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Aviation Fuel Hedging and Firm Value Analysis using Dynamic Panel Data Methodology: Evidence from the U.S. Major Passenger Airlines

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ABSTRACT

Purpose

Investigation of the relation between firms' values and aviation fuel hedging activities via a dynamic panel data methodology for the major U.S. passenger airlines during the period 2002-2011.

Design/methodology/approach:

We use data from nine U.S. major passenger airlines representing 77.2 per cent of the U.S. domestic airline industry, in terms of available seat miles. The data is taken from the Securities and Exchange Commission (SEC) 10-K filings, the Bloomberg database and the Bureau of Transportation Statistics. In accordance with the dynamic panel data methodology, we use cross-sectional dependence tests, first generation panel unit root tests, the Durbin-Hausman panel co-integration test, and the panel fully modified ordinary least square estimator, respectively.

Findings:

The Durbin-Hausman panel co-integration (DHP) test reveals a statistically significant long run relationship between firms' values and aviation fuel hedging activities for the U.S. major passenger airlines. Moreover, the results of the fully modified least square estimation suggest that aviation fuel hedging has positive impact on those firms' values. Additionally, we discuss the U.S. major passenger airlines loss of ten to fifteen per cent of their value in the global financial crisis. Another important finding is that merger agreements results in an almost 10 per cent increase in those firms' values..

Research limitations/implications:

– Clear hedging information was manually searched for in the airlines' annual audited reports. This process was both time consuming, and labour intensive.

Originality/value:

This is the first study that focuses exclusively on the major U.S. passenger airlines, for the effects of hedging strategies on firm value. Furthermore, we use the DHP test which allows for a co-integration relationship in the case of integrated of different order series.

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1. Introduction

According to the Federal Aviation Administration (2016), the civil aviation sector had an economic activity of \$1.6 trillion, contributed 5.1 per cent to gross domestic product, and more importantly, provided 10.6 million jobs in the U.S. economy during 2014. These figures clearly show that the civil aviation sector is an indispensable facilitator in the economies they belong to. However, they are exposed to unexpected ascent in operating costs, deriving from increasing aviation fuel prices.

As shown in Figure 1, the percentage contribution of fuel costs to operating expenses for the major U.S. passenger airlines increased until 2008. In 2008, aviation fuel cost constituted approximately one third of operating expenses. In the case of possible global oil price shocks in the future, aviation fuel cost is likely to be the primary cost factor, outstripping labour costs.

At this stage, we should investigate how to deal with unexpectedly rising aviation fuel costs. According to Morrell (2007), airlines could increase the fuel efficiency of their operations, and/or place additional cost such as surcharges on their customers, and/or hedge their fuel cost using physical or derivatives markets. Under safety constraints, there are some limitations to increasing fuel efficiency.

Besides being costly, it takes longer time. On the other hand, it is not easy for passenger airlines to implement surcharges. Airlines' financial managers strive for stabilizing fuel prices by using hedging strategies. Moreover, they can stabilize operating costs, cash flows and profits with the help of hedging instruments. These influential tools are expected to ultimately affect firms' values.

Modigliani and Miller (1958) propose that the firm's value is independent from hedging strategies under the perfect market hypothesis. However, firms do not

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encounter any financial frictions in their model as opposed to the real financial world. In case of relaxing the perfect market hypothesis, it is likely to observe considerable value effects of hedging strategies.

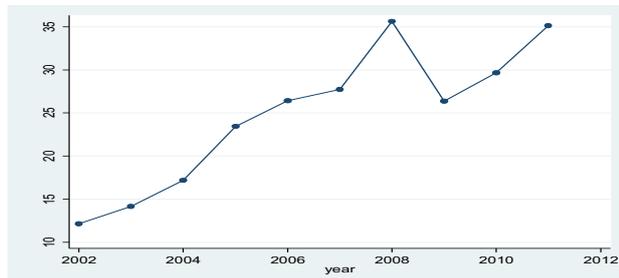


Figure 1¹: Percentage of aggregated² aviation fuel cost among operating expenses for the U.S. major passenger airlines

It is essential to analyze the relationship between firms' values and hedging activities for different time intervals and economic situations. In the past two decades, a number of researchers have studied the relation in several industries by using different econometric techniques. Nevertheless, their findings are either contradictory, or there is no general agreement about this relationship.

This issue was first investigated empirically by Allayannis and Weston (2001). In their seminal paper, they showed a positive relation between firm value and the use of foreign currency derivatives on U.S. nonfinancial firms over the period of 1990-1995. In a similar manner, Gomez-Gonzales et al. (2012) suggest that hedging lead to higher growth in Colombian nonfinancial firms' value in the period of 1995-2008. Likewise, Carter et al. (2006) point out the positive relationship between aviation fuel hedging and airline firms' values in the U.S. airline industry over the 1992-2003 period. In spite of the evidence of hedging premium, several studies reported hedging discount. Khediri and

Folus (2010) put forth that firms' values do not increase by using derivative instruments. In a similar fashion, Nguyen and Faff (2010) reveal hedging discount for Australian publicly listed companies over the period of 1999-2000. Recently, for the U.S. airline industry, Treanor et al. (2014) argue that airlines having more hedging activity due to higher fuel price exposure are not valued higher than those airlines following more stable hedging strategies.

Among such discussions in the related literature, we examine the relationship between firms' values and aviation fuel hedging activities by using dynamic panel data methodology, unlike the other studies in the literature, for the U.S. major passenger airlines during 2002-2011 period which includes the 2008 global financial crisis, following the large fluctuations in oil prices. To the best of our knowledge, this is the first study that focuses exclusively on the U.S. major passenger

airlines while investigating the effects of hedging strategies on firm value.

2. Sample and Variables

2.1 Sample

The Air Transport Association of America (ATA) classifies U.S. airlines into three categories based on their annual operating revenue. Major airlines are those generating annual operating revenue in excess of \$1 billion, while those with annual revenue between \$100 million and \$1 billion are categorized as national airlines. On the other hand, regional airlines provide both services to a specific geographic region of the country and generate annual operating revenues less than \$100 million. Further broad classification can also be made as passenger and cargo airlines. However, we focus on passenger airlines rather than cargo airlines, which can easily apply surcharges in the case of a sudden increase in fuel cost.

On the other hand, major airlines more commonly use hedging instruments compared to smaller airlines. That is because, implementing hedging strategies require more sophisticated finance department and experienced managers. This might be unaffordable for smaller airlines. In addition, some of the smaller airlines operate as a charter airline. They generally do not bear the risk of aviation fuel cost and passes on savings to their customers. Another reason why we investigate the effects of aviation fuel hedging on firm value exclusively, via the major passenger airlines, is the access to sufficient information regarding the hedging activities of those firms over the period of 2002-2011.

We use data from nine U.S. major passenger airlines; American Airlines, Alaska Airlines, JetBlue Airways, Continental Airlines, Delta Air Lines, Airtran Airways, United Air Lines, US Airways, and Southwest Airlines in the period of 2002 to 2011. They are listed as major passenger airlines in the 2011 IATA report. When market share of the U.S. major passenger airlines are calculated, it has been revealed that the sample represents 77.2 per cent of domestic industry in terms of ASM³ based on the data obtained from Bureau of Transportation Statistics.

The availability of clear and complete data on hedging information is essential for conducting such an empirical research. As discussed by Judge (2006), data extracted from audited financial statements does not have a non-response bias inherent in survey design. We used Securities and Exchange Commission (SEC) 10-K filings audited annual reports to obtain airlines' financial and operating data and hedging information as of 31st of December per annum. The market value of common stock is taken from the Bloomberg database.

2.2 Variables

¹ Unless otherwise is stated all the figures and tables are produced by the authors.

² Aggregated figures are obtained by calculating the weighted average of aviation fuel cost for each year. The weight is based on the total assets of airlines.

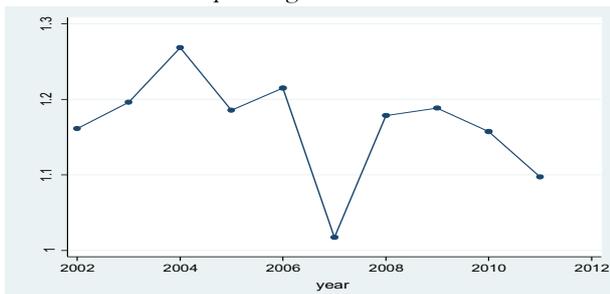
³ Available seat miles (ASM) represent one seat flown one mile. For instance, an airline with 200 passenger seats, flown distance of 1000 miles, indicates 200,000 available seat miles.

The dependent variable is firm value, which is measured according to Tobin's q. This is the most commonly used proxy for firm value in empirical studies. Firms' values are measured by the simple approximation of Tobin's q⁴, developed by Chung and Pruitt (1994).

Figure 2 shows that aggregated Tobin's q for the U.S major passenger airlines plumbs the depths in the year of 2007. However, the aggregated Tobin's q is higher than 1 during 2002-2011. This means the market value of the U.S. major passenger airlines exceeds the replacement costs of their assets even after the global financial crisis. We use the natural logarithm of Tobin's q [*LTOBINQ*] instead of the absolute value in econometric estimation.

The aim is to investigate the relation between aviation fuel hedging practices and the U.S. major passenger airlines firm values. Airlines disclose their hedging information in terms of the percentage of their aviation fuel requirements for the coming year. Therefore, we use the percentage of next year's aviation fuel requirements hedged [*NEXTHEDGED*] as a measure of fuel hedging activities. The coefficient of this variable shows that if an airline hedged 100 per cent of its fuel requirements, at what percentage its firm value would be expected to change compared to that airline's hedging none of its fuel requirements.

Figure 2: Aggregated⁵ Tobin's q for the U.S. major passenger airlines



There are a number of factors that can affect firm value in addition to aviation fuel hedging. That is why we include several control variables consistent with Allayannis and Weston (2001) and Carter et al. (2006). First, as underlined by Allayannis and Weston (2001), larger firms are more likely to use hedging instruments due to the high start-up cost of the hedging program.

Therefore, we need to take into consideration the possible effect of firm size. Hence, the natural logarithm of total assets is used to control firm size [*LTA*]. Second, firm's value might be affected by its capital structure. Accordingly, we control for leverage [*LEVERAGE*] by using the ratio of long term debt to total assets. Third, a profitable firm is more likely rewarded by investors. To

3.2 Panel Unit Root Tests

We examine time series specifications of the variables under investigation before carrying out panel regressions. As discussed by O'Connell (1998), the null hypothesis of a unit root can be rejected in the presence of cross-section

account for the effect of profitability, we use the return on assets [*ROA*] which is the ratio of net income to total assets. Fourth, the more investment opportunities firms have, the more likely they are to have higher firms' values.

Hence, we include the natural logarithm of the ratio of capital expenditures to sales [*LINVOPP*] as a proxy for investment opportunities. Fifth, firms' values are expected to be higher following merger agreements. Therefore, we use a merger dummy [*MD*] that is equal to 1 on and after the date of merger agreement to control for effects of merger agreements. A positive (negative) coefficient on *MD* suggests that merger agreement leads to an increase (a decrease) in firm value. Finally, we use a crisis dummy [*CD*] for the year of 2007 to take into account possible detrimental effects of global financial crisis.

3. Empirical Methods and Results

3.1 Estimation of Panel Data Models

The model under investigation is as follows:

$$y_{it} = \alpha + X'_{it}\beta + u_{it} \quad (1)$$

$$u_{it} = \mu_i + \vartheta_{it} \quad (2)$$

with *i* denoting airlines and *t* denoting years. α is a scalar and β is a $K \times 1$ vector and X_{it} is the *i*th observation on *K* explanatory variables. The term μ_i is the unobserved individual specific effect or individual heterogeneity for the *i*th airline. The ϑ_{it} is the remainder stochastic disturbance term. We define y_{it} and X_{it} as follows:

$$y_{it} = [LTOBINQ_{it}] \quad (3)$$

$$X_{it} = \begin{bmatrix} NEXTHEDGED_{it} \\ LTA_{it} \\ LEVERAGE_{it} \\ ROA_{it} \\ LINVOPP_{it} \\ CD_{it} \\ MD_{it} \end{bmatrix} \quad (4)$$

As stated by Baltagi (2008), the fixed effects model is a suitable specification when we concentrate on a specific set of *N* firms and our inference is limited to the behaviour of these set of firms. Since we focus exclusively on the major U.S. passenger airlines, we follow the fixed effect specification.

correlations among series. Correspondingly, we test for the presence of cross-sectional dependence in panels prior to panel unit root tests. We use the Pesaran's CD test (2004), Friedman's test (1937) and Frees' test (2004) to test the cross-sectional dependence. The results of the tests are given in Table 1. On the report of all tests, we

⁴The Tobin's q ratio is calculated as follows: (market value of equity + liquidation value of preferred stock + book values of long-term debt and current liabilities + book value of inventory - current assets) divided by book value of total assets.

⁵Aggregated figures are obtained by calculating the weighted average of Tobin's q for each year. The weight is based on the total assets of airlines.

cannot reject the null hypothesis of no cross-sectional dependence. Therefore, we can use first generation panel unit root tests which do not allow for cross-section

correlations, instead of second generation panel unit root tests¹.

Table 1: Fixed effects regression results

NEXTHEDGED	0.0017**	0.0017**	
LTA	-0.2119***	-0.2126***	0.2140***
LEVERAGE	0.8819***	0.8772***	0.8537***
LINVOPP	0.0534**	0.0539**	0.0664***
ROA	-0.0118		0.006
F test	18.84***	23.85***	21.79***
Pesaran	1.187	1.196	1.216
Frees	0.096	0.096	0.281
Friedman	13.156	13.156	11.615
DHP	32.821***	25.627***	2.322**

Note: *, ** and *** indicate that statistics are significance at the 10, 5, and 1 per cent level of significance respectively.

We use the LLC test (Levin, Lin and Chu, 2002), MW test (Maddala and Wu, 1999), IPS test (Im, Pesaran and Shin, 2003), Fisher type tests (Maddala and Wu, 1999; Choi, 2001) in order to test unit root in panel data. The test result is illustrated in Table 2¹ and Table 3. They show contradictory results. Hence, the results of the panel unit root tests give the impression of being integrated of different order series.

To investigate whether the series are cointegrated or not, we use Durbin-Hausman Panel (DHP) test² (Westerlund, 2008) which allows for a cointegration relationship in the case of integrated of different order series. Furthermore, this test takes account of possible cross-sectional correlations in the residuals. The DHP test results are shown at the bottom of Table 1.

According to DHP test results, we reject the null hypothesis of no cointegration in all cases. Therefore, the DHP indicates for all model specifications that the models are panel cointegrated at one per cent significance level.

That is to say, there exists a statistically significant long run relationship between firm values and explanatory variables in the U.S. major passenger airlines. Hence, we use the panel fully modified ordinary least square (panel FMOLS) estimator proposed by (Pedroni, 2000) to estimate cointegrating regressions for all specifications. The panel FMOLS is a consistent estimator in relatively small samples. Furthermore, it controls for the possible endogeneity and serial correlation.

Table 2: Panel unit root tests results (series in level)

	LLC intercept	LLC intercept + trend	MW intercept	MW intercept + trend	IPS intercept
LTOBINQ	-1.672**	-5.089***	17.048	28.015*	0.377
NEXTHEDGED	-2.968***	-5.758***	26.46*	29.826**	-1.011
LTA	-9.569***	-3.056***	91.915***	15.283	-2.861***
LEVERAGE	-1.514*	-4.297***	12.041	27.388*	0.486
ROA	-7.3***	-8.228***	63.688***	49.851***	-3.496***
LINVOPP	-2.587***	-6.276***	26.426*	44.388***	-0.963

Note: For all test the null hypothesis is non-stationary. The LLC test assumes common unit root process and the others assume individual unit root process. *, ** and *** indicate that statistics are significance at the 10, 5, and 1 per cent level of significance respectively.

Table 3: Panel unit root tests results (Continued) (series in level)

	IPS intercept + trend	Fisher ADF intercept	Fisher ADF intercept + trend	Fisher PP intercept	Fisher PP intercept + trend
LTOBINQ	-0.619	15.241	23.711	17.254	36.75***
NEXTHEDGED	-0.729	24.158	25.02	28.155	40.964***
LTA	0.437	42.377***	13.387	59.382***	25.139
LEVERAGE	-0.144	12.705	19.441	11.585	24.216
ROA	-1.386*	45.00***	34.471***	61.99***	65.565***
LINVOPP	-0.566	23.756	27.477*	29.618	48.462***

Note: For all test the null hypothesis is non-stationary. The LLC test assumes common unit root process and the others assume individual unit root process. *, ** and *** indicate that statistics are significance at the 10, 5, and 1 per cent level of significance respectively.

3.3 Empirical Findings

¹See for instance, Pesaran (2007), Hadri and Kurozumi (2012) and Pesaran, Smith and Yamagata (2013).

²Besides these panel unit root test, Breitung test (Breitung, 2000) and Hadri test (Hadri, 2000) were carried out as well. The results

confirm Table 2 and Table 3. Therefore, we do not report the results to save space.

²We use GAUSS codes written by Joakim Westerlund from Department of Economics at Lund University.

We estimate eight different model specifications and present the results of panel fully modified least square estimation in Table 4 and Table 5. There is a positive long run relationship between firms' values and aviation fuel

hedging for the U.S. major passenger airlines. The coefficient on *NEXTHEDGED* becomes statistically significant at five per cent, when the *MD* is excluded from the model.

Table 4: Panel fully modified least squares results

	Model 1	Model 2	Model 3	Model 4
LTA	-0.2148***	-0.1886***	-0.3195***	-0.2783**
LEVERAGE	0.9663***	0.9793***	0.8012***	0.842***
LINVOPP	0.0677**	0.086**	0.1225**	0.1452***
ROA	0.0074	0.029	0.0258	0.0458
NEXTHEDGED	0.0025**	0.0023**	0.002	0.001
CD		-0.1185**		-0.1483*
MD			0.1213*	0.097
Adj. R-sq.	0.7695	0.7894	0.7469	0.778

Note: *, ** and *** indicate that statistics are significance at the 10, 5, and 1 per cent level of significance respectively.

One of the important findings is that the coefficient on *CD* is both economically and statistically significant. We discuss how the global financial crisis has a detrimental impact on firm value; in the crisis of 2007, the U.S. major passenger airlines lose out almost ten to fifteen per cent of their firm value. The parameter *MD* is positive and economically significant for all cases; however, it becomes statistically significant in the absence of the *CD*. After

merger agreement, the value of the merging firm increases almost 10 per cent for the U.S. major passenger airlines. All of other control variables except for *ROA* are statistically significant in all model specifications. The *LEVERAGE* and *LINVOPP* have positive long run effects on the firm value. However, the *LTA* has negative long run impact on the firm value.

Table 5: Panel fully modified least squares results (Continued)

	Model 5	Model 6	Model 7	Model 8
LTA	-0.2145***	-0.1894***	-0.313***	-0.273**
LEVERAGE	0.971492***	0.9913***	0.8169***	0.8638***
LINVOPP	0.0677**	0.085***	0.1203**	0.1421**
NEXTHEDGED	0.0026**	0.0023**	0.0021	0.002
CD		-0.1164**		-0.1459*
MD			0.1183*	0.0947
Adj. R-sq.	0.773	0.7926	0.7529	0.7824

Note: *, ** and *** indicate that statistics are significance at the 10, 5, and 1 per cent level of significance respectively.

4. Conclusion

We use dynamic panel data methodology to investigate the relationship between firms' values and aviation fuel hedging activities for the period of 2002 to 2011 which exhibits large fluctuations in oil prices. We reveal a positive long run impact of aviation fuel hedging on firms' values for the U.S. major passenger airlines. For this reason, airlines should use hedging strategies to stabilize their aviation fuel cost in addition to other managerial

tools. In the year of the global financial crisis, the major U.S. passenger airlines lose approximately ten to fifteen per cent of their firm values.

However, market value of the U.S. major passenger airlines exceeds the replacement costs of their assets even after the global financial crisis. Besides, merger agreements lead to approximately ten per cent increase in firms' values. This study can be extended to multi-country sample. However, obtaining and analysing hedging information remains to be laborious.

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