requirements Hedged		0.3475 *	0.2770	0.3323 ***
		(0.069)	(0.132)	(0.005)
Charter Indicator	-0.0619	-0.0575	-0.2775 **	-0.0074
	(0.598)	(0.621)	(0.014)	(0.888)
Fuel Pass-through Indicator	-0.2549 *	-0.2367 *	0.1172	-0.1826 ***
	(0.082)	(0.096)	(0.380)	(0.004)
Foreign Currency Derivatives Indicator	0.0969	0.1006	0.0199	0.1375 **
	(0.506)	(0.508)	(0.895)	(0.031)
Interest Rate Derivatives Indicator	0.0484	0.0408	0.1194	-0.0326
	(0.745)	(0.785)	(0.250)	(0.549)
R^2	0.4555	0.4627	0.4725	
Log Likelihood				-57.84
Wald χ^2				340.97 ***

simple approximation and more rigorous constructions of Q.[20] 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.

Our sample consists of 28 airlines over a maximum period of 1992-2003 with a total of 251 firm-year observations of Tobin's Q. Given unavailability of operating lease data for five firm-years, the lease-adjusted Q variable has 246 observations.

B. Empirical Models: Firm Value and Hedging

Table VI presents initial results for the estimation of the effect of jet fuel hedging on airline firm value. The only distinction between the first two models is that we utilize a binary fuel-hedging variable in Model 1, while we use a continuous variable in Model 2. Both models are estimated using pooled OLS with robust standard errors that account for clustered data.[21]

The results shown in the first two models illustrate a positive relation between jet fuel hedging and airline firm value. However, the coefficient on the binary variable in Model 1 is not statistically significant. This result implies that merely choosing to hedge future jet fuel purchases, regardless of the amount, has a statistically immeasurable effect on value. However, the economic magnitude of the coefficient, 0.0442, is similar to the hedging premiums documented by Allayannis and Weston (2001).

Using the continuous hedging measure, the results in Model 2 of Table VI show that the greater the hedged percentage of next year's fuel requirements, the higher is firm value. The coefficient is statistically significant at the 10% level. The coefficient of 0.3475 implies that an airline with 100% of its fuel requirements hedged would exhibit a value premium of almost 35% relative to one with none of its fuel requirements hedged. The average amount of fuel hedged across firm-years in which hedging is positive is 29.4% (see footnote 5). Thus, an average hedging firm exhibits a value premium of about 10.2%. The magnitude of this value premium is considerably larger than the 5% currency-hedging premium found by Allayannis and Weston (2001).

Models 3 and 4 of Table VI demonstrate that the magnitude of the hedging premium associated with the continuous hedging variable is robust to differing econometric specifications. In these specifications, we estimate the regressions using fixed effects and time-series feasible generalized least squares (FGLS), respectively.[22] The coefficients on the hedged percentage of fuel requirements variable are about 0.28 and 0.33 in Models 3 and 4, and the coefficient is statistically significant in the FGLS specification.

[20]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.

[21]The fact that Q is an independent variable in the hedging specifications presented in Section III and hedging variables are independent variables in the firm value regressions raises concerns about endogeneity and simultaneity biases. To address this issue, we conduct tests for endogeneity (e.g., Kennedy, 1992) of hedging in the value regression (and vice versa). We find no support for the hypothesis that Q is endogeneous in the hedging specification. On the other hand, we find limited support that hedging is endogeneous in the Q regressions. To our knowledge, there are no instrumental variable regression methodologies that can account for a censored variable in one of the regressions. As a robustness check, we use fitted values from the hedging specification as an independent variable in the firm value regression, and continue to find economically significant relations (and often statistically significant) between firm value and the percentage-hedged variable.

[22]We also estimate the model using a random effects model. The results are very similar to those estimated in the pooled OLS regression of Model 2.

In Section III, we adjust Tobin's Q, assets, leverage, and capital expenditures to account for the effect of operating leases. In untabulated results, we repeat the analyses shown in Table VI. The results continue to suggest a hedging premium, although the magnitudes of the coefficients are about 30% - 60% of the size of those shown in Table VI. This change occurs generally across all independent variables. The statistical significance of the hedging coefficients remains similar to that of the coefficients shown in Table VI. A potential explanation for the change in magnitudes is that the operating lease adjustment has the effect of increasing (decreasing) the level of Q for low (high) Q firms. This occurs because our measurement of Q assumes that the market value of debt is equal to the book value of debt. If the market value of debt is less than the book value for low Q firms and hedging has a positive effect on market value, then the observed relation between fuel hedging and value may be diluted using the adjusted Q values.

The results shown in Tables V and VI raise a question about causality: higher Q firms are shown to hedge more in Table V, and firms that hedge more are associated with higher values of Q. An alternative means to measure the value consequences of hedging is to measure the change in value when firms change hedging policy. This type of analysis is less likely to suffer from endogeneity that may call the Table VI results into question. Table VII shows the results from regressions of changes in natural logarithm of Q on changes in the independent variables.

Table VII illustrates that changes in jet fuel hedging are positively related to changes in firm value. The first model uses changes in the binary hedging variable, and the coefficient implies a hedging premium of about 6%. The second model uses changes in the continuous variable. The positive coefficient of 0.188 suggests that a change from no hedging to the average (for hedging firms) of 29.4% is associated with a value change of about 5.5%. The hedging coefficients are statistically significant at 10% in both models. To confirm that changes in Q are not driving the results we observe in Table VII, we also conduct regressions of changes in the hedging variables on changes in the independent variables shown in Table V. We find no evidence that increases in Q are associated with increases in the amount or probability of hedging future jet fuel purchases.

C. Is the Hedging Premium Related to Investment Opportunities?

The analysis presented in the prior section of the article establishes a positive relation between hedging and firm value. In Section III, we illustrate that the determinants of jet fuel hedging by airlines are largely consistent with an underinvestment theory. In this section, we present analyses designed to ascertain whether such a rationale explains the hedging premium.

As an initial test, Table VIII shows the results of regression models that are comparable to those presented in Table VI. The only difference is the inclusion of two additional independent variables measuring the interaction of jet fuel hedging with capital expenditures. In Model 1, we use the binary fuel-hedging variable multiplied by the capital expenditures-to-sales ratio. Models 2 – 4 utilize the percentage-hedged variable to calculate the interaction term.

Table VIII shows no significant relation between the fuel-hedging variables and firm value. Meanwhile, the coefficient on the interaction of capital expenditures and hedging is positive and statistically significant in two of the four models. The interpretation is that for airlines hedging future fuel purchases, greater capital spending is associated with higher firm value. As an example of the value premium associated with hedging, we use the average level of capital expenditures-to-sales of 11.7% and a hedge ratio of 29.4%. Using the coefficients

Table VII. Estimates of the Relation Between Changes in Firm Value and Changes in Hedging Behavior

This table shows results of regressions of the change in firm value, as measured by the change in the natural logarithm of Tobin's Q, on measures of the change in hedging behavior and other firm characteristics. Year dummy variables are included in all regressions, but are not reported. T-statistics are calculated using standard errors corrected for clustering by firm in the sample data. The resulting p-values are shown in parentheses beneath the parameter estimates. Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, ***, respectively.

Variable	Model 1 Pooled OLS (n = 201)	Model 2 Pooled OLS (n = 200)
Constant	-0.1319 (0.437)	-0.1635 (0.341)
Δ ln(Assets)	-0.3075 ** (0.037)	-0.2975 ** (0.049)
Δ Dividend indicator	-0.0296 (0.689)	-0.0243 (0.754)
Δ LT debt-to-assets	0.9063 *** (0.006)	0.8968 *** (0.006)
Δ Cash flow-to-sales	0.6597 (0.238)	0.6628 (0.246)
Δ Cap exp to sales	0.2406 (0.403)	0.2558 (0.355)
Δ Z-score	0.1270 (0.223)	0.1257 (0.229)
Δ Credit rating	-0.0176 (0.201)	-0.0169 (0.217)
Δ Advertising-to-sales	-3.7460 (0.653)	-3.8363 (0.644)
Δ Cash-to-sales	-1.1210 *** (0.000)	-1.1094 *** (0.000)
Δ Positive % fuel hedged indicator	0.0602 * (0.060)	
Δ % of next year's fuel requirements hedged		0.1881 * (0.068)
Δ Charter indicator	-0.0881 (0.410)	-0.0820 (0.444)
Δ Fuel pass-through indicator	0.0744 (0.277)	0.0799 (0.213)
Δ Foreign currency derivatives indicator	-0.0148 (0.923)	-0.0241 (0.873)
Δ Interest rate derivatives indicator	-0.0669 (0.381)	-0.0686 (0.368)
R^2	0.4382	0.4390

Table VIII. Firm Value and the Interaction of Capital Expenditures and Hedging

This table reports the results of regressions of firm value, as measured by the natural logarithm of Tobin's Q, on measures of hedging behavior, other firm characteristics, and the interaction of capital expenditures and hedging. Models 1 and 2 are estimated with OLS using robust standard errors that account for the clustered sample. Model 3 is estimated as a firm fixed effects model. Model 4 uses time-series feasible generalized least squares with heteroskedastically consistent standard errors. Year dummy variables are included in all regressions, but are not reported. p-values are reported in parentheses below the coefficients. Statistical significance at the 10%, 5%, and 1% levels is indicated by *, **, ***, respectively.

Variable	Model 1 Pooled OLS (n = 229)	Model 2 Pooled OLS (n = 228)	Model 3 Fixed Effects (n = 228)	Model 4 FGLS (n = 228)
Constant	-0.0258	-0.0479	1.1994	-0.4375
	(0.971)	(0.947)	(0.155)	(0.269)
ln(Assets)	-0.1708***	-0.1743***	-0.1504	-0.1252***
	(0.003)	(0.003)	(0.120)	(0.000)
Dividend Indicator	0.2133**	0.1952*	0.1393	0.1802***
	(0.037)	(0.053)	(0.214)	(0.000)
LT Debt-to-Assets	0.6891*	0.7099*	0.4992**	0.8136***
	(0.078)	(0.075)	(0.028)	(0.000)
Cash Flow-to-Sales	1.4557*	1.3757	1.1966**	0.3701
	(0.089)	(0.104)	(0.016)	(0.295)
Cap exp to sales	-0.1405	-0.1473	-0.2023	-0.0512
	(0.750)	(0.726)	(0.556)	(0.840)
Z-score	0.0964	0.0954	0.1057***	0.1733***
	(0.211)	(0.213)	(0.003)	(0.000)
Credit Rating	-0.0066	-0.0061	-0.0179	-0.0078
	(0.596)	(0.637)	(0.100)	(0.135)
Advertising-to-Sales	11.6926***	11.1158***	-3.4211	9.2981***
	(0.002)	(0.002)	(0.550)	(0.000)
Cash-to-Sales	-0.2204	-0.1856	-0.2002	-0.0893
	(0.671)	(0.723)	(0.634)	(0.699)
Positive % fuel hedged indicator	-0.0397			
	(0.743)			
% of next year's fuel requirements hedged		0.0356	0.1507	0.0595
		(0.889)	(0.688)	(0.707)
Positive % fuel hedged indicator x Cap exp	0.6749			
	(0.130)			
% of next year's fuel requirements hedged x Cap exp to sales		1.8249*	0.8057	1.7720***
		(0.063)	(0.699)	(0.003)
Charter indicator	-0.0606	-0.0546	-0.2777**	0.0020
	(0.603)	(0.636)	(0.014)	(0.970)
Fuel pass-through indicator	-0.2547*	-0.2404*	0.1152	-0.1866***
	(0.080)	(0.088)	(0.390)	(0.003)
Foreign currency derivatives indicator	0.0881	0.0816	0.0043	0.1343**
	(0.549)	(0.595)	(0.978)	(0.041)
Interest rate derivatives indicator	0.0600	0.0611	0.1209	-0.0212
	(0.687)	(0.691)	(0.245)	(0.704)
R^2	0.4605	0.4687	0.4730	
Log likelihood				-54.35
Wald χ^2				572.25***

from Model 2 of Table VIII, the average hedging firm is expected to be valued 7.3% higher than a non-hedging firm ((1.8249 x 0.117 x 0.294) + (0.0356 x 0.294)). The first term in parentheses represents the portion of the hedging premium associated with capital expenditures, and is about 86% of the total. If we repeat the hedging premium decomposition for the other models similarly, we find that the interaction of hedging and capital expenditures explains 201%, 38%, and 78% of the hedging premium in Models 1, 3, and 4, respectively.

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 might be more reflective of future capital expenditures. As a result, investors place additional value on capital expenditures made today by hedgers because of greater confidence that these are a better proxy for future investment opportunities.[23]

Thus far, we have limited the analysis to one-stage regression specifications. The theoretical framework for our empirical study suggests the following link: 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(predicted capital expenditures$_t$, hedging$_t$, other controls)

To model this framework, we regress capital expenditures-to-sales on the cash flow-to-sales, lagged Q, and lagged percent hedging variables. The fitted values from the first-stage capital expenditures estimation are then utilized in the second-stage estimation of Q.

Table IX presents results of the first-stage estimation of capital expenditures-to-sales, and the second-stage estimation of Q. To obtain an estimated hedging premium from this system, we multiply the hedging coefficient reported in the first-stage estimation by the average hedge percentage, and then multiply this amount by the coefficient on the predicted 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 obtain the total hedging premium, we then add the product of the hedging variable coefficient from the second-stage Q estimation and the average hedge percentage. We report results using Q and capital expenditures that are unadjusted (first two columns) and adjusted (last two columns) to account for operating leases.

The results shown in the first and third columns of Table IX illustrate that predicted capital expenditures are positively related to firm value. The second and fourth columns illustrate the effect of lagged hedging on capital expenditures. In both cases, the coefficients are positive and economically significant (although the relation is not statistically significant when adjusted capital expenditures are used).

The implied hedging premium from the models using unadjusted Q and capital expenditures is about 20.7% [e.g., (0.0742 x 0.294 x 9.6394) + (-0.0126 x 0.294)]. The term in the first parentheses represents the proportion of the hedging premium attributable to the

[23]An additional implication of our analysis is that hedging airlines should be better able to acquire other firms. As a simple test of this hypothesis, we gather acquisition data for the sample firms from Bloomberg and regress the number of acquisitions completed during the sample time frame on a dummy variable equal to one if the airline hedged fuel purchases during the time frame. We find a positive relation that is statistically significant at the 1% level.

Table IX. The Effect of Hedging on Value via Capital Expenditures

This table shows results of regressions calculated with a two-stage process. In the first stage, we regress capital expenditures-to-sales on cash flow-to-sales, lagged Q, and the lagged percentage of fuel requirements hedged. In the second stage, we regress natural logarithm of Q on the predicted value of capital expenditures-to-sales estimated for each firm-year from the first-stage regressions. Coefficients are listed first with p-values listed below each coefficient. Year indicators are included in the regressions of Q, but are not reported. Standard errors in the regressions of Q are corrected to account for the clustered sample. Statistical significance is denoted by *, **, and *** to represent 10%, 5%, and 1% significance, respectively.

Variable	ln(Q) (n = 203)	CAPX-to-Sales (n = 206)	ln(Q): Lease Adj (n = 201)	CAPX-to-Sales: Lease Adj (n = 204)
Constant	-1.0114	0.0602 ***	-0.2699	-0.0941
	(0.158)	(0.000)	(0.373)	(0.173)
ln(Assets)	-0.1605 ***		-0.0798 ***	
	(0.006)		(0.004)	
Dividend indicator	0.1703 *		0.0870 *	
	(0.073)		(0.072)	
LT debt-to-assets	0.7211 **		0.3631 **	
	(0.044)		(0.020)	
Cash flow-to-sales	-0.8372	0.2296 ***	-0.6964	1.1678 ***
	(0.344)	(0.005)	(0.261)	(0.000)
Predicted cap exp-to-sales	9.6394 ***		1.2260 **	
	(0.000)		(0.010)	
Z-score	0.0619		0.0516 *	
	(0.178)		(0.084)	
Credit rating	-0.0006		-0.0030	
	(0.962)		(0.549)	
Advertising-to-sales	9.7274 ***		5.2255 **	
	(0.005)		(0.033)	
Cash-to-sales	-0.3732		-0.3647 *	
	(0.438)		(0.099)	
% of next year's fuel requirements hedged	-0.0126		0.0713	
	(0.942)		(0.373)	
Charter indicator	-0.0475		-0.0111	
	(0.553)		(0.803)	
Fuel pass-through indicator	-0.2070 **		-0.0760	
	(0.038)		(0.171)	
Foreign currency derivatives indicator	0.0968		0.0603	
	(0.506)		(0.368)	
Interest rate derivatives indicator	0.0324		-0.0130	
	(0.766)		(0.809)	
Lagged Q		0.0344 **		
		(0.013)		
Lagged Q (lease-adjusted)				0.2928 ***
				(0.000)
Lagged % of next year's fuel requirements hedged		0.0742 *		0.1104
		(0.056)		(0.330)
R^2	0.6070	0.0999	0.6627	0.2153

effect of hedging on capital expenditures. Thus, this model suggests that the hedging premium is entirely due to its effect on investment. If we examine the models that use Q and capital expenditures adjusted for leases, the implied hedging premium is much smaller (about 6.1%). In this case, the proportion of the hedging premium associated with investment is about 65.5%.

D. How Does the Hedging Premium Change over Time?

Allayannis and Weston (2001) document that the hedging premium among firms with foreign currency exposure is highest during years in which the US dollar appreciates. This result suggests that investors place higher valuations on hedging firms during periods in which hedging provides positive payoffs.

We analyze hedging premiums over time by interacting the hedge ratio with year indicator variables. Table X shows the coefficients on the by-year hedging variables from the same models as shown in Table VI, Models 2–4. The results generally show hedging premiums increasing over the time period studied with the highest values occurring in 2002 and 2003. For example, the coefficients on the 2002 hedge ratio variable are all statistically significant. The 2003 coefficients are statistically significant in two of three cases.[24]

We also examine the coefficient on the hedge ratio variable across different time periods depending upon the credit rating environment. From Table III, we observe that credit rating changes were entirely negative during 1992 – 1994 with limited changes, followed by overwhelmingly positive changes from 1995 – 1998. The 2000 – 2003 period was characterized by an inordinate number of downgrades. The interaction of the 2000 – 2003 indicator variable with the hedge ratio shows a positive and statistically significant relation with firm value in all three specifications. This result implies that investors have valued hedging increasingly during recent years in which airlines have suffered from greater financial constraints.

Table X also shows hedging premiums during different jet fuel price conditions. By observing Figure 1, we categorize four different price regimes: 1) low prices and volatility from 1992-1996, 2) declining prices during 1997-1998, 3) increasing prices from 1999-2000, and 4) high prices and volatility during 2002-2003. In results that are consistent with those seen earlier, we observe premiums that appear to increase over time with the highest premiums occurring in the 2002-2003 period. Thus, the results may be consistent with investors putting a higher value on hedging during periods of high prices and volatility.

V. 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

[24]The stock price response of airlines to the September 11, 2001 attacks was quite varied as documented in Carter and Simkins (2004). We use their data to examine if hedging explains any of the variation of airline stock returns on September 17, 2001 (when the stock market reopened). In untabulated results, we find that the percentage hedged variable is positively related to abnormal returns, and exhibits stronger statistical significance than any of the variables included in their analysis..

Table X. Hedging Premiums over Time

This table shows the results from regressions of the natural logarithm of Q on the percentage of next year's fuel requirements hedged multiplied by a regime dummy variable (e.g., year, fuel pricing, etc.). The same set of control variables as shown in Table VI, Models 2 – 4 are utilized, but not reported. Statistical significance is denoted by *, **, and *** to represent 10%, 5%, and 1% significance, respectively.

	Coefficients on Percentage of Next Year's Fuel Requirements Hedged * Regime Dummy		
	Pooled OLS	Fixed Effects	FGLS
Panel A. Hedging Premiums by Year			
1994	-0.0267	0.5358	-0.2944
1995	-0.7683	0.0375	-0.8341
1996	0.5085	-0.4331	0.2993
1997	0.0871	0.0606	0.1846
1998	0.1112	0.0324	0.3073 *
1999	0.2491	0.1634	0.2517
2000	0.6318	0.4345	0.6061 **
2001	0.3374	0.1648	0.4282 *
2002	1.1909 **	1.0251 **	0.9362 ***
2003	0.5749 *	0.4561	0.4665 **
Panel B. Hedging Premiums by Credit Rating Regime			
1992 - 1994 (downgrades)	-0.1286	1.0056	0.0140
1995 - 1998 (upgrades)	0.0249	-0.0255	0.0765
2000 - 2003 (downgrades)	0.5919 *	0.5154 **	0.6541 ***
Panel C. Hedging Premiums by Fuel Price Regime			
1992 - 1996 (low prices & volatility)	-0.2902	0.3175	-0.1293
1997 - 1998 (declining prices)	0.0485	-0.0010	0.1346
1999 - 2000 (increasing prices)	0.2568	0.2307	0.1344
2002 - 2003 (high prices & volatility)	0.7717 **	0.6320 **	0.7134 ***

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, and suggests that the results of Jin and Jorion (2004) might be a consequence of their sample choice. 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 assets of distressed airlines at discounted prices. 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.

One caveat of our analysis is necessary. While we find that firm value is positively associated with the amount of hedging, we do not claim that airlines can magically increase value by increasing the amount of fuel hedged. If airlines optimally choose an appropriate hedge ratio based on the benefits achievable from hedging, then firm value should reflect this optimal hedging percentage. Rather, the hedging premium reflects that those firms with greater ability to take advantage of the benefits associated with hedging, such as enhanced ability to invest in economically profitable projects, have higher optimal valuations if their hedging policy is chosen optimally. For example, the Froot et al. (1993) framework implies that an airline possessing valuable investment opportunities if fuel prices increase should choose to hedge until it is ensured of enough cash flow to fund all of these investments. For another airline evaluating the same set of investment opportunities, if none are valuable then this airline has no incentive to hedge future jet fuel purchases.■

Appendix. Example Disclosures Illustrating Fuel Price Risk for Airlines

The 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 Do Not Hedge Future Jet Fuel Purchases

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 Hedges Future Jet Fuel Purchases

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 or Charter Arrangements

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: 1) under the terms of the Company's basic contracts, the customer is responsible for providing fuel, 2) under the terms of its full service contracts with the US Government, the Company is reimbursed for the cost of fuel it provides, and 3) 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.

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