Hedging Gone Wild: Was Delta Air Lines' Purchase Of Trainer Refinery A Sound Risk Management Strategy?

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JEL Classification: G32, G31, L1
Keywords: Financial risk and risk management; Capital budgeting; Industrial organization-Market structure

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1. Introduction

Why would an airline ever choose to purchase and operate a petroleum refinery? Even though jet fuel is an airline's largest single cost, modern economic and management thought stresses that corporations should focus on their core business activities and purchase key inputs from efficient specialist suppliers. Since 2012, Delta Air Lines has conducted a real-world test of the benefits of vertically integrating to lock in supplies of jet fuel as part of the firm's risk management strategy [Anderson (2014), Hecht (2015); Helman (2015), and Dastin (2016)]. This study assesses whether that strategy has been successful through the lens of the corporate risk management and vertical integration literatures.

On April 30, 2012, Delta Air Lines announced that its Monroe Energy subsidiary had entered an agreement with Phillips 66 to acquire the Trainer oil refinery and related facilities in eastern Pennsylvania for $180 million (Lemer, 2012). Delta paid $150 million itself and the Commonwealth of Pennsylvania contributed the other $30 million. Before the acquisition, this refinery had been unprofitable for several years. Due to its dependence on expensive imported light crude oil and its inability to consistently meet tightening environmental and product standards, coupled with other severe problems plaguing all East Coast US refineries, Phillips 66 had shut the plant down in September 2011 (McCurty, 2012).

At the time the deal was announced, Delta argued that it was not so much trying to hedge its exposure to jet fuel prices, *per se*, but rather to refining profit margins, specifically the crack spread measuring the differentially higher valuations for jet fuel over the raw crude oil from which the fuel is processed. More comprehensively, Delta's press releases state that it chose to purchase the refinery because of (1) widely fluctuating oil prices and the non-availability of a jet fuel hedging instrument; (2) Delta's poor financial hedging performance before 2012; (3) the company's desire to capture the refining crack spread, which had been rising steadily after oil prices rebounded from their early 2009 lows and at times reached $17 per barrel and; and (4) Delta's need to secure jet fuel supplies for its New York City hubs–from which the company flew 68,000 flights every year–at a time when several East Coast refineries were being mothballed. An important factor not emphasized by Delta's public disclosures was the refinery's value. Delta spent roughly the cost of a single wide-bodied aircraft to acquire the 185,000 barrel per day (b/d) facility. Because macroeconomic conditions drove several major East Coast refiners to financial distress (U.S. Department of Energy, 2012), their assets commanded fire sale prices in 2012. For comparison, a New Jersey refinery with Trainer's same production capacity fetched nearly twice as much in 2015 (Larino, 2015) while a 264,000 b/d Houston plant drew bids of $1.2 to $1.5 billion the following year (Resnick-Ault and Seba, 2016). For $100 million above Trainer's sticker price, Par Pacific Holdings, Inc. acquired a regional Wyoming refinery with *only 10 percent of Trainer's capacity* (Brelsford, 2015). Clearly, Trainer's price made the asset a significant bargain.

Market reaction to the deal was dichotomous. Most industry analysts and academic commentators derided it on industrial organizational grounds (why should an airline be able to competently run a refinery?). However, other analysts and stock investors applauded the announcement, and the stock price rose by 3.5% on April 12, 2012, the day the rumor was announced (Massoudi, 2012), and by over 5% around the official purchase announcement date of April 30, 2012 (Lemer, 2012). Although it was little noticed at the time, the purchase announcement also caused a sharp drop in Delta's perceived credit risk, proxied by CDS spreads on its outstanding bonds. Nor did uncertainty about the wisdom of the acquisition vanish in the years immediately following Delta's Trainer purchase, as discussed approvingly by Wright (2013), Hecht (2015), and Levine-Weinberg (2015b), but with opprobrium by Zhang (2014), Helman (2015), and Dastin (2016).

The results of our empirical analyses confirm and extend those in Massoudi (2012) and Lemer (2012). We find that Delta's stock price experienced a positive cumulative abnormal return of around 5% in the three days centered on the acquisition announcement. Also, we find a mean abnormal return of 74 basis points for bond trades within the ten days centered on the announcement date. A brief analysis of CDS trades also indicates that the CDS market anticipated the deal would reduce risk. Indeed, our analysis validates market participants' initial optimism. We find evidence through panel regressions that Delta's exposure to the crack spread declined in the post-acquisition period (through year-end 2016), though none of its competitors shared this benefit. Moreover, credit spreads in the loan and bond markets declined more for Delta than its competitors in the post-acquisition period. Though the positive stock market returns could stem from the highly favorable terms on which Delta acquired the refinery, the rest of our analysis supports a longer-term, asset pricing story. Specifically, bondholders and CDS holders benefited--in the form of higher bond returns, reduced bond and loan spreads, and lower equity exposure to crack spread--from anticipated and realized risk-reduction from Delta operating the refinery. We believe the stock market results are best interpreted as evidence of stockholders' correct anticipation of this risk-reduction.

This paper proceeds as follows. Section 2 summarizes the relevant literature on hedging and risk management and vertical integration. Section 3 describes the context that led to the acquisition.

In section 4, we discuss why Delta, and not another airline, acquired the refinery. The empirical analysis starts in section 5, where we perform event studies of the stock and bond market reaction. We study the channels through which Trainer could add value to Delta in section 6. Section 7 concludes.

2. Related Literature

Two principal streams of literature inform our analysis, the literature on hedging and risk management and the literature on vertical integration (VI). Both literatures try to explain the existence of hedging and VI and both depart from the notion of perfect markets--perfect capital markets, in the case of hedging, and perfect product markets in the case of VI. Below, we briefly discuss the main predictions of these two literatures.

2.1. Predictions of the hedging and risk management literatures

Commodity markets have been the subject of many empirical studies on the value of hedging and the characteristics of hedgers. These studies are motivated by the theoretical work on determinants of risk management value. In general, theories assert that hedging can add value by reducing the likelihood of costly financial distress (Smith and Stulz, 1985); reducing the need for costly external financing (Froot, Scharfstein, and Stein, 1993); reducing agency costs among managers, debt holders and equity holders (Geczy, Minton and Schrand, 1997); and benefiting from convexity in the cost structure (see Aretz and Bartram (2010) for an extensive review of these theories and the empirical support each receives).

Empirical studies of the value of hedging commodity risk are mixed. Jin and Jorion (2006) study 119 oil and gas companies and find that hedging reduces exposure to oil and gas price risk, but does not affect market values. Nelson, Moffitt, and Affleck-Graves (2005) find no long run abnormal returns in commodity hedging firms. On the other hand, MacKay and Moeller (2007) find that hedging concave revenues and convex costs is value enhancing; they show that a sample of 34 oil refiners could have increased their market values between 2% and 3% through hedging. Gilje and Taillard (2016) study Canadian oil companies that experience a reduction in hedging effectiveness. They find that highly leveraged Canadian hedgers reduce investment, sell assets, and have lower valuations, consistent with theories predicting that hedging affects firm value by alleviating financial distress costs and underinvestment.

The airline industry, specifically, has been the focus of many hedging studies. Carter, Rogers, and Simkins (2006) estimate a 5% hedging premium in U.S. airlines. They conclude that this premium is in line with the Froot et al. (1993) prediction that airlines hedge to offset the underinvestment problem potentially faced when fuel prices rise. With higher fuel prices, un-hedged firms will not be able to take positive NPV projects and thus will lose potential value. Lin and Chang (2009), however, fail to corroborate these results for airlines around the world. Rampini, Sufi, and Visnwanathan (2014) show that, contrary to what existing theories predict, airlines in distress hedge less; those with higher net worth, cash flow, or credit ratings hedge more; and hedging drops sharply as airlines approach distress and recovers thereafter. Explaining this behavior, they show that collateral requirements in both hedging and financing result in a trade-off between the two that only firms with high net worth can accommodate. Treanor et al. (2014) link time-varying airline exposure to fuel cost with hedging behavior and firm value. They find that firms hedge more when they experience greater exposure to fuel prices. Although they find a hedging premium, as do Carter, Rogers, and Simkins (2006), they find evidence that the hedging premium does not increase with airline exposure to fuel prices, indicating that investors do not value selective hedging (Adam and Fernando (2006) also discuss selective hedging and firm value).

More recently, the literature has focused on the distinction between operational and financial hedging. Guay and Kothari (2003) raise serious doubts about estimated value effects from derivatives hedging. They argue common estimates of hedging premia in capital markets are grossly disproportionate to observed levels of hedging activity. Instead, they suggest that derivatives hedging may correlate with operational hedging, with the latter commanding a premium. Kim, Mathur, and Nam (2006) show how operational and financial hedging can be substitutes for one another while Lim and Wang (2007) argue that they are complementary. Treanor et al. (2014) adopt this framework in the context of U.S. airlines. They show that airlines rely on both types of hedging, but operational hedging likely has a bigger impact on performance and firm value. They conclude that derivatives hedging may be used more as a means of 'fine-tuning' an airline's exposure.

2.2. Predictions of the vertical integration literature

Many articles have examined the costs and benefits of vertical integration (VI) in the context of acquiring a key supplier, both theoretically and with empirical analyses [see Perry (1989), Lafontaine and Slade (2007), and Kedia, Ravid, and Pons (2011) for reviews]. The industrial organization (IO) literature asserts that in the presence of imperfect competition, firms can generate value through VI by rationing, shutting out competitors, eliminating externalities, obtaining exclusive contracts, and price discriminating. Such factors thoroughly characterize the airline industry. Because substantial outlays for capital and technology are required to efficiently operate an airline, barriers to entry are extremely high (Shepherd, 1984). The result is an airline industry which, in the United States, can be considered an oligopoly (Berry, 1990), and in many other countries a near-monopoly. Further, the various classes of airline customers (Business, First, Economy, etc.) represent an ideal setting for price discrimination (Stavins, 2001).

A large body of empirical research supports the notion, pioneered by Williamson (1971), that specificity of assets to be acquired is an important determinant of VI. When firms need to invest in specialized assets but the market exchange of these assets is costly, VI can align incentives of the parties involved and lead to efficient investment. Clearly, this is the case for airlines as most new commercial airplanes cost over $100 million. Other studies focus on incomplete contracts and the incentives they create. If contracts are hard to specify, enforce, and monitor on the outside and it is cheaper to do so within the firm, VI can increase contract efficiency (Kedia, Ravid, and Pons, 2011; Lafontaine and Slade, 2007).

Several studies specifically examine the interaction between financial hedging and VI. Haushalter (2000) asserts that VI is a substitute for financial hedging. Hankins (2011) corroborates this result, empirically, by showing that large increases in operational hedging (e.g., acquisitions) are followed by large declines in financial hedging among bank holding companies. Similarly, Mackay and Moeller (2007) write "firms that are both vertically integrated and diversified have lower risk management values and hedge rates, consistent with the idea that such firms benefit from natural hedges." Turning to Delta's refinery purchase, we expect the acquisition to have a stabilizing effect on the airline's fuel costs net of refining profits. If jet fuel prices increase, higher airline operating costs will be partially offset by higher refinery profits. This is true because refining margins tend to move with crude oil prices, as Figure 1 shows. Through this mechanism, we expect the refinery to reduce Delta's cash flow volatility. To the extent that investors value reduced cash flow volatility, hedging, in this case through the refinery acquisition, can potentially increase firm value (Froot et al., 1993). This notion is also consistent with Garfinkel and Hankins' (2011) finding that reducing cash flow volatility is a motive for VI.

****** Insert Figure 1 about here ******

More broadly, many scholars have studied the impact of uncertainty on the motive to engage in VI. Levy (1985) finds that unanticipated shifts in product demand positively predict the likelihood to vertically integrate. Helfat and Teece (1987) study how VI can reduce uncertainty. They distinguish state contingent uncertainty, such as uncertainty in prices, from uncertainty resulting from lack of information. VI can reduce the latter. Carlton (1979) suggests that producing inputs internally can help a firm facing price uncertainty by allowing it to produce cheaply. He shows that firms are likely to integrate backward when they encounter substantial variability in the input market and the input market is uncorrelated with fluctuation in their own downstream market. Though general economic conditions affect both oil production and customer demand for air travel, an airline's upstream and downstream markets are far from perfectly correlated. For example, the sharp oil price decline over the latter half of 2014 appears entirely unrelated to factors affecting travel demand. Finally, Hirshleifer (1988) argues that risks for crop growers and processers are complementary. As such, forward contracting or vertical integration can benefit both parties. A natural analogy extends to refiners and airlines. Because the market for jet fuel derivatives is very thin, vertical integration may offer these two industries a better operational hedge. Fan (2000) studies VI among petrochemical firms and links it with input cost uncertainty through detailed industry-specific analysis. He finds strong evidence from the 1970s that input price uncertainty and asset specificity jointly affect VI in the industry. Oil shocks in the 1970's caused contracting problems in the petrochemical industry, and several organizations responded by vertically integrating.

Indeed, input cost uncertainty was arguably the chief driver of Delta's Trainer purchase. With mounting U.S. East Coast refinery closures threatening to cripple Delta's ability to procure reasonably priced jet fuel, the growing pains of learning how to operate the refinery seemed more than bearable compared to the costs associated with probable fuel shortages. In fact, then-Delta CEO Richard Anderson justified the move through input cost savings: "If the refinery closed or was consolidated, our fuel price would rise 10%-15%. If we bought it, we could begin to lower our fuel costs" (Anderson, 2014). Fan and Goyal (2006) find that, on average, vertical mergers are associated with significant positive wealth effects. The average wealth effect during the three-day window around the announcement is 2.5% in this study. On the other hand, Kedia, Ravid, and Pons (2011) find no effect on the value generated from VI in the face of market uncertainty. Garfinkel and Hankins (2011) find that risk management is indeed one of the motives behind VI. They show that VI reduces cash flow volatility and cost of goods sold. They also find changes in slack cash (used to protect against the effect of variability in internal funding) is negatively related to VI, consistent with VI providing an additional hedge.

Perhaps the most similar studies to ours are Forbes and Lederman (2009 and 2010). These authors investigate vertical integration between major and regional carriers in the airline industry. The earlier paper finds that major airlines choose to vertically integrate on routes frequently subject to inclement weather and those more integral to the airline's overall flight network. The latter paper validates this strategy's effectiveness in promoting continued operation of the airline's network. In other words, airlines vertically integrate when there is a higher risk of weather delays and when a disruption would severely impact operations.

Thus, vertical integration as a means of risk management in the airline industry is not a novel concept. However, Delta's radical acquisition represents the first attempt at taking on a different, arguably more important risk: fuel price volatility.

3. The Context Leading to Delta's Acquisition of Trainer

The U.S. airline industry was deregulated in 1978. From deregulation until recently, the airline industry has suffered consistent losses (Carter, Rogers, and Simkins, 2006), which has puzzled industrial organization economists. As shown by Borenstein (2011), this dismal financial record is not what economists predicted in 1978 and it is a challenge to the views of deregulation advocates. He shows that there is no conventional long-run equilibrium explanation for an industry that perpetually loses money, but he does offer some explanations based on taxes, cost shocks, demand shocks, and/or a series of unfavorable events.

Another significant partial explanation for this enduring lack of airline industry profitability is the nearly monotonic increase in the cost of jet fuel that has occurred since 1978. Fuel price increases over the past 15 years, in particular, coincide with reduced profits and, in many cases, operating losses among carriers. As shown in Table 1, intense competition has driven airfare upward, but at a much slower pace than the upward trend in oil prices (see Figure 1 for the evolution of crude oil and jet fuel prices). These trends put great pressure on the airline industry. From 1995 to 2003, fuel costs an average of $0.66 per gallon. In 2012-2014, one gallon of jet fuel costs around $3. The rise in the cost of fuel between 2000 and 2012 resulted in fuel becoming aviation's first or second largest operating expenses, depending upon the year. From 1995 to 2003, fuel represented about 15% of operating costs; during 2012-2014, it was 30%. This incentivized airlines to save on the fuel cost bill wherever possible, resulting in airline productivity–most commonly measured as the number of available seat miles (ASMs) per gallon of fuel consumed (ASM/g)–rising 14.5% from 2000 to 2010, from 55.4 to 64.8 ASM/g (Firestine and Guarino, 2012).

****** Insert Table 1 about here ******

In this context, Delta Air Lines surprised the market with its move to acquire Trainer refinery in order to curtail the cost and ensure the supply of jet fuel. Delta acquired Trainer through its subsidiary, Monroe Energy LLC, which operates the refinery with its own management team and board. A timeline of the events leading up to Delta's purchase and subsequent developments is presented in Table 2. The deal bought Delta a refinery with a 180,000 barrel (7,560,000 gallon) per day capacity and pipelines and terminal assets that allow it to supply jet fuel throughout the Northeastern United States, especially to LaGuardia and JFK airports. Trainer itself represents 13% of the US East Coast jet fuel supply. Trainer was idled and put up for sale in September 2011, among other refineries representing 50% of East Coast capacity. According to an EIA report in 2012 (U.S. Department of Energy, 2012), most of these closures were attributed to the inability to process heavy sour crude, which trades at much lower prices than the benchmark Brent.

****** Insert Table 2 about here ******

An important component of the Delta move was the ability to swap non-jet fuel refinery outputs, like diesel and gasoline, for jet fuel (kerosene) sourced from elsewhere in the United States. Delta initially entered two swap agreements: one with Phillips 66 and the other with British Petroleum (BP), described in Figure 3. The agreement with Phillips 66 required Delta to deliver specified quantities of non-jet fuel products in exchange for specified amounts of jet fuel. If Delta or Phillips 66 did not have the specified quantities, the delivering party was required to procure any shortage from the open market. The remaining production of non-jet fuel products was to be sold to BP under a long-term buy/sell agreement to exchange non-jet fuel products for jet fuel. Figure 2 shows how much jet fuel Trainer provides to Delta from production and from swap agreements. In the announcement disclosing the intended acquisition, Delta mentioned that it expected to save $300 million annually in fuel expenses by sourcing jet fuel from Trainer.

****** Insert Figures 2 and 3 about here ******

In July 2014, the BP swap agreement was terminated early and BP was replaced with another, unnamed, counterparty. Shortly thereafter, Monroe announced that Bridger LLC, a privately held midstream company, would supply 65,000 bpd of North Dakota Bakken crude to its refinery, helping it reduce its reliance on costlier imports.

Delta reports the gain/loss from its financial hedging program as well as the gain/loss from its refinery segment in its quarterly SEC filings. Considering the Trainer acquisition as an operational hedge, this provides an explicit measure of the gains/losses from both financial and operational hedging, unlike existing studies of operational hedging (Fan, 2000; Hankins, 2011), which had to derive conclusions from indirect tests. Table 3 shows Delta's gains/losses from hedging and from refinery operations as well as the cumulative gain/loss since 4Q2012. This table clearly shows that Delta's derivatives hedging program continued mostly large and highly variable losses over the next three years, whereas refinery operations show a cumulative gain and were far less volatile.

****** Insert Table 3 about here ******

To understand the full impact Trainer can have on Delta's exposure to input costs, we must also consider traditional hedging instruments (financial hedges) that Delta employs, since incorporating the refinery's output has likely affected the company's use of other financial instruments. Because derivatives contracts on kerosene are not directly traded on commodity exchanges and the over-the-counter market is nearly illiquid with high illiquidity premia, airlines tend to hedge fuel price exposure with related crude oil and heating oil (a heavy diesel cut) contracts (Adams and Gerner, 2012) which introduces substantial basis risk (Adam-Muller and Nolte, 2011). Airlines employ futures, options, forward purchase agreements, collars and swaps, among other strategies, to reduce exposure to fuel price fluctuations. Towards that end, we hand-collect hedging data from quarterly SEC filings for Delta and other publicly traded U.S. airlines. Our primary measure of hedging intensity is the hedge ratio for the following quarter, which estimates the amount of next quarter's fuel consumption hedged by derivative contracts. Table 4 shows that the dramatic ramp up in the extent of hedging by Delta is abnormal relative to its competitors. Appendix 1 details how these hedge ratio computations are made.

****** Insert Table 4 about here ******

In contrast with the findings of Haushalter (2000) and Hankins (2011), who assert that financial hedging and vertical integration are substitutes, Delta initially increased both the extent and the duration of hedging after the acquisition as shown in Table 4. Figure 4 summarizes quarterly reports of the notional balance of barrels that underlie Delta's derivatives contracts along with the latest maturity of these contracts. The airline appears to have ramped up hedging toward the end of 2013 and reduced it by 2015 after losing $1.2 billion from plummeting crude oil prices in 2014. Delta does not disclose the breakdown of commodity types underlying these contracts though reason suggests that, post-acquisition, the company would hedge the crack spread less and crude oil more. Trainer, an operational hedge against the crack spread, allows Delta to reduce its financial hedging against the crack spread and, increasing its capacity to hedge crude. Increased derivatives hedging may also stem from speculation or more expertise acquired through refinery operation. Unfortunately, SEC filings and earnings call transcripts provide insufficient information to understand Delta's motivations for this puzzling increase in derivatives hedging.

****** Insert Figure 4 about here ******

4. Why Delta?

An external and an internal factor could explain why Delta, and not another airline, acquired a refinery. The internal factor is an innovative management culture. The Trainer refinery acquisition was not Delta's only innovative move, as noted by its CEO Richard Anderson in 2014:

"We started, just after our two-year restructuring, with an employee profit-sharing program that continues to differentiate us from our peers. Each year, 10% of earnings before taxes and management compensation is paid out in bonuses. A year after our 2008 merger with Northwest Airlines, we added a stock ownership plan also unique in the industry that gave our pilots, flight attendants, ground crew members, and support staff 15% of the company's equity. We have reclaimed our reservations system, becoming the only U.S. airline to own and control this key operations data. We have deepened our foreign partnerships by buying a minority stake in three overseas carriers--Aeromexico, Brazil's GOL, and the UK's Virgin Atlantic--and strengthened our existing alliance with Air France-KLM. We have also moved toward vertical integration (and better management of fuel costs) by acquiring an oil refinery, a decision that shocked both aviation and oil industry observers."

The external factor is related to the specificity of Trainer to Delta. According to the VI literature, asset specificity is a major reason why companies vertically integrate, especially to confront uncertainty. Trainer could be a very important source of jet fuel for New York-based flights as its output represents 13% of total East Coast refining capacity. Moreover, the acquisition includes pipelines and terminal assets, allowing Trainer to supply jet fuel to LaGuardia and JFK. The New York market is an important part of Delta's network strategy. Delta considers LaGuardia to be a new domestic hub, and has increased capacity at LaGuardia by 42% since March 2012, adding 100 new flights and a total of 26 new destinations. According to the Bureau of Transportation Statistics (BTS), Delta's share of passengers in the New York market is 22.8%, while JetBlue and American come next with 21.9% and 16%, respectively. Also in 2012, the company invested more than $160 million in a renovation and expansion project at LaGuardia to enhance the customer experience. In 2010, Delta started a five-year $1.2 billion renovation project at JFK to turn it into an international hub in the New York City area (Delta's 2012 Financial Report).

5. Empirical Analysis of Delta's Acquisition of Trainer Refinery

To empirically separate the causal impact of the refinery from potentially coincidental operating environments we attempt to contrast Delta with its peers throughout our empirical analysis. Thus, we must first determine the appropriate peers to use within the U.S. airline industry. According to the United States Department of Transportation, there are more than 50 passenger airlines, most of which are small regional carriers. Given that Delta is a major public passenger airline, we restrict our sample to large public carriers designated as a "major carrier" by the U.S. Department of

Transportation as of the end of 2012 (the first quarter after the acquisition). The following airlines meet these criteria: AirTran (AAI), Alaska (ALK), Allegiant (ALGT), American (AMR before its merger with US Airways, AAL after), Frontier (FRNT), Hawaiian (HA), JetBlue (JBLU), SkyWest (SKYW), Southwest (LUV), Spirit (SAVE), United (UAL), US Airways (LCC), and Virgin (VA). We restrict our analysis to the sample from 2009 through the second quarter of 2016. Beginning in 2009 allows enough time to gauge airlines' performance before the acquisition, yet avoids the worst of the recent financial crisis. Table 5 summarizes these airlines' capacity in terms of available seat miles, market share at the end of 2012, and their market state during the sample period.

****** Insert Table 5 about here ******

5.1. Event studies

In this section, we use event study methods to study the reaction of equity and bond markets to the refinery acquisition announcement. We begin with a stock market event study to assess the acquisition's anticipated impact on Delta's shareholders. We cross-validate these results through a relatively new econometric technique, the synthetic control method (pioneered by Abadie and Gardeazabal, 2003) which constructs a hypothetical Delta Air Lines using a linear combination of its competitors' stock returns. Examining the difference between Delta's stock returns and the predicted returns of synthetic Delta presents another estimate of the acquisition's value. Next, we conduct a bond market event study to gauge the acquisition's effect on Delta's creditors. We validate bond market results by examining another proxy for Delta's credit risk, its CDS spread.

5.1.1. Equity market

We test whether the refinery acquisition affects investor welfare through the event study framework described by Campbell, Lo, and MacKinlay (1997). Our event date, April 30, 2012, is the day Delta publicly announced it would acquire the refinery. If investors favored the deal, Delta's stock price should exhibit significantly positive abnormal returns around the announcement date. Insignificant returns are consistent with investor indifference toward the acquisition, while negative returns would suggest anticipated value destruction from the purchase. Importantly, while acquisition rumors circulated prior to the official announcement, any information impounded in Delta's stock price prior to that date would bias our findings away from statistical significance.

We estimate the following model using return data from CRSP:

$$R_{Delta,t} = \alpha + \beta_{Mkt} * R_{Mkt,t} + e_t \quad (1)$$

where $R_{Delta,t}$ denotes Delta's stock return on day t, $R_{Mkt,t}$ denotes day t return on the value weighted index of all CRSP stocks (a proxy for the market portfolio) obtained from Kenneth French's website, and e_t is the residual term. Abnormal returns are defined as the difference between actual and fitted returns. We cumulate abnormal returns over the event window to gauge how stockholders expect the acquisition to impact value. We use the Patell Z test to determine whether the cumulative abnormal return, CAR, around the announcement is statistically significant.

Table 6 presents the results of our stock market event study. Panel A shows that Delta experienced a positive CAR of 5.71% over the three-day period centered on the announcement date, that is CAR (−1, +1). Though this value is only significant at the 10 percent level, it is informative considering a sample size of one firm in this event study. Panel B disaggregates this CAR to show that most of the abnormal return takes place the day before the announcement. This suggests some degree of anticipation or news leakage in the market. While we favor the market model's simplicity as an estimation model, untabulated analysis confirms identical results using the Fama and French 3-factor model or the Fama and French 3-factor model augmented with an airline industry factor. Overall, these results suggest that Delta increased shareholder wealth through the acquisition. Given Delta's $8.79 billion market capitalization two trading days prior to the announcement, a three-day CAR (−1, +1) of 5.71% translates to $501.9 million in wealth generated.

****** Insert Table 6 about here ******

To test these results' robustness, we employ the synthetic control method (SCM) pioneered by Abadie and Gardeazabal (2003) and Abadie, Diamond, and Hainmueller (2010). Acemoglu et al. (2016) also use SCM to study the wealth effect of the announcement that Tim Geithner would become Treasury Secretary in November 2008 on financial firms with links to Geithner. We analogously employ SCM to study the effect of the Trainer acquisition announcement on Delta's returns. The technique attempts to synthesize Delta's stock return in the absence of the acquisition using a weighted average of its competitors' returns. The weight assigned to each competitor airline is determined in such a way as to minimize squared errors between Delta's actual returns and Synthetic Delta's returns in the pre-acquisition period. That is, if $R_{Delta,t}$ is the return on Delta's stock and $R_{i,t}$ is the return on airline i of the control group, we construct a synthetic Delta stock return by solving the following program:

$$\{w_i\}_{i \in Control\ Group} = argmin\ \sum_t^T \left(R_{Delta,t} - \sum_i w_i R_{i,t}\right)^2 \qquad (2)$$

subject to $\sum \omega_i = 1$ where [t, T] is the estimation window in the pre-acquisition period and ω_i is the weight assigned to the stock return of airline i. Once ω_i for each airline in the control group is determined, the cumulative return of the three days centered on the announcement day, denoted by CAR_{Delta} (−1, +1), is calculated as:

$$CAR(-1,+1)_{Delta} = \sum_{-1}^{+1}\left(R_{Delta,t} - \sum_i w_i R_{i,t}\right) \qquad (3)$$

We repeat the same analysis replacing Delta with each other airline in the control group and calculating its CAR_i (−1, +1) over the same window. These CAR_i (−1, +1) help construct a distribution of cumulative returns not caused by the treatment against which the significance of CAR_{Delta} (−1, +1) is tested. The pool of control units consists of public airlines, among those in Table 5, that were actively trading at the time of the announcement. Namely, it includes Allegiant, United, SkyWest, Southwest, JetBlue, Hawaiian, Alaska, Spirit and U.S. Airways. We use observations from January 1, 2011 to 50 days before the announcement in the estimation window. We choose 50 days to avoid the possible effect of news leakage before the announcement. Stock return data come from CRSP. If the acquisition announcement positively (negatively) affects shareholders, then Delta's CAR (−1, +1) should be significantly higher (lower) than that of other airlines.

Table 7 shows the result of SCM analysis. The results show that in synthetic Delta, United Air Lines (UAL), Jet Blue (JBLU) and US Airways (LCC) are given large weights (0.335, 0.23 and 0.201 respectively). This is expected as LCC and UAL, like Delta, are network and legacy carriers while JBLU shares with Delta a heavy presence in the New York market, as discussed in the last section. This lends credibility to the SCM estimates. SCM results also support the idea that the market reacts positively, relative to industry peers, to Delta's refinery purchase announcement. Delta's stock price experiences a 5.1% CAR (−1, +1), a number that is significantly higher than other firms experienced over the announcement period, indicating that the effect is unique to Delta around the announcement date. Ideally, one would employ bootstrapping techniques to construct a distribution of cumulative abnormal returns of the control group against which the treatment cumulative abnormal return could be tested. Industrial limitations constrain our control group to only seven units which renders bootstrapping impractical. However, Delta's CAR lies 2.1 standard deviations from the center of the control group. This sizable distance suggests that the effect for Delta is significantly different from that of the control group. Thus, from the above results, it is clear the stock market reacted favorably to news of the refinery's purchase.

****** Insert Table 7 about here ******

5.1.2. Bond market

To better understand how the refinery purchase affected overall company value, we investigate how the market for Delta's bonds reacted to the acquisition announcement. Whereas the positive stock-market reaction could be explained on the ground of buying a cheap and underpriced asset, bondholders are less likely to share in this residual benefit. If bondholders also react positively, it would provide evidence of an incremental positive anticipated effect on Delta's ongoing operations. Generally, bondholders could value the acquisition as a means of reducing exposure to fuel price risk. However, they could also believe that diversifying into an industry outside of management's expertise will be risky and would increase the likelihood of default. In fact, Moody's credit rating agency issued the following statement two days after the announcement:

> "*The decision by Delta Air Lines to purchase the Trainer refinery complex is negative for Delta's credit profile. We believe potentially significant operating and financial risks accompany owning and operating an oil refinery, which could lead to shortfalls between actual financial benefits and those of the project's business case.*" (Root and Mulvaney, 2012)

If bondholders agree with the rating agency, we expect significantly negative returns around the announcement date. Conversely, if Delta's anticipated fuel price risk reduction is expected to occur, we expect positive excess returns.

Bessembinder et al. (2009) and Ederington, Guan, and Yang (2015) identify several complications to bond market event studies, including infrequent trading and significant heteroskedasticity between bonds and firms. These issues render classic event study techniques problematic. Fortunately, the authors provide insightful recommendations on how to best conduct a bond market event study; we adhere to their suggestions as closely as possible. Specifically, we: (1) generate returns using daily rather than monthly bond price data; (2) compute daily bond prices as the volume-weighted average of all trades for a given bond on a given day; (3) extend our event window to the (-5,+5) period to account for infrequent trading; (4) calculate expected bond returns using bond-level control groups matched on maturity and credit rating (we alternatively employ a control group of all airlines' bonds and airline bonds matched on maturity and credit rating); (5) account for heteroskedasticity across bonds and firms by standardizing each return; and (6) employ non-parametric tests for statistical inference.

From the TRACE database, we obtain all bond trades six months before and after April 30, 2012. Merging this set with the Mergent RISD Bond Rating database obtains that bond's ratings; bonds with missing CUSIPs or ratings are dropped. As per Bessembinder et al. (2009) and Ederington et al. (2015), we eliminate canceled, corrected, and commission trades; trades with settlement dates over one week in the future; when issued or special trades; trades with sales conditions; zero-coupon bonds; bonds in default; and irregular trades – indicated by the TRACE "as of" flag.

To compute returns, we require that a bond trades at least once in the five days prior to the announcement date and at least once in the five subsequent days. When a bond trades multiple times in one day, we weight each trade by the square root of trade volume to obtain a daily bond price. We calculate returns for up to eight periods over the t-5 to t+5 window where t=0 represents the announcement date. For example, a bond that trades on days t-3, t+1, and t+5 generates two returns: the 5-day return from t-3 to t+1 and the 9-day return from t-3 to t+5. Returns are then standardized by that bond's 5- and 9-day return standard deviations calculated from trades occurring six months before the 11-day event window and six months after. For each day, d, from 3 to 11, if the bond does not generate at least six d-day returns in the twelve months around the event window, its returns are excluded to avoid unrepresentative standard deviations. Returns are trimmed at the 1 and 99% levels to mitigate the impact of extreme outliers. Finally, standardized d-day returns for each of Delta's bonds that trade in the event window are compared to standardized d-day returns for a maturity and rating matched sample of all bonds, airline standardized d-day bond returns, and maturity and rating matched airline d-day standardized bond returns. These differences are tested for statistical significance using the Student's t and signed rank tests.

The results of our bond market event study are reported in Table 8. Panel A describes mean and median returns for Delta and the three benchmarks. The positive mean and median returns for Delta range from two to three times mean and median benchmark returns, depending on the benchmark. When accounting for heteroscedasticity between bonds, the contrast is even starker. Delta's returns exceed zero by three to six times as many standard deviations as benchmark returns do. Panels B and C show that these differences are highly statistically significant, regardless of the choice between raw or standardized returns and between parametric or nonparametric tests. Overall, bond market participants positively value the acquisition, despite Moody's bearish forecast.

****** Insert Table 8 about here ******

Figure 5 presents levels (upper chart) and changes (lower chart) in CDS spreads, respectively. Visual analysis of this figure indicates that Delta's perceived default risk falls dramatically while those of United, Southwest, and JetBlue remain constant around the time of the acquisition. We examine these spread differentials econometrically in section 6.6. Unfortunately, CDS data are available only for analyzing these four airlines around the acquisition announcement.

****** Insert Figure 5 about here ******

6. Has Delta's Strategy Been Successful?

After verifying that all event study results point in the same direction – shareholders, creditors, and CDS investors expect the acquisition to generate value – we explore whether Trainer's acquisition and integration has proven to be an effective hedge for Delta over the subsequent four years. The corporate risk management literature predicts that risk management can add value by reducing the likelihood of costly financial distress (Smith and Stulz, 1985); reducing the need for costly external financing (Froot et al., 1993); reducing underinvestment and asset substitution, and benefiting from convexity in the cost structure. We first determine whether Trainer reduces fuel price risk for Delta relative to its peers. Next, we assess whether the equity market credits Delta with the risk reduction. Finally, we test whether debt markets also perceive reduced risk for Delta, post-Trainer.

6.1. Fuel price variability reduction

One channel through which Trainer could add value is by reducing the company's cash flow variability. We first check if Trainer has the *potential* to reduce variability of Delta's largest single expense: fuel costs, which averaged around 25% of operational costs throughout our sample period. To analyze this question, consider a simple model where Q_T is the total gallons of jet fuel consumed by Delta and P_J, P_c and P_o are the prices of jet fuel, crack spread, and crude oil, respectively. Note that, by definition, $P_J = P_c + P_o$. Then:

$$Q_T \times P_J = Q_T \times P_C + Q_T \times P_O = Q_r \times k + Q_m \times P_C + Q_T \times P_O \quad (4)$$

where Q_r is the amount of jet fuel sourced from the refinery, Q_m is the amount sourced from the market and k is a constant or at least predictable per unit refining cost. It can be shown that if $\alpha_m = Q_m/Q_T$, then:

$$Var(\Delta P_J) = \alpha_m^2 Var(\Delta P_c) + Var(\Delta \mathrm{P_o}) + 2\alpha_m Cov(\Delta P_c, \Delta P_o) \quad (5)$$

which can be written as:

$$\sigma_J^2 = \alpha_m^2 \sigma_c^2 + \sigma_o^2 + 2\alpha_m \sigma_c \sigma_o \rho_{c,o} \quad (6)$$

The Δ sign denotes a first difference in equations 5. For Delta, the amount of jet fuel sourced from the market, α_m, is around 0.6 (meaning Trainer supplies about 40% of Delta's jet fuel needs) while it is 1 for other airlines. Thus, the variability of Delta fuel cost is a function of the correlation between the change in jet crack price and the change in oil price, $\rho_{c,o}$. If the correlation is positive, then there always exists a potential for variability reduction; if $\rho_{c,o}$ is negative, then it depends on the size of α_m and the extent of correlation. We plot the rolling version of equation 6 using weekly data on jet fuel, crack spread, and crude oil prices. We use a rolling window of 50 weeks. Figure 6 shows the rolling standard deviation using equation 6 when $\alpha_m = 0.6$ (which corresponds to Delta) and when $\alpha_m = 1$ (which corresponds to other airlines). In almost all realized scenarios of co-movement between oil and crack, partially sourcing jet fuel from a refinery can reduce the variability of jet fuel costs per barrel.

****** Insert Figure 6 about here ******

To assess the economic significance of these estimates, note that Delta has consumed around 3,867 million gallons of jet fuel per year since 2012. Equation 6 implies that the refinery can reduce Delta's standard deviation in fuel costs by up to $256 million. Of course, this calculation assumes k, the per-unit cost of refining, to be constant. However, this need not be the case. For example, operational disruption is a key source of risk to refineries. In their 2012 annual report, Delta states: "During the December 2012 quarter, fuel production increased at the refinery. However, super storm Sandy negatively impacted the refinery start-up, slowing production and lowering efficiency levels. The refinery recorded a $63 million net loss for the quarter." Nevertheless, the per-unit cost of refining is expected to be less variable than the jet fuel crack spread so the refinery should still reduce total volatility.

6.2. Perceived risk reduction in equity markets

If Trainer is perceived by investors as a valuable hedging tool, then one would expect Delta's equity price exposure to the crack spread to be significantly less than other airlines' in the post-Trainer period. To test this hypothesis, we estimate the following OLS model:

$$R_{i,t} = \alpha_i + \beta_m R_{m,t} + \beta_o R_{o,t} + \beta_c R_{c,t} + \beta_p post_t + \beta_{po} post_t \times R_{o,t} + \beta_{pc} post_t \times R_{c,t} + \beta_{oh} HR_{i,t} \times R_{o,t} + \beta_{ch} HR_{i,t} \times R_{c,t} + \epsilon_{i,t} \quad (7)$$

where $R_{i,t}$ is the log return on the share price of airline *i* at time *t*; $post_t$ is a dummy for the post-Trainer period; $R_{m,t}$ is the log return on the value weighted market portfolio, used as a proxy for the market portfolio; $R_{c,t}$ is the log return on the crack spread, measured as the difference between jet fuel and crude oil prices; $R_{o,t}$ is the log return on the price of WTI oil benchmarks; and $HR_{i,t}$ is the hedge ratio of airline *i*, which equals the fraction of next quarter's consumption currently hedged. A hedge ratio at time t corresponds to the ratio that is reported in the last published statement. We use weekly data from the beginning of 2009 to May 2017. Price data are obtained from CRSP and hedge ratios are obtained from the companies' quarterly filings; Appendix 1 details the hedge ratio calculation. The parameter of interest is β_{pc}. It is expected to be negative and significant if the market perceives that Trainer reduces Delta's exposure to the crack spread. We run this regression, separately, for Delta and its peers to allow the slope coefficients to change for each airline.

Table 9 shows the regression estimates of the above model for Delta as well as its peers. We can see from the table that exposure to oil is significantly negative and much higher than that to crack spread. This is expected, since crude oil constitutes a much larger fraction of the jet fuel price. In the post-Trainer period, Delta stock price sensitivity to the oil price has increased significantly.

However, this is not special to Delta as most of the airlines share the same trend in the post-Trainer period suggesting that the trend is due to something common to the airline industry in general. For Delta, β_{pc}, the parameter of interest shows the expected sign and it is significant at the 10% significance level. Unlike Delta, other major airlines do not shows any significant change in their exposure to crack spreads in the post-Trainer period. Only Spirit airlines (SAVE) did have a significant reduction in its exposure to the crack spread in the post-Trainer period. It is unlikely for this to be due to something common between the two airlines. Both are different in their size and their business model. Also, as is clear from Table 4, Spirit has a very volatile hedging policy in the post-trainer period.

****** Insert Table 9 about here ******

To validate the above result, we estimate the difference-in-difference version of equation 7. That is, we estimate the following model:

$$
\begin{aligned}
R_{i,t} = \gamma + \alpha_i + \beta_m R_{m,t} + \beta_o R_{o,t} + \beta_c R_{c,t} + \beta_{oh} HR_{i,t} \times R_{o,t} + \beta_{ch} HR_{i,t} \times R_{c,t} \\
+ \beta_p post_t + \beta_{po} post_t \times R_{o,t} + \beta_{pc} post_t \times R_{c,t} + \beta_{po,DAL}\, post_t \times DAL_t \times R_{o,t} \\
+ \beta_{pc,DAL}\, post_t \times DAL_t \times R_{c,t} + \epsilon_{i,t} \qquad (8)
\end{aligned}
$$

where DAL is a dummy for Delta Air Lines and all other variables are defined as in equation 7. The parameter of interest is now $\beta_{pc,DAL}$. Again, weekly observations from May 2009 to December 2015 are used for the estimation. Price data are obtained from CRSP and hedge ratios are obtained from the companies' quarterly filings. Airlines included are those with sufficient trading history before and after the acquisition, namely, Delta, Allegiant, United, SkyWest, Southwest, Jet Blue, Hawaiian, Alaskan, Spirit and U.S. Airways. Table 10 shows the difference-in-difference estimation results. As seen with separate regressions reported in Table 9, $\beta_{pc,DAL}$ is negative and significant at the 5% level. As a robustness check, we repeat the same regression for Spirit airlines instead for Delta to investigate the results seen in Table 9. In unreported results, we find that $\beta_{pc,SAVE}$ is not significant. Taken together, these results indicate that Delta's equity exposure to the crack spread has been reduced *because* of Trainer.

****** Insert Table 10 about here ******

6.3. Perceived risk reduction in bond and loan markets

Campello et al. (2011) predict that a company with better risk management will have less costly access to external financing. To assess whether the acquisition reduces Delta's credit risk, we use a difference in differences estimation technique. We measure how the difference between Delta's bond yields and those of its competitors changes around the acquisition. Through this framework, we can better control for credit spread changes resulting from macroeconomic factors such as crude oil price swings or fluctuating air travel demand. Our sample period is 2008 through 2016, which constitutes seventeen quarters before the acquisition, two quarters associated with the acquisition announcement and implementation, and seventeen quarters after the acquisition. Our sample includes bond yields from Delta, U.S. Airways, American, United, Southwest, Hawaiian, and JetBlue. We require stock market data to compute a firm's market to book ratio (one of our controls), then estimate the following OLS model:

$$
\begin{aligned}
Spread_{c,i,t} = \alpha + \beta_D * Delta + \beta_P * Post + \beta_{DP} * Delta * Post \\
+\gamma_{TC} * Trade\ Characteristics_{i,t} + \gamma_{FC} * Firm\ Characteristics_{c,t} \\
+\gamma_{BC} * Bond\ Characteristics_i + \gamma_{MC} * Crude\ Oil\ Environment_t + e_{i,t} \qquad (8)
\end{aligned}
$$

where $Spread_{c,i,t}$ is the difference between the firm *c*, bond *i* yield to maturity on trading day *t* and the benchmark treasury yield. If a bond trades multiple times in one day, its yield is the sum of individual trade yields weighted by the square root of respective trade volumes. The benchmark treasury yield is computed as a linear combination of yields for the two reported U.S. treasury securities that mature around the bond's maturity date (the closest-maturity treasury before the airline bond's maturity and the closest after). For example, consider a trade of an airline bond with eight years remaining until maturity. Because the U.S. treasury does not report an 8-year treasury yield, benchmark treasury yield would be calculated as 2/3 of the reported 7-year treasury yield that day plus 1/3 of the 10 year treasury yield. If the trade occurs on a day for which no treasury rates are reported, the last treasury rate is used.

In all specifications, β_{DP} is the coefficient of interest. A negative sign indicates that Delta's bond yields significantly decline in the post-acquisition period after controlling for trends in other airlines' bond yields. We control for other important determinants of bond yields in the literature; it has been shown that smaller trades suffer from a larger bid-ask bounce and trades closer to maturity reflect less repayment uncertainty (Ederington et al., 2015). We, therefore, include trade size and time remaining to maturity as trade-level controls. We control for firm size, leverage, and growth opportunities using the natural logarithm of book assets, the ratio of book debt to book assets, and the sum of market equity and book liabilities scaled by book assets, respectively. We account for periods of rapid crude oil price increases (January 2009 through April 2011) and decreases (June 2014 through January 2016) with two indicator variables whose values equal one if the trade takes place within that period, and zero otherwise. For robustness, we employ year fixed effects in another specification.

Bond-level idiosyncrasies such as level of seniority, collateral, and embedded options also significantly affect yields. We therefore include controls for call, put, and convertibility options; bond seniority; credit enhancements; restrictive covenants; the presence of collateral; coupon frequency, and bond type (corporate debenture, corporate convertible, asset-backed security, with corporate pass through as the omitted category). An alternative specification employs bond fixed effects. Finally, we include a variable to represent bond rating categories. If the bond is rated in the top two categories (AAA/AA), this variable equals 1. If the bond is rated A, then the variable's value is 2. If BBB, then 3, and so on. Because our data contain many observations of the same bond, we cluster standard errors at the bond level.

Our bond trade data contain several extreme outliers. Second, third and fourth sample moments for daily bond yields are 13391.48, 79.72 and 7530.28, respectively. We truncate at the 1 percent tails of bond yields to mitigate the impact of extreme outliers. This process attenuates our coefficient estimates over five-fold; however, these lower estimates appear far more economically plausible. For illustrative purposes, we report untruncated regression results truncated in a robustness specification.

We retain all bond trades in the TRACE database with an issuer SIC code of 4512 (commercial air travel). Using the full CUSIP, we then merge this dataset with bond attributes and ratings obtained from the Mergent RISD bond issues and ratings databases. We then join our data to the COMPUSTAT and CRSP databases for issuer accounting and market characteristics. Finally, we merge hedging data hand collected from quarterly SEC filings in the process detailed in Appendix 1.

Table 11 displays results from OLS regressions of equation 8. Column 1 reports our baseline regression results. As expected, bond traders appear to credit Delta with reducing risk through the acquisition. Pre-acquisition spreads on Delta's bonds exceed those of its competitors, on average. In the post-acquisition period, competitors' yield spreads rise by a statistically significant 3.5 percentage points. However, over the same period, Delta's yield spreads fall relative to its peers by 1.3 (=3.5-4.7) percentage points. These results are statistically significant and robust to including year-fixed effects (Column 2) and airline-fixed effects (Column 3) and swapping individual bond attributes for bond-fixed effects (Column 4). Results appear much stronger without truncating (Column 6), though we believe the presence of significant outliers distorts the true relationship between the acquisition and Delta's credit risk. Outlying observations belong exclusively to other airlines, not Delta.

****** Insert Table 11 about here ******

When examining investment and non-investment grade bonds, separately (Columns 5 and 6, respectively), we observe no impact on Delta's investment grade bond yields distinct from its competitors. However, all airlines' investment grade bonds appeared to enjoy lower yields in the later period, after April 2012. In contrast, all airlines' sub-investment grade bond yields experience significant increases after the acquisition though Delta's increased by only 30 percent [=(9.087-6.434)/9.087] of the industry mean increase. Finally, Column 7 restricts the sample to eight quarters centered on the refinery purchase announcement (2Q2012) and consummation (3Q2012) to eliminate potential noise from our sample. Statistically and economically significant results continue to obtain.

Control variables generally assume the expected signs when significant. Larger firms with more growth opportunities appear to enjoy lower spreads. Collateralization and the inclusion of put and conversion options tend to lower spreads while call options and a non-semi-annual coupon scheme are associated with higher spreads. However, two puzzling relationships emerge in this table: worse rated bonds and those with longer maturities appear to have lower spreads, all else equal. One possible explanation for these effects is an observation bias. Because we only observe spreads for bonds which trade, it could be that longer maturity and worse rated bonds require better fundamentals to trade in the first place.

To support our bond yield results, we replicate the difference in difference bond regressions using loan spreads as our variable of interest instead of bond yields:

$$Spread_{i,t} = \alpha + \beta_D * Delta + \beta_P * Post + \beta_{DP} * Delta * Post + \gamma_C * Loan\ Characteristics_{i,t} + e_{i,t} \quad (9)$$

We obtain all new bank loans issued to airlines from 2009 to 2014 from Dealscan. Our dependent variable is the loan spread over the relevant-maturity LIBOR rate. We include the same three difference-in-difference variables and again are interested in the coefficient for the interaction term of *Delta* and *Post*. We control for the loan amount, number of participants, maturity, presence of collateral, and whether it is a term loan or revolver. Standard errors are clustered at the firm level.

Table 12 confirms the bond spread results, using newly arranged loan spread data instead. The coefficient on the *Delta*Post* term indicates that Delta's spreads decrease by 70 basis points relative to its competitors in the post-acquisition period. Because of this test's extremely limited sample size, this table is offered as supplemental support for our claim that creditors deem Delta a safer borrower post-acquisition. Again, the difference-in-difference framework offers preliminary causal evidence that the acquisition itself helped lower Delta's cost of borrowing. Spreads are generally higher for Delta but decrease dramatically post-acquisition. Spreads increase with amount borrowed and the presence of collateral, though the latter result is likely associative, not causal.

****** Insert Table 12 about here ******

Taken together, our credit market results provide evidence that Delta's access to credit markets is enhanced by the acquisition. Delta's bonds, particularly its non-investment grade bonds, experience lower spreads after Trainer's successful integration as do its loans. This is consistent with creditor assessment of lower risk, post-Trainer. Such an explanation supports theories of hedging and vertical integration as risk management tools and appears inconsistent with Moody's original prediction that the operational risk associated with owning a refinery will outweigh its benefits.

7. Conclusions

This study assesses whether Delta Air Lines' June 2012 acquisition and subsequent integration of the Trainer oil refinery has been successful. Delta justified this groundbreaking move as a means of ensuring jet fuel supply to important operational hubs in the northeastern United States and reducing exposure to the crack spread by acquiring it. The acquisition can be viewed as creating an operational hedge against rising fuel costs.

Delta's management was optimistic at the acquisition announcement, highlighting the low acquisition price ($150 million) and anticipating substantial annual savings in fuel costs ($300 million). However, analysts, academics and credit rating agencies generally derided the move as a dramatic leap outside Delta's sphere of expertise. Empirically, we find that most of Delta's stakeholders shared the company's positive outlook when this deal was announced. In the three days centered on the April 30, 2012 acquisition announcement, cumulative abnormal stock returns exceeded 5 percent, creating over $500 million of equity value. Abnormal bond returns appeared less intense but still significant, with yields dropping 50 basis points immediately after the acquisition was announced. CDS spreads also experienced a distinct drop around the announcement.

Not only did stakeholders anticipate benefits from the acquisition, *ex ante*, but they realized these benefits *ex post*. We show that Delta's stock price sensitivity to crack spreads decreased after the acquisition. By examining individual airlines, we show the significant reduction in stock price sensitivity to crack spread changes is unique to Delta and is not observed for any other airline. Through a difference in differences framework, we reaffirm the significance of Delta's decrease relative to its peers' sensitivity changes. Thus, we conclude that Delta's stockholders are better insulated from increases in refining margins after the acquisition. Its creditors, too, appeared satisfied with the deal through time. Despite Moody's foreboding opinion, Delta's bonds and loans experience a significant reduction in required yields after the acquisition. Our difference in differences methodology supports a causal interpretation: the refinery reduced risk to creditors and CDS holders. This is consistent with theoretical models which argue that hedging reduces default risk. Our tests of equity exposure to crack spreads offer further support for this channel.

Overall, this case study documents that significant operational hedging benefits can be achieved through vertical integration. While prior research generally approaches these topics abstractly and in isolation, Delta's Trainer acquisition offers a large-scale, unique and ideal intersection. Positioned at this intersection, our study shows that even combinations between drastically different industries, with very little overlapping managerial expertise, can benefit equity and debt holders through the risk-reducing synergies of vertical integration. Decomposing this benefit into successful operational hedging and a useful option to produce versus procure inputs is a task we leave for future research.

References

Abadie, A., Diamond, A., Hainmueller, J. 2010. Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program. Journal of the American Statistical Association 105, 493-505.

Abadie, A., Gardeazabal, J. 2003. The economic costs of conflict: A case study of the Basque Country. American Economic Review 93, 113-132.

Acemoglu, D., Johnson, S. Kermani, A., Kwak, J., Mitton, T. 2016. The value of connections in turbulent times: Evidence from the United States. Journal of Financial Economics 121, 368-391.

Adam, T., Fernando, C. 2006. Hedging, speculation, and shareholder value. Journal of Financial Economics 81, 283–309.

Adam-Muller, A.F., Nolte, I. 2011. Cross hedging under multiplicative basis risk. Journal of Banking and Finance 35, 2956-2964.

Adams, Z., Gerner, M. 2012. Cross hedging jet-fuel price exposure. Energy Economics 34, 1301-1309.

Anderson, R. H. 2014. Delta's CEO on using innovative thinking to revive a bankrupt airline. Harvard Business Review.

Aretz, K., Bartram, S. M. 2010. Corporate hedging and shareholder value. Journal of Financial Research 33, 317–371.

Berry, S. 1990. Airport Presence as Product Differentiation. American Economic Review 80, 394-399.

Bessembinder, H., Kahle, K. M., Maxwell, W. F., Xu, D. 2009. Measuring abnormal bond performance. Review of Financial Studies 22, 4219–4258.

Borenstein, S. 2011. Why can't US airlines make money? American Economic Review 101, 233–237.

Brelsford, R. 2015. Par Pacific acquires Wyoming refinery, logistic assets. Oil & Gas Journal, July 15.

Campbell J, Lo A., MacKinlay, A. 1997. The Econometrics of Financial Markets. Princeton University Press, Princeton, NJ.

Campello, M., Lin, C., Ma, Y., Zou, H. 2011. The real and financial implications of corporate hedging. Journal of Finance 66, 1615–1647.

Carlton, D. W. 1979. Vertical integration in competitive markets under uncertainty. Journal of Industrial Economics 27, 189–209.

Carter, D. A., Rogers, D. A., Simkins, B. J. 2006. Does hedging affect firm value? Evidence from the us airline industry. Financial management 35, 53–86.

Dastin, J. 2016. US airlines tried to save on fuel, and now they are regretting it. Business Insider, January 22.

Dlouhy, J. 2015. As Delta refinery snaps up Nigerian crude, U.S. producers ask congress for freedom to export. Reuters, July 6.

Ederington, L., Guan, W., Yang, L. Z. 2015. Bond market event study methods. Journal of Banking & Finance 58, 281–293.

Fan, J. P. 2000. Price uncertainty and vertical integration: An examination of petrochemical firms. Journal of Corporate Finance 6, 345–376.

Fan, J. P., Goyal, V. K. 2006. On the patterns and wealth effects of vertical mergers. Journal of Business 79, 877–902.

Firestine, T., Guarino, J. 2012. A Decade of Change in Fuel Prices and U.S. Domestic Passenger Aviation Operations. Bureau of Transportation Statistics, U.S. Department of Transportation

Forbes, S., Lederman, M. 2009. Adaptation and vertical integration in the airline industry. American Economic Review 99, 1831-1849.

Forbes, S., Lederman, M. 2010. Does vertical integration affect firm performance? Evidence from the airline industry. RAND Journal of Economics 41, 765-790.

Froot, K. A., Scharfstein, D. S., Stein, J. C. 1993. Risk management: Coordinating corporate investment and financing policies. Journal of Finance 48, 1629–1658.

Garfinkel, J. A., Hankins, K. W. 2011. The role of risk management in mergers and merger waves. Journal of Financial Economics 101, 515–532.

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

Gilje, E., Taillard, J. 2016. Does hedging affect firm value? Evidence from a natural experiment. Unpublished working paper. University of Pennsylvania.

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

Hankins, K. W. 2011. How do financial firms manage risk? Unraveling the interaction of financial and operational hedging. Management Science 57, 2197–2212.

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

Hecht, A. 2015. Delta Air Lines: Will their refining business or a price war tank this stock? Seeking Alpha, January 26.

Helfat, C. E., Teece, D. J. 1987. Vertical integration and risk reduction. Journal of Economics and Organization 3, 47.

Helman, C. 2015. How cheap oil has Delta Air Lines jet fooled. Forbes, January 21.

Hirshleifer, D. 1988. Risk, futures pricing, and the organization of production in commodity markets. Journal of Political Economy 96, 1206-1220.

Jin, Y., Jorion, P. 2006. Firm value and hedging: Evidence from us oil and gas producers. Journal of Finance 61, 893–919.

Kedia, S., Ravid, S. A., Pons, V. 2011. When do vertical mergers create value? Financial Management 40, 845–877.

Kim, Y.S., Mathur, I., Nam, J. 2006. Is operation hedging a substitute for or complement to financial hedging? Journal of Corporate Finance 12, 834-853.

Lafontaine, F., Slade, M. 2007. Vertical integration and firm boundaries: The evidence. Journal of Economic Literature 45, 629–685.

Larino, J. 2015 New Jersey company to buy Chalmette refinery from ExxonMobil, Venezuela. The Times-Picayune, June 18.

Lemer, J. 2012. Delta buys refinery to combat fuel cost. Financial Times, April 30.

Levine-Weinberg, A. 2015a. Delta Air Lines, Inc. is on track for huge q1 fuel cost savings. Motley Fool, August 27.

Levine-Weinberg, A. 2015b. Delta's refinery bet is finally paying off. The Motley Fool, August 27.

Levy, D. 1985. The transaction cost approach to vertical integration: An empirical examination. Review of Economics and Statistics 67, 438-445.

Lim, S. S., Wang. H. 2007. The effect of financial hedging on the incentives for corporate diversification: The role of stakeholder firm-specific investments. Journal of Economic Behavior & Organization 62, 640-656.

Lin, R., Chang. Y. 2009. Does Hedging Add Value? Evidence from the Global Airline Industry. Unpublished working paper. Jinwen University of Science and Technology.

MacKay, P., Moeller, S. B. 2007. The value of corporate risk management. Journal of Finance 62, 1379–1419.

Massoudi, A. 2012. Wall Street extends rally on earnings hopes. Financial Times, April 12.

Maxon, T. 2014. American Airlines dumps its fuel hedges and saves. Dallas Morning News, July 16.

McCurty, J. 2012. Analysis: Delta's refinery bid looks better on second glance. Financial Times, April 30.

Nelson, J., Moffitt, J.S., Affleck-Graves, J. 2005. The impact of hedging on the market value of equity. Journal of Corporate Finance 11, 851-881.

Perry, M. K. 1989. Vertical integration: determinants and effects. Handbook of industrial Organization 1, 183–255.

Rampini, A. A., Sufi, A., Viswanathan, S. 2014. Dynamic risk management. Journal of Financial Economics 111, 271 – 296.

Resnick-Ault, J., Seba, E. 2016. Lyondell's Houston refinery draws bids from Aramco, Valero, Suncor: sources. Reuters, October 21.

Root, J., Mulvaney, M. 2012. Moody's says purchase of Trainer PA refinery is a credit negative for Delta Air Lines. Moody's Investors Service, New York, NY.

Shepherd, W. G. 1984. "Contestability" vs. competition. American Economic Review 74, 572–587.

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

Stavins, J. 2001. Price discrimination in the airline market: The effect of market concentration. Review of Economics and Statistics 83, 200–202.

Treanor, S. D., Simkins, B. J., Rogers, D. A., Carter, D. A. 2014. Does operational and financial hedging reduce exposure? Evidence from the US airline industry. Financial Review 49, 149–172.

U.S. Department of Energy, 2012. Potential Impacts of Reductions in Refinery Activity on Northeast Petroleum Product Markets. Independent Statistics and Analysis. Washington, DC.

Williamson, O. E. 1971. The vertical integration of production: Market failure considerations. American Economic Review 61, 112–123.Wright, R. 2013. Delta Air line dividend promise signals robust financial health. Financial Times, May 8.

Zhang, B. 2014. How delta bought a refinery and wound up saving its rivals a ton of cash. Business Insider, September 2.

Appendix 1: Hedge ratio computation

Our hedge ratios are defined as the percentage of next quarter's anticipated fuel consumption that is hedged by petroleum product derivatives.[1] Most airlines report some version of this ratio although reporting is not consistent. When an airline reports the ratio directly, we use the reported number. Some airline-quarter observations specify the hedge ratio as of quarter-end while other report as of the filing date. The discrepancy is typically one or two months and is unlikely to systematically bias our results.

On quarterly filings, most airlines do not report the percentage of *next quarter's* anticipated fuel consumption hedged but, rather, the percentage of the *remaining year's* anticipated fuel consumption hedged. Likewise, on annual filings, airlines report the percentage of *next year's* anticipated fuel consumption hedged. We make a simplifying assumption that fuel consumption is spread out evenly over the year. For example, if, on its first quarter SEC filing, an airline reports that it has hedged 44% of its anticipated fuel consumption for the remainder of the year, we assume that it has hedged 44% of its anticipated fuel consumption for the second quarter, as well. While this assumption is not realistic, the measurement error (contained in the residual term) is unlikely to correlate with dependent or independent variables. As such, this measurement error introduces noise, not bias, into our model.

A final source of hedge ratio measurement error pertains specifically to Delta. It is the only airline that does not report hedge ratios. Instead, Delta reports total hedge volume, the maturity date of the last hedge contract, and anticipated fuel consumption, for the remainder of the year. To compute a hedge ratio for Delta, we first divide the total hedge volume by the number of quarters until the final contract's maturity date estimate quarterly hedge volume. Likewise, we estimate quarterly anticipated fuel consumption by dividing the reported anticipated fuel consumption for the remainder of the year by the number of quarters remaining in the year. Finally, we divide quarterly hedge volume by anticipated fuel consumption for the next quarter to obtain Delta's quarterly hedge ratio. Because of the simplifying assumptions, this ratio exceeds 100% for three quarters. For these observations, we right censor the observation at 100% to reduce the overestimate's impact.

[1] Jet fuel derivatives markets are too illiquid for airlines to hedge. Thus, airlines typically hedge using crude oil and heating oil derivatives. Hedging instruments include forward contracts, swaps, collars, and options.

Figure 1. Evolution of crude oil and jet fuel prices

This chart shows the time series of crude oil and jet fuel prices per barrel from April 1990-August 2016. Data are sourced from The U.S. Energy Information Administration.

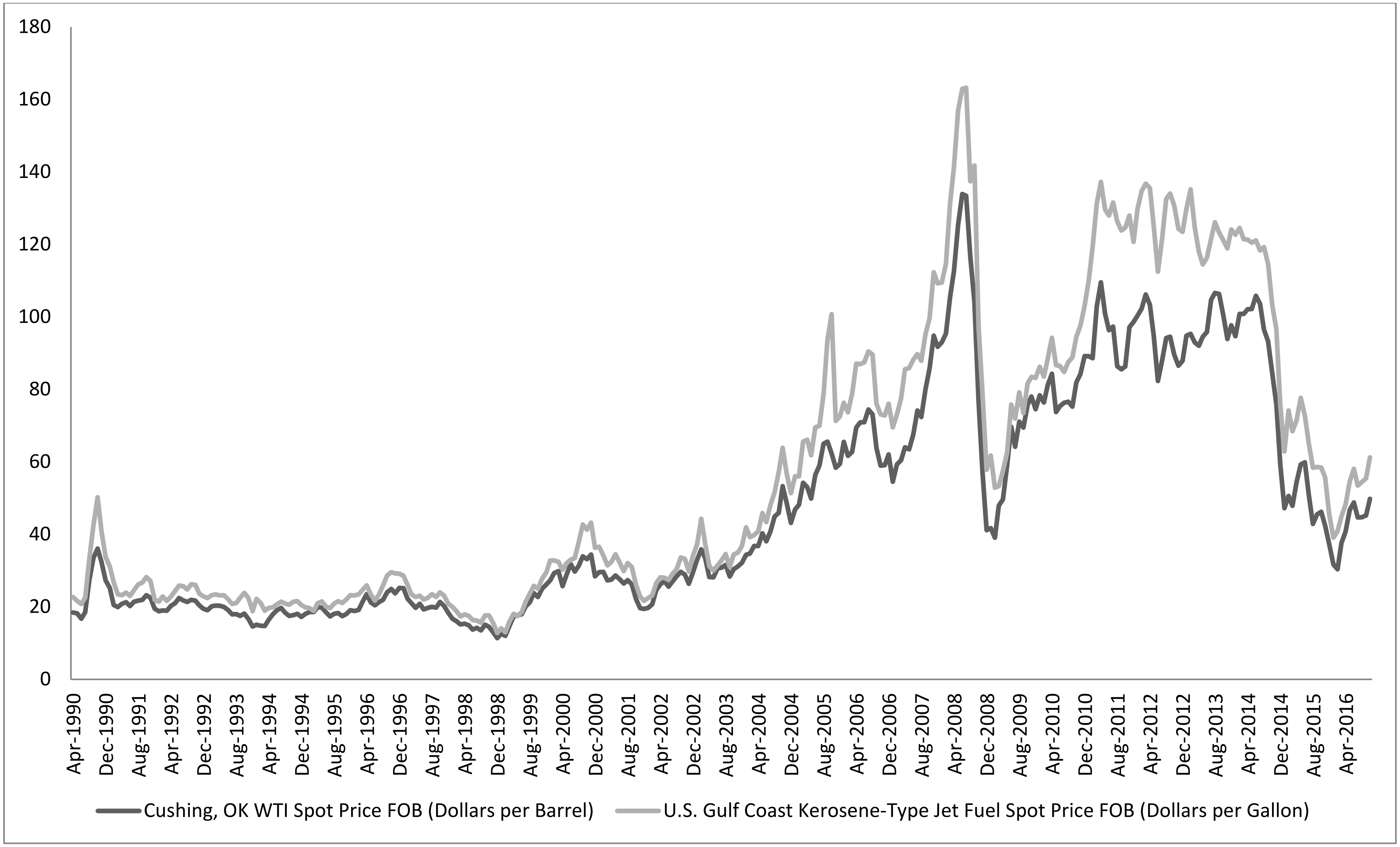


Table 1. Summary statistics for U.S. airline industry for the U.S. airline industry over 1995-2014

This table summarize U.S. airline industry performance over four periods from 1995 through 2014. Data are from the U.S. Bureau of Transportation, Bloomberg, and the Airline Data Project.

Period	**1995-2003**	**2004-2007**	**2008-2011**	**2012-2014**
Commodity Price ($)				
Crude Oil (WTI)	23.17	59.14	84.00	92.30
Crude Oil (Brent)	21.60	57.61	87.39	101.64
Jet Per Barrel	26.38	72.66	102.64	116.68
Jet Crack Spread	4.78	15.05	15.25	15.05
Average U.S. Airfare	306.47	314.55	327.00	350.99
Fuel costs as a percentage of operating expenses (%)				
American	0.12	0.23	0.27	0.29
Delta	0.12	0.21	0.28	0.29
United	0.11	0.22	0.25	0.26
US Airways	0.09	0.19	0.22	0.24
Southwest	0.15	0.24	0.32	0.33
JetBlue	NA	0.30	0.35	0.36
Alaska	0.13	0.24	0.26	0.27
Hawaiian	0.15	0.24	0.29	0.32
All Airlines	0.12	0.22	0.27	0.29
Average cost per gallon ($)				
American	0.65	1.71	2.52	2.85
Delta	0.62	1.80	2.82	3.18[2]
United	0.69	1.75	2.43	2.91
US Airways	0.66	2.21	2.49	2.84
Southwest	0.66	1.32	2.46	3.16
JetBlue	0.37	1.69	2.58	2.91
Alaska	0.67	1.78	2.59	2.92
Hawaiian	0.71	1.84	2.52	2.87
All Airlines	0.66	1.71	2.57	2.99
	2000-2003	**2004-2007**	**2008-2011**	**2012-2014**
Net Income/Loss (Million $)				
American	-1422.00	-218.25	-523.25	-276.00
Delta	-608.25	-3401.75	-1559.50	4069.33
United	-2028.75	95.50	-1226.50	326.67
US Airways	-642.75	-152.75	0.00	0.00
Southwest	424.25	460.75	228.50	770.33
JetBlue	44.00	10.75	41.25	232.33
Alaska	-53.93	12.80	120.33	476.33
Hawaiian	-22.20	-13.28	63.23	58.01
All Airlines	-4633.96	-4032.70	-5120.65	6000.01

[2] Delta's high average fuel cost over this period is largely due to losses on their derivatives hedging position when oil prices dramatically decreased in 2014. This severity of these losses are shown in Table 3.

Table 2. Timeline of major events pre- and post-Trainer acquisition

This table presents a timeline of major events related to the Trainer acquisition. Information is gathered from SEC filings, media announcements, and the Energy Information Administration.

During 2011	Many shutdowns of refineries in the east coast: • ConocoPhillips idled its Trainer refinery (185,000 barrels per day [bbl/d]) in September 2011. • Sunoco's Marcus Hook refinery (178,000 bbl/d) was idled in December 2011 • HOVENSA's U.S. Virgin Islands refinery (350,000 bbl/d) closed in February 2012. • Sunoco has announced plans to close the Sunoco Philadelphia refinery (335,000 bbl/d) in July 2012 if no buyer is found. In sum, this represent around 50% of U.S. East Coast Refineries Operating Capacity.
April 30, 2012	On April 30, 2012, Delta Airlines announced its plan to purchase Phillips 66's Trainer refinery in Pennsylvania. Monroe, Delta subsidiary, invested $180 million received a $30 million grant from the Commonwealth of Pennsylvania. The acquisition includes pipelines and terminal assets that will allow the refinery to supply jet fuel to our airline operations throughout the Northeastern U.S., including our New York hubs at LaGuardia and JFK. Monroe Energy will exchange gasoline and other refined products from Trainer for jet fuel from Phillips 66 and BP elsewhere in the country through multi-year agreements. The remaining production of non-jet fuel products is being sold to BP under a long-term buy/sell agreement effectively exchanging those non-jet fuel products for jet fuel.
September 2012	The Trainer refinery has started production under a new management team from September 2012 onwards
March 2014	Monroe received its first shipment of Shale oil
June 2014	A multi-year product exchange agreement with a significant counterparty, BP Products North America, Inc., was terminated early effective July 1, 2014, and replaced with another unnamed counterparty.
July 2014	Monroe announced that Bridger LLC, privately held midstream company, would supply 65,000 bpd of North Dakota Bakken crude to its refinery, helping it reduce its reliance on more costly imports.
July 2014	Monroe Energy, the Delta subsidiary has time-chartered the 330,000-barrel MR Seabulk Arctic, a Jones Act vessel built in 1998, for two years beginning in August.
Feb 2015	Delta reports 105 million in Trainer profits for 2014 year
July 2015	Monroe sourced oil from Nigeria. Trainer has not imported more than two million barrels of Nigerian crude in any month since June 2013. The narrowing spread has made it about $2 a barrel cheaper to import West African crude than to ship Bakken by rail from North Dakota.
February 2016	Delta report 290 million from refinery operations during 2015

Figure 2. Trainer's supply of jet fuel to Delta, 2Q2013-4Q2016

The figure depicts quarterly jet fuel consumed by Delta and the amount sourced from Trainer. Trainer supply includes jet fuel production fuel obtained through swaps for other refined products. Data are sourced from Delta SEC filings.

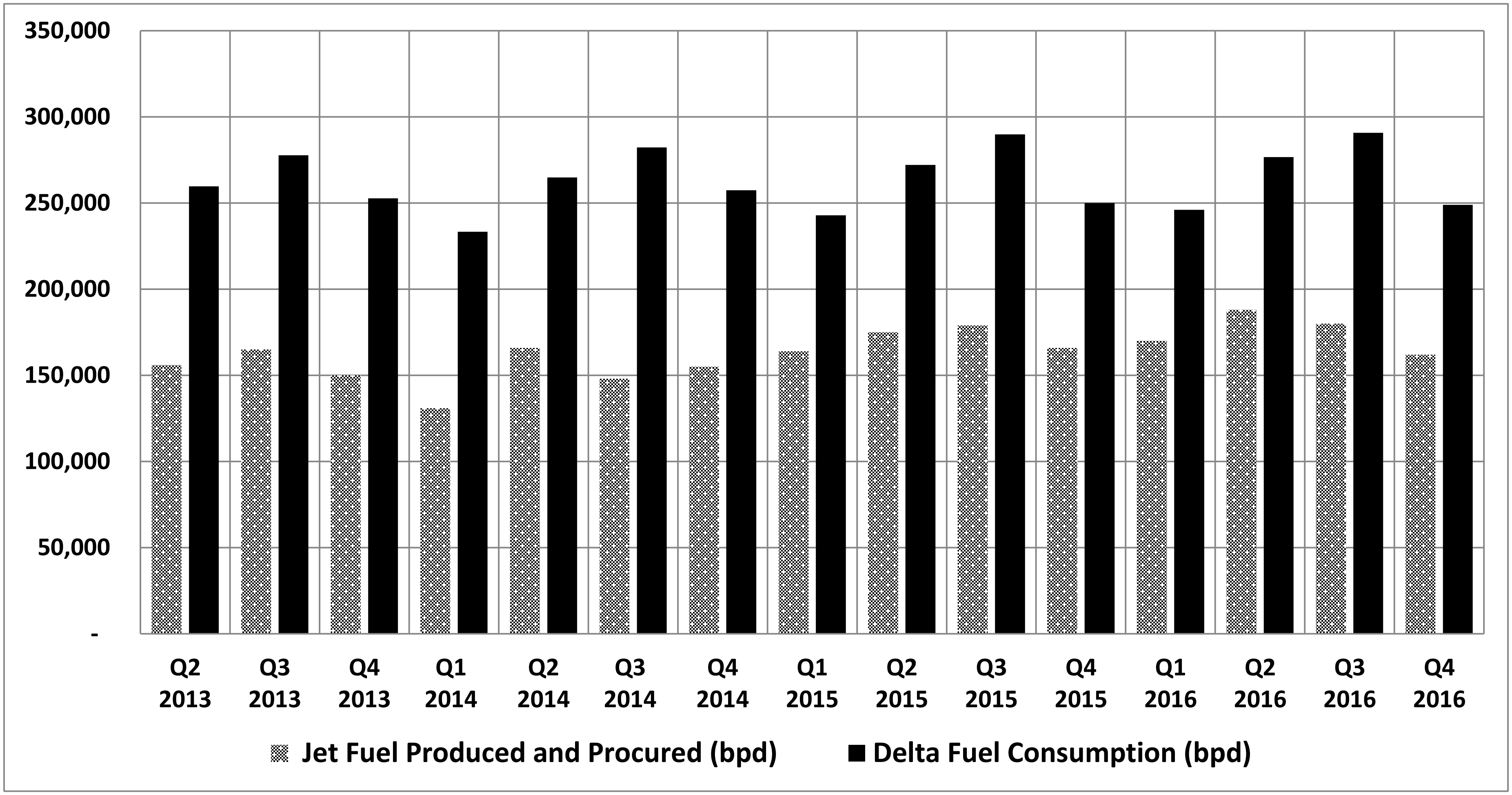


Figure 3. Swap agreements between Delta and Phillips 66 and BP

This figure explains the original two swap agreements between Delta, Phillips 66, and BP. The BP agreement was terminated in July 2014 and replaced with a different swap agreement with undisclosed parties. This graphic is taken from Delta's 2012 SEC 10-K filing.

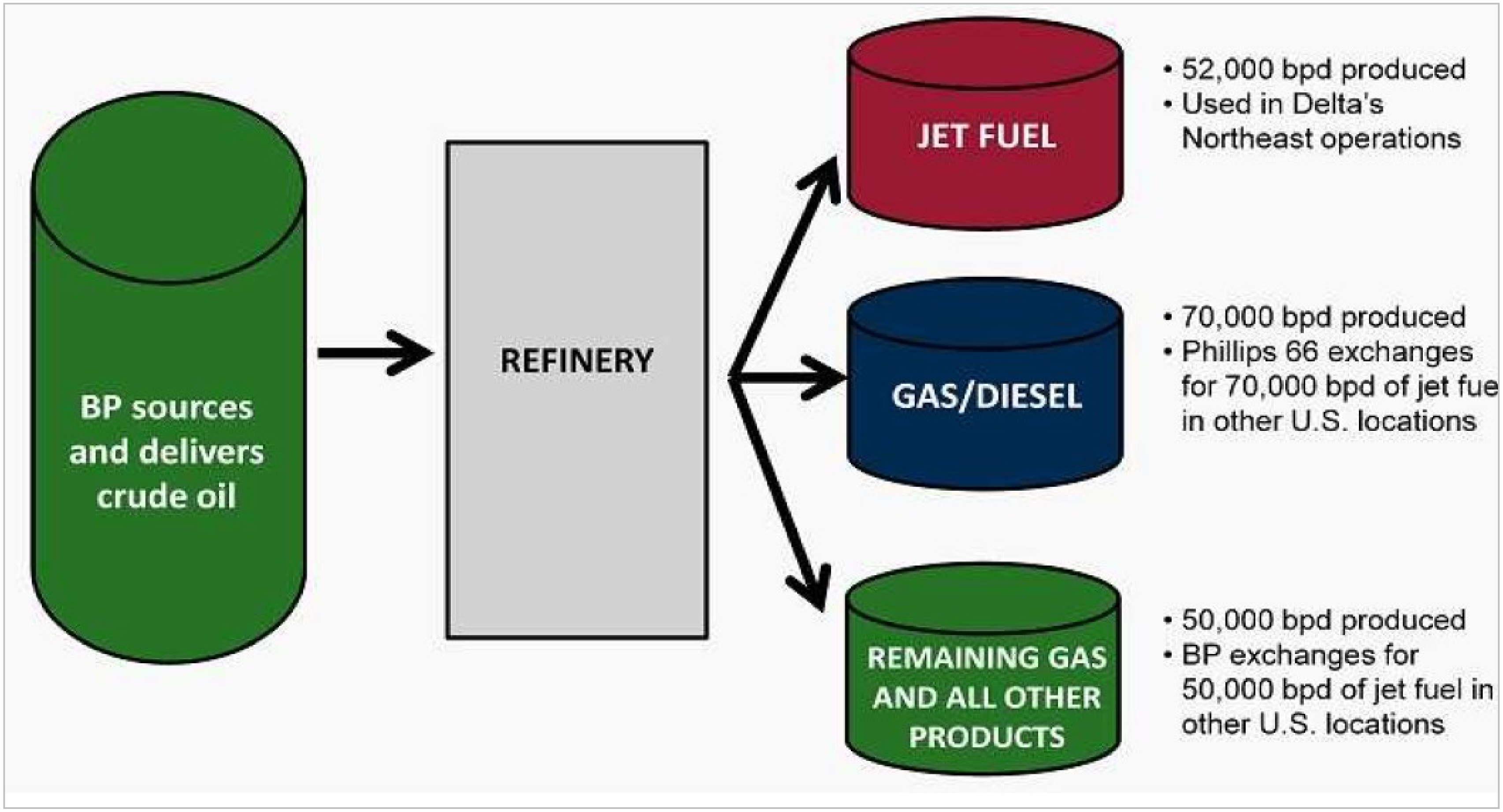


Table 3. Delta's gain/loss from hedging and from refinery operations, 4Q2012-4Q2015

The table shows the gain/loss from Delta's financial hedging program along with the gain/loss from its refinery segment from Q4 2012 through Q2 2016. Data are sourced from Delta's SEC filings. Gain/Loss from hedging program includes only Delta's fuel hedge program. It excludes other hedging programs like foreign exchange and interest rate hedging.

	Gain/Loss From Hedging Program (millions $)	**Refinery Operating Income/Loss (millions $)**
Q4-2012	**40**	**-63**
Q1-2013	**77**	**-22**
Q2-2013	**-116**	**-51**
Q3-2013	**352**	**3**
Q4-2013	**150**	**-46**
Q1-2014	**73**	**-41**
Q2-2014	**99**	**13**
Q3-2014	**-284**	**19**
Q4-2014	**-2146**	**105**
Q1 2015	**-467**	**86**
Q2 2015	**126**	**90**
Q3 2015	**-349**	**106**
Q4 2015	**-245**	**8**
Q1 2016	**-273**	**-28**
Q2 2016	**3**	**-10**
Sum ($)	**-2960.0**	**169.0**
Mean ($)	**-197.3**	**11.3**
Std. ($)	**584.0**	**58.7**
Coef. Of Var.	**-0.338**	**0.192**

Table 4. Hedging policies for Delta and other airlines

The table shows hedge ratios for Delta and other publicly traded U.S. airlines from 2008 through December 2016. Hedge ratios are defined as the percentage of next quarters anticipated fuel consumption hedged by petroleum-product based derivatives. Columns 1 through 12, respectively, list hedge ratios for Delta (DAL), AirTran (AAI), Allegiant (ALGT), Alaska (ALK), American (AAL), Frontier (FRNT), Hawaiian (HA), JetBlue (JBLU), US Airways (LCC), Southwest (LUV), Spirit (SAVE), and United (UAL) while each is in our sample. Though SkyWest is a publicly traded U.S. airline, it is a contractor that operates small, regional flights for larger airlines. As such, its fuel expenses are reimbursed by the contracting airlines and has no need for a hedging program. Data are sourced from SEC filings.

Quarter Ending	Hedge Ratio for:											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	DAL	AAI	ALGT	ALK	AAL	FRNT	HA	JBLU	LCC	LUV	SAVE	UAL
Dec-16	5%		0%	42%	0%		50%	10%		63%	0%	0%
Sep-16	1%		0%	50%	0%		50%	12%		72%	0%	13%
Jun-16	4%		0%	50%	0%		40%	24%		71%	0%	12%
Mar-16	1%		0%	47%	0%		50%	0%		60%	0%	12%
Dec-15	12%		0%	50%	0%		35%	0%		0%	0%	17%
Sep-15	19%		0%	50%	0%		50%	15%		0%	23%	23%
Jun-15	20%		0%	50%	0%		47%	14%		65%	19%	22%
Mar-15	23%		0%	50%	0%		50%	17%		0%	35%	15%
Dec-14	46%		0%	50%	0%		39%	17%		0%	35%	22%
Sep-14	100%		0%	50%	0%		65%	27%		20%	29%	39%
Jun-14	72%		0%	50%	0%		52%	23%		41%	50%	21%
Mar-14	100%		0%	50%	16%		47%	13%		34%	0%	22%
Dec-13	100%		0%	50%	19%		36%	16%	0%	43%	0%	24%
Sep-13	86%		0%	50%	40%		36%	27%	0%	48%	21%	45%
Jun-13	61%		0%	50%	34%		38%	26%	0%	93%	17%	47%
Mar-13	40%		0%	50%	28%		55%	18%	0%	82%	0%	32%
Dec-12	47%		0%	50%	21%		63%	5%	0%	12%	5%	31%
Sep-12	58%		0%	50%	39%		67%	23%	0%	29%	10%	44%
Jun-12	47%		0%	50%	40%		66%	23%	0%	46%	19%	45%
Mar-12	42%		0%	50%	32%		65%	20%	0%	0%	8%	34%
Dec-11	32%		0%	50%	21%		62%	27%	0%	6%	40%	29%
Sep-11	40%		0%	50%	52%		56%	40%	0%	45%	38%	47%
Jun-11	35%		0%	50%	48%		56%	43%	0%	50%	3%	41%
Mar-11	25%	63%	0%	50%	38%		56%	38%	0%	35%		36%
Dec-10	38%	52%	0%	50%	35%		59%	32%	0%	52%		28%
Sep-10	37%	58%	0%	50%	40%		53%	43%	0%	40%		55%
Jun-10	35%	64%	0%	50%	42%		60%	47%	0%	48%		72%
Mar-10	28%	45%	0%	50%	34%		56%	42%	0%	44%		49%
Dec-09	22%	41%	0%	50%	24%		50%	60%	0%	50%		36%
Sep-09	17%	55%	0%	50%	31%		54%	58%	0%	31%		55%
Jun-09	20%	52%	0%	50%	32%	20%	54%	12%	4%	37%		73%
Mar-09	22%	45%	0%	50%	32%	0%	54%	8%	9%	29%		52%
Dec-08	16%	33%	0%	50%	38%	24%	49%	8%	14%	10%		34%
Sep-08	66%	84%	0%	50%	32%	24%	42%	53%	45%	85%		49%
Jun-08	44%	66%	0%	50%	27%	0%	29%	41%	39%	80%		10%
Mar-08	29%	41%	0%	50%	24%	0%	15%	32%	31%	70%		25%

Figure 4. Hedging activities of Delta Air Lines, March 2011-March 2017

This figure shows the notional balance in barrels that underlies Delta's derivatives contracts along with the latest maturity of these contracts at the end of each quarter. Data are sourced from Delta's SEC filings.

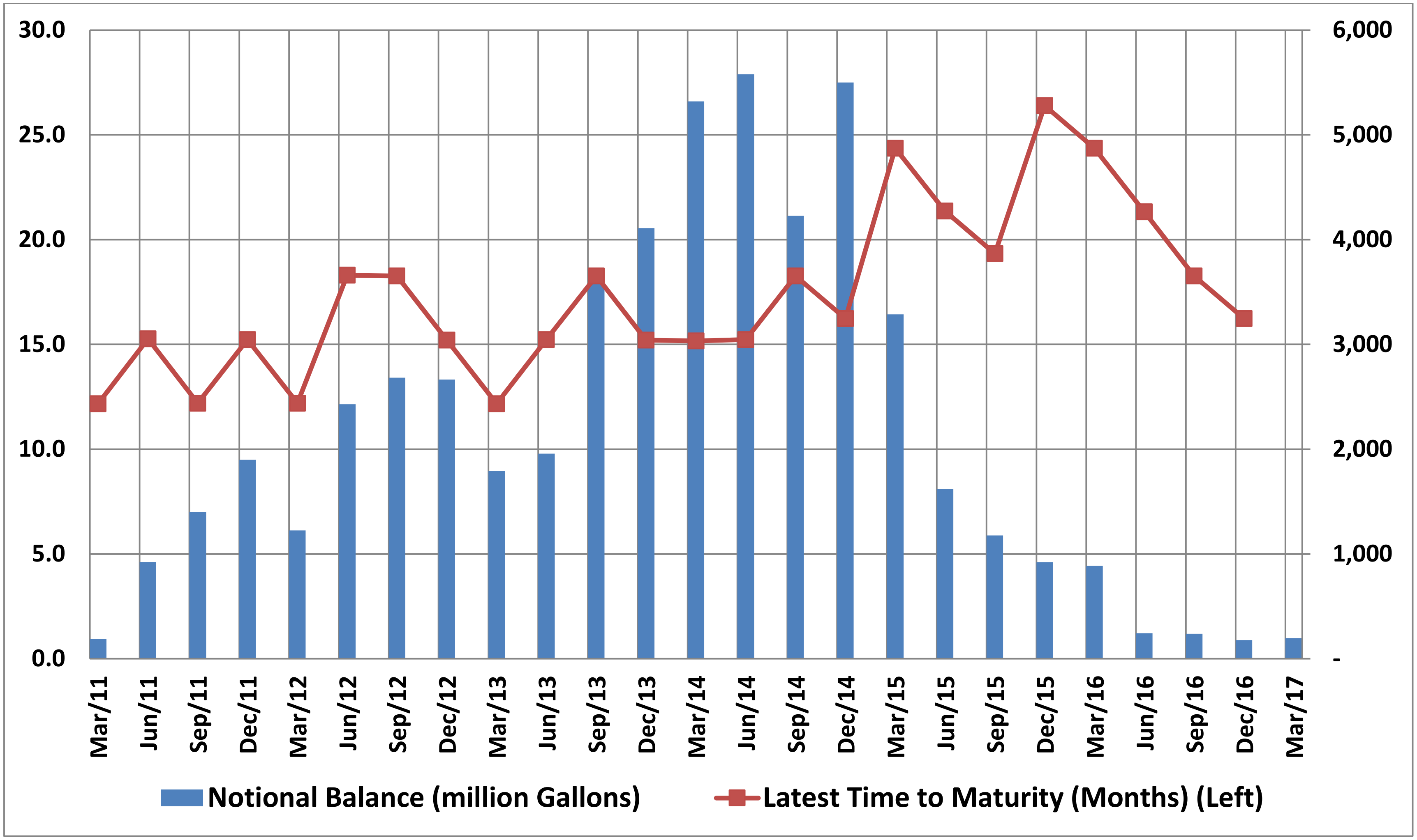


Table 5. Delta Airlines and its peers

The table shows each airline's market state between 2009 and 2016 as well as its average annual available seat miles (ASM) and market share based on Revenue Passenger. ASM and market share figures come from the Bureau of Transportation Statistics.

Airline	Ticker	Market State, 2009 through 2016	ASM (million)	Market Share (%)
Delta	DAL	Trading throughout the period. On October 29, 2008, Delta acquired Northwest airlines. Delta and Northwest began reporting jointly in January 2010.	108,016	16.28
United	UAL	On October 1, 2010, United acquired Continental Airlines. United changed its name from United to United Continental.	107,776	16.12
Southwest	LUV	Trading throughout the period	106,384	15.05
American	AAL	American Airlines parent, AMR Corp., filed for bankruptcy protection in November 2011. After its emergence from Chapter 11, It acquired US Airways Group and start trading under AAL from 12/6/2013. American and US Airways began reporting jointly as American Airlines (AAL) in July 2015	87,238	12.90
US Airways	LCC	Merged with American Airlines. Last trading day under LLC was 12/6/2013.	53,783	8.10
JetBlue	JBLU	Trading throughout the period	33,596	4.98
Alaska	ALK	On November 12, 2010, SkyWest, Inc. completed its acquisition of ExpressJet airlines	25,579	3.89
AirTran	AAI	Stopped trading on May 2, 2011 after being acquired by Southwest Airlines. Southwest and AirTran began reporting jointly in January 2015.	23,342	3.36
SkyWest.	SKYW	Trading throughout the period	15,880	2.29
Virgin America	VA	Offered to public in 14/11/2014 and has been trading ever since.	12,053	1.69
Frontier	FRNT	Frontier Airlines 's stock was suspended on April 22, 2008 after it filed for Chapter11. In October 2013, Frontier was sold to the private equity firm Indigo Partners.	10,462	1.65
Hawaiian	HA	Trading throughout the period	9,912	1.51
Spirit	SAVE	Went public in May 2011 and has been trading ever since	9,685	1.47
Allegiant	ALGT	Trading throughout the period	6,967	1.10

Table 6. Stock market event study results

This table presents the results of an event study of stock market reactions around Delta's announcement to purchase the Trainer refinery. Expected returns are estimated using the Market Model. The announcement date, April 30, 2012, is day zero. Panel A lists the cumulative abnormal return, CAR, over the (+1,-1) period while Panel B lists daily abnormal returns for the 7 days centered on the announcement date. The Patell z-score tests for statistical significance of abnormal returns and cumulative abnormal returns. Boldface denotes significance at the 10% level.

Panel A: Cumulative Abnormal Return (CAR)

Window	CAR	Patell Z	p-value
(-1,+1)	**5.71%**	**1.309**	**0.0952**

Panel B: Abnormal Returns (AR)

Day	AR	Patell Z	p-value
-3	-1.73	-0.686	0.2463
-2	-1.67	-0.664	0.2533
-1	**3.61**	**1.434**	**0.0758**
0	1.87	0.741	0.2294
1	0.23	0.093	0.4628
2	-1.46	-0.581	0.2805
3	1.91	0.758	0.2241

Table 7. Synthetic Control Method (SCM) event study results

The table shows the results of SCM described in Abadie & Gardeazabal (2003). We construct a synthetic match for Delta by solving the following program:

$$\{w_i\}_{i \in \text{Control Group}} = \text{argmin} \sum_{t}^{T} \left(R_{Delta,t} - \sum_{i} w_i R_{i,t} \right)^2$$

subject to $\sum \omega_i = 1$ where [t,T] is the estimation window in the pre-acquisition period and ω_i is the weight assigned to the stock return of the airline i. Once ω_i for each airline in the control group is determined, the $CAR_{Delta}(-1,+1)$ is calculated as:

$$CAR_{Delta}(-1,+1) = \sum_{-1}^{+1} \left(R_{Delta,t} - \sum_{i} w_i R_{i,t} \right) .$$

We repeat the same analysis replacing Delta with each other airline in the control group and calculate its $CAR_i(-1,+1)$ over the same window. These $CAR_i(-1,+1)$s help construct a distribution of cumulative returns that is not caused by the treatment against which the significance of $CAR_{Delta}(-1,+1)$ is tested. The pool of control units consists of public airlines, among those in Table 5, that were actively trading at the time of the announcement. Namely, United (UAL), SkyWest (SKYW), Southwest (LUV), Jet Blue (JBLU), Hawaiian (HA), Alaska (ALK), Spirit (SAVE) and U.S. Airways (LCC). The announcement was in April 30, 2012. We use observations from January 1, 2011 to 50 days before the announcement in the estimation window. Data on stock market returns come from CRSP.

	DAL	**ALGT**	**ALK**	**FRNT**	**HA**	**JBLU**	**LCC**	**LUV**	**SKYW**	**UAL**
					CAR(-1,1)					
	0.051	0.022	-0.029	0.008	-0.002	-0.005	0.011	-0.050	0.017	-0.055
Day					**Abnormal Return**					
-3	-0.008	-0.001	0.006	0.086	-0.017	0.027	-0.019	0.004	-0.030	-0.008
-2	-0.005	-0.010	-0.009	-0.001	0.005	0.033	0.023	0.031	0.006	-0.034
-1	0.019	0.012	-0.023	0.036	0.011	0.019	0.002	-0.014	0.003	-0.036
0	0.017	-0.018	0.004	-0.029	-0.007	-0.009	0.010	0.012	0.022	-0.012
1	0.015	0.029	-0.011	0.000	-0.006	-0.014	0.000	-0.048	-0.009	-0.007
2	-0.016	0.038	-0.027	0.002	0.006	0.023	-0.007	0.047	-0.018	-0.006
3	0.001	0.023	-0.006	-0.004	-0.010	0.038	-0.001	-0.065	0.018	-0.018
Airline					**Weights on Each Airlines in the Control Group**					
DAL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ALGT	0.000	NA	0.395	0.000	0.109	0.000	0.133	0.267	0.497	0.144
ALK	0.022	0.454	NA	0.325	0.475	0.000	0.402	0.167	0.228	0.000
FRNT	0.000	0.000	0.000	NA	0.013	0.031	0.108	0.107	0.000	0.116
HA	0.094	0.062	0.120	0.009	NA	0.101	0.000	0.000	0.000	0.000
JBLU	0.230	0.021	0.000	0.146	0.205	NA	0.000	0.000	0.000	0.101
LCC	0.201	0.118	0.319	0.284	0.000	0.000	NA	0.080	0.055	0.038
LUV	0.078	0.072	0.039	0.085	0.000	0.000	0.023	NA	0.220	0.000
SKYW	0.041	0.115	0.058	0.010	0.000	0.000	0.046	0.179	NA	0.000
UAL	0.335	0.158	0.000	0.142	0.000	0.194	0.068	0.000	0.000	NA

Table 8. Bond market event study results

This table presents bond market event study results around Delta's April 30, 2012 announcement to purchase the Trainer refinery. Delta's returns are compared against three benchmarks: all other airline bond returns, returns from a sample of all bonds matched to each Delta bond on maturity and credit rating, and returns from airline bonds matched on maturity and rating. Panel A describes raw and standardized returns for the four groups. R (SR) denotes raw (standardized) returns. Panels B tests for mean and median differences between Delta's and various benchmarks returns using the Students T and Wilcoxon Signed Rank tests, respectively. P-values from those tests are reported beside mean and median differences. Panel C replicates these tests for standardized returns.

Panel A: Descriptive Statistics

Benchmark	Bonds	Returns	Pct+	Mean R	Mean SR	Median R	Median SR
Delta	4	27	0.9259	0.0101	1.1869	0.0093	1.1484
Airlines	33	240	0.7000	0.0048	0.2038	0.0037	0.2042
Matched	1808	120463	0.7532	0.0050	0.3763	0.0045	0.3792
Airlines Matched	8	88	0.8068	0.0043	0.2709	0.0037	0.2888

Panel B: Raw Returns

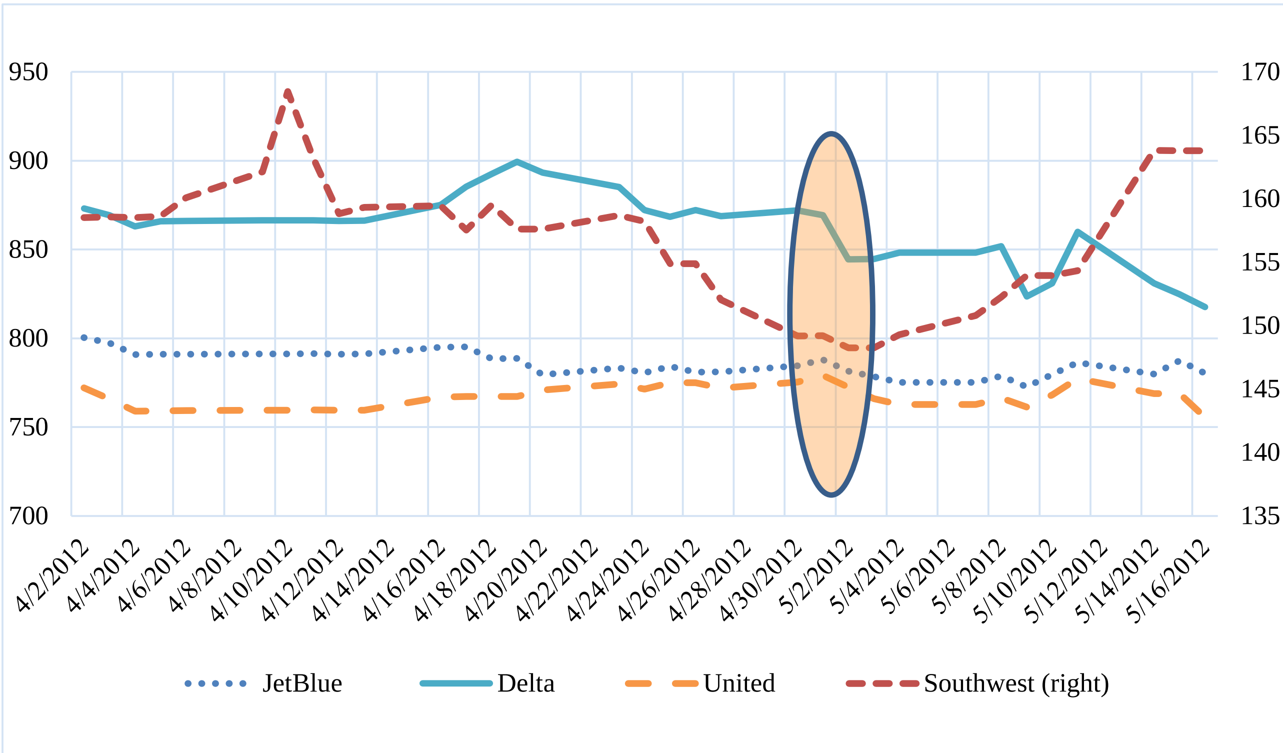
Benchmark	Dif Mean	Student's t p-value	Dif Med	Signed Rank S p-value
Airlines	0.0057	0.0009	0.0044	0.0006
Matched	0.0043	0.006	0.0029	0.0122
Airlines Matched	0.0074	0.0006	0.0091	0.0003

Panel C: Standardized Returns

Benchmark	Dif Mean	Student's t p-value	Dif Med	Signed Rank S p-value
Airlines	0.9898	<.0001	0.9278	<.0001
Matched	0.8043	<.0001	0.7631	<.0001
Airlines Matched	1.0539	<.0001	1.0660	<.0001

Figure 5. Daily spreads of credit default swaps

The first figure depicts the level of credit default swap (CDS) spreads on 5 year CDSs for Delta, JetBlue, Southwest and United senior debt.. The second figure depicts the change in CDS levels. CDS spreads are sourced from Datastream.



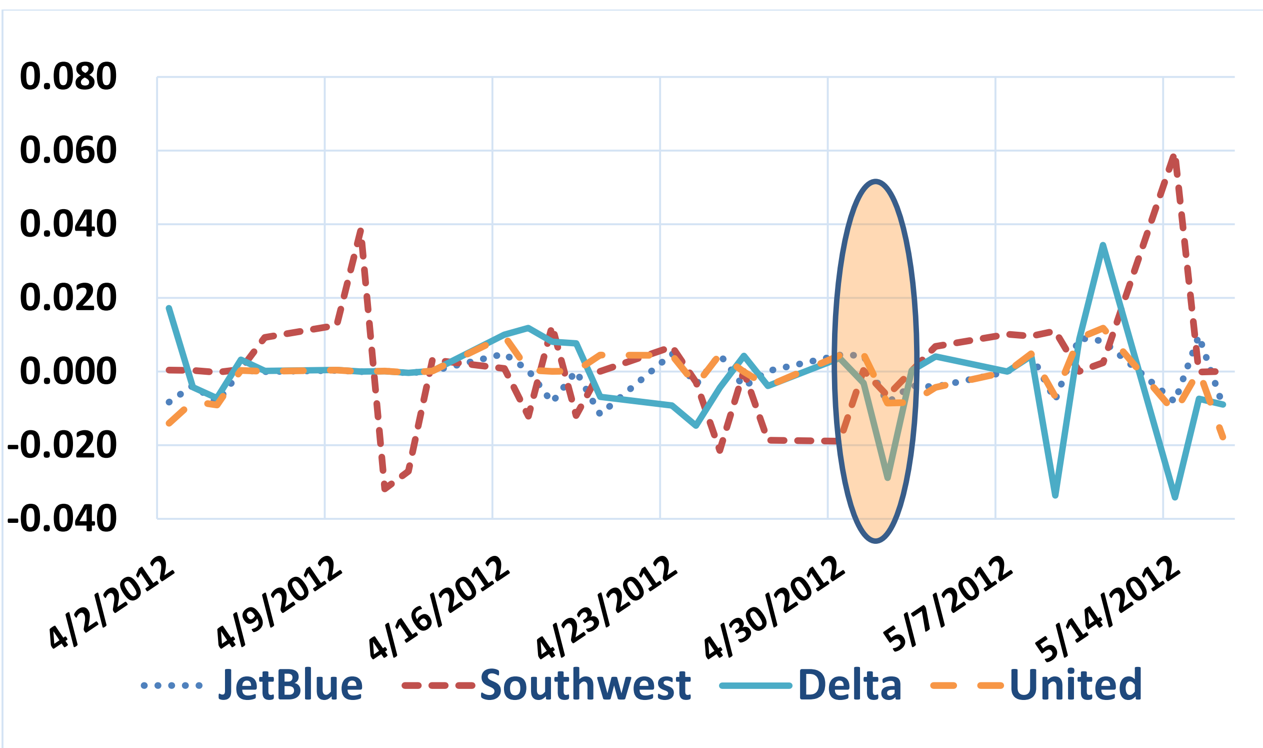


Figure 6. Rolling standard deviations with and without Trainer refinery, December 2009-July 2016

The figure depicts the 50-week rolling standard deviation of the change in jet fuel price according to the following equation:

$$Var(\Delta P_J) = \alpha_m^2 Var(\Delta P_c) + Var(\Delta \mathrm{P_o}) + 2\alpha_m Cov(\Delta P_c, \Delta P_o)$$

The vertical axis depicts the square root of the right hand side of the above equation, which measures the variability of the change in jet fuel cost with Trainer (the case where $\alpha_m = 0.6$) and without Trainer (the case where $\alpha_m = 1$). Data are weekly.

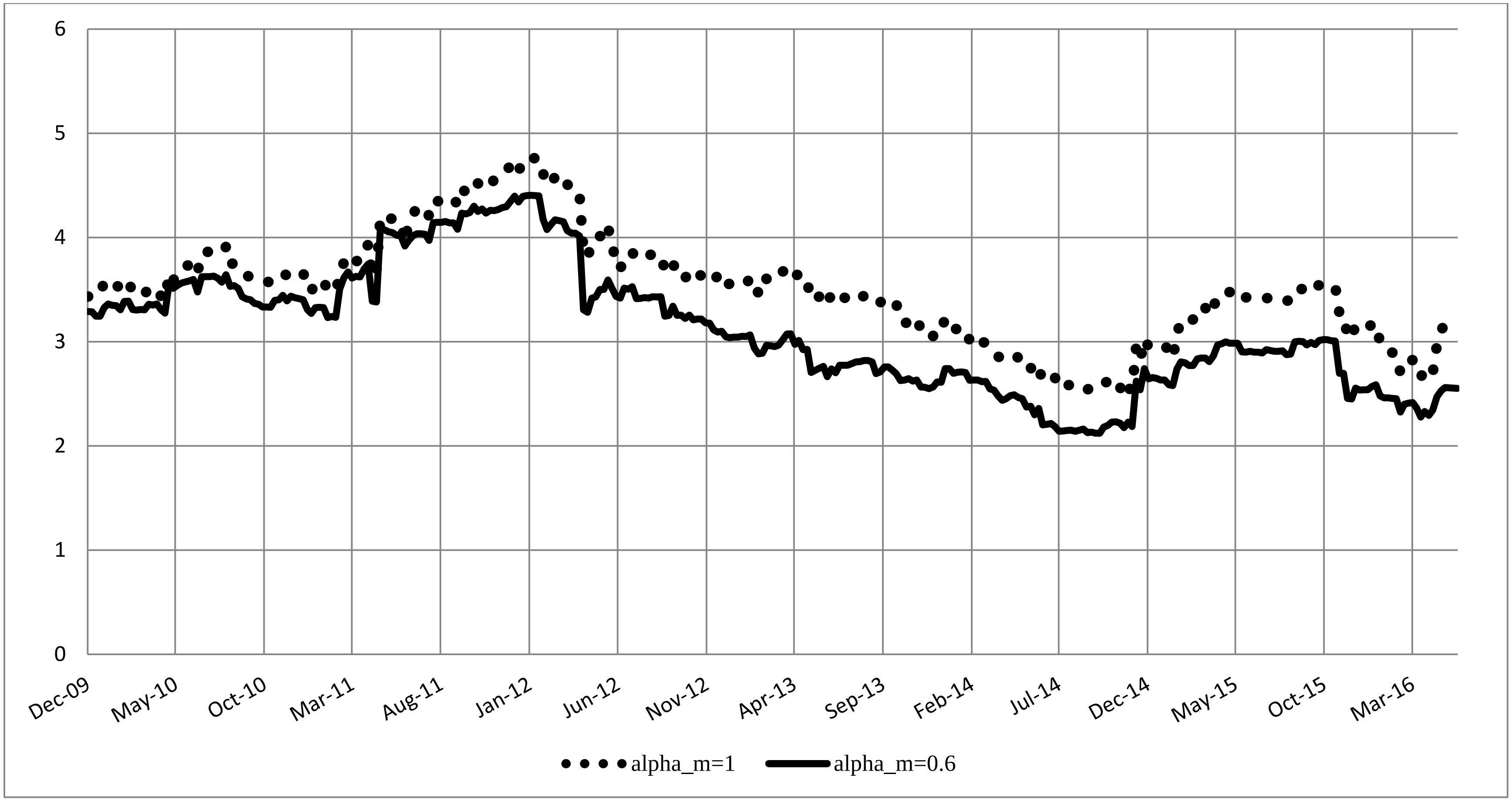


Table 9. Delta's equity exposure: Separate regressions

The table shows the result of the following regression:

$$R_{i,t} = \alpha_i + \beta_m R_{m,t} + \beta_o R_{o,t} + \beta_c R_{c,t} + \beta_p post_t + \beta_{po} post_t \times R_{o,t} + \beta_{pc} post_t \times R_{c,t} + \beta_{oh} HR_{i,t} \times R_{o,t} + \beta_{ch} HR_{i,t} \times R_{c,t} + \epsilon_{i,t}$$

Where $post_t$ is a dummy for the post-Trainer period. $R_{m,t}$ is the log return on CRISP value-weighted portfolio as a proxy for the market portfolio. $R_{c,t}$ is the log return on the crack spread, measured by the difference between jet fuel price and oil price. $R_{o,t}$ is the log return on the price of WTI (left columns of Panel HR_i is the last hedging ratio of airline i observed at time t. In Panel B, $R_{o,t}$ is calculated using WTI benchmark. Weekly observations from the beginning of 2009 to May 2017 were used for the estimation. Price data were obtained from CRISP and hedging ratios were obtained from the companies' quarterly filings. Panel A shows the result for Delta and Panel B shows the result for other airlines. ALGT and has a zero hedge policy and ALK has a constant hedge policy. SKYW is a contractor that operates small regional flights for larger airlines. As such, its fuel expenses are reimbursed by the contracting airline. Therefore, it has no need for a hedging policy. White cross-section standard errors were used.

i		C	RM	RO	RC	RO x HR	RC x HR	POST	POST x RM	POST x RO	POST x RC	R2	N
DAL	Coef.	0.000	1.710	-0.389	0.028	-0.388	-0.001	0.001	-0.101	0.344	-0.054	0.354	424
	Prob.	0.956	0.000	0.000	0.308	0.005	0.990	0.809	0.681	0.002	0.056		
HA	Coef.	0.000	1.565	0.905	0.025	-2.394	-0.041	0.002	0.389	-0.083	-0.004	0.341	424
	Prob.	0.959	1.565	0.240	0.877	0.071	0.889	0.744	0.206	0.726	0.928		
JBLU	Coef.	-0.002	1.842	-0.585	-0.015	0.336	-0.022	0.004	-0.391	0.370	0.019	0.362	424
	Prob.	0.672	0.000	0.000	0.620	0.374	0.830	0.414	0.117	0.005	0.553		
LCC	Coef.	0.003	2.294	-0.704	0.029	0.334	-0.650	-0.003	-0.070	0.474	-0.073	0.309	246
	Prob.	0.626	0.000	0.000	0.581	0.919	0.228	0.753	0.895	0.087	0.360		
LUV	Coef.	-0.001	1.461	-0.388	-0.007	0.174	0.018	0.005	-0.129	0.195	0.004	0.424	424
	Prob.	0.772	0.000	0.000	0.754	0.248	0.768	0.150	0.483	0.021	0.889		
UAL	Coef.	0.004	2.061	-0.814	0.028	0.264	0.011	-0.003	-0.404	0.609	-0.036	0.310	424
	Prob.	0.467	0.000	0.003	0.768	0.688	0.952	0.655	0.219	0.001	0.578		
SAVE	Coef.	0.003	0.940	0.153	0.147	-0.440	0.006	-0.003	0.719	-0.183	-0.177	0.297	300
	Prob.	0.595	0.020	0.592	0.117	0.323	0.969	0.680	0.119	0.516	0.054		
ALGT	Coef.	0.001	1.026	-0.421	0.005			-0.001	0.060	0.345	-0.013	0.186	424
	Prob.	0.729	0.000	0.000	0.858			0.855	0.804	0.006	0.677		
ALK	Coef.	0.005	1.492	-0.388	0.018			-0.002	-0.122	0.245	-0.030	0.402	424
	Prob.	0.107	0.000	0.000	0.555			0.550	0.553	0.008	0.387		
SKYW	Coef.	-0.003	0.987	-0.106	0.009			0.003	0.996	-0.044	0.012	0.287	424
	Prob.	0.482	0.000	0.321	0.647			0.620	0.001	0.734	0.701		

Table 10. Delta's equity exposure: Difference-in-Difference estimation

The table shows the result of the following regression:

$$
\begin{aligned}
R_{i,t} = \gamma + \alpha_i + \beta_m R_{m,t} + \beta_o R_{o,t} + \beta_c R_{c,t} + \beta_{oh} HR_{i,t} \times R_{o,t} + \ \beta_{ch} HR_{i,t} \times R_{c,t} \\
+ \beta_p post_t + \beta_{po} post_t \times R_{o,t} + \beta_{pc} post_t \times R_{c,t} \\
+ \beta_{po,DAL}\, post_t \times DAL_t \times \ R_{o,t} + \beta_{pc,DAL}\ post_t \times DAL_t \times \ R_{o,t} R_{c,t} \\
+ \epsilon_{i,t}
\end{aligned}
$$

Where $post_t$ is a dummy for the post-Trainer period. $R_{m,t}$ is the log return on CRISP value-weighted portfolio as a proxy for the market portfolio. $R_{c,t}$ is the log return on the crack spread, measured by the difference between jet fuel price and oil price. $R_{o,t}$ is the log return on the price of WTI. HR_i is the last hedging ratio of airline i observed at time t. α_i is airline dummies. DAL is dummy for Delta airline. Weekly observations from the beginning of 2009 to May 2017 were used for the estimation. Price data were obtained from CRISP and hedging ratios were obtained from the companies' quarterly filings. Airlines included are: Delta, Allegiant, United, SkyWest, Southwest, Jet Blue, Hawaiian, Alaskan, Spirit and U.S. Airways. White cross-section standard errors were used. To preserve space, α_is are not reported.

	Coeff.	p-val
γ	-0.0001	0.9745
R_M	1.6573	0.0000
R_o	-0.4156	0.0000
R_C	-0.0013	0.9395
R_o x HR	-0.1215	0.0822
R_C x HR	-0.0039	0.8560
POST	0.0007	0.7935
POST x R_O	0.2820	0.0000
POST x R_C	-0.0025	0.9043
DAL	-0.0012	0.5692
DAL x R_O	-0.0411	0.4936
DAL x R_C	0.0276	0.0438
DAL x POST	0.0014	0.5647
DAL x POST x R_O	0.0310	0.6574
DAL x POST x R_C	-0.0461	0.0149
R-squared	0.2637	
N (Panel)	3693	
Periods	424	

Table 11. Bond yield difference-in-difference results

The table reports the result of a difference-in-difference OLS regression of airline bond yield spreads. The dependent variable, *spread*, is the spread above the comparable maturity Treasury security. The three difference-in-difference dependent variables are three indicator variables. *Dal* equals 1 if the Delta is the borrower and 0 otherwise; *post* equals 1 if the bond trades after April 30, 2012 and 0 otherwise; and *dal_post* is the interaction between the two. Control variables include the number of years remaining till maturity, daily volume traded, logged assets at the beginning of the quarter, book leverage at the beginning of the quarter, market to book ratio at the beginning of the quarter, hedge ratio at the beginning of the quarter, S&P or Moody's credit rating at the beginning of the quarter, an indicator variable equal to 1 if the bond trades during the rising oil price environment of January 2009 to April 2011and 0 otherwise, an indicator variable equal to 1 if the bond trades during the falling oil price environment of June 2014 to January 2016and 0 otherwise, and indicator variables for various bond characteristics including whether the bond has call, put, convertibility provisions, credit enhancements, whether it specifies collateral, whether it is a senior note, corporate debenture, corporate convertible, or asset backed security, and whether it pays quarterly coupons. Column 1 includes all variables, column 2 swaps the oil_up and oil_down indicators for year fixed effects; Column 3 includes firm-fixed effects; Column 4 includes bond fixed effects; Columns 5 and 6 respectively include investment grade and non-investment grade bonds; and Column 7 uses data from only the two years centered on quarters 2 and 3 of 2012 whereas the other columns employ the 9 years centered on those quarters. Each reports regressions on data truncated at the 1% tails of *spread* except column 8. Standard errors are clustered at the bond level. T-statistics are reported below estimated coefficients. *, **, and *** denote statistical significance at the 10, 5, and 1 percent levels.

	Dependent Variable							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Independent Variable	spread	spread	spread	spread	spread	spread	spread	spread
Delta*Post	-4.694**	-3.699**	-4.732**	-4.364*	-0.280	-6.434**	-3.251**	-19.518*
	(-2.310)	(-2.171)	(-2.079)	(-1.744)	(-0.963)	(-2.229)	(-2.080)	(-1.821)
Delta	3.793**	2.921**		-15.527***	-0.014	6.636**	3.586**	13.230
	(2.178)	(2.062)		(-3.565)	(-0.028)	(2.069)	(2.117)	(1.471)
Post	3.467*	1.514	2.426	3.830	-0.909***	9.087***	2.193	12.665*
	(1.935)	(1.504)	(1.288)	(1.633)	(-9.583)	(3.202)	(1.481)	(1.814)
years remaining	-0.406***	-0.464***	-0.450***	0.325	-0.288***	-0.748***	-0.457***	-0.987
	(-3.679)	(-3.618)	(-3.096)	(0.742)	(-6.396)	(-4.286)	(-3.636)	(-1.345)
trading volume	-0.000	-0.000	-0.000	0.000	0.000	-0.000	0.000*	-0.000
	(-0.302)	(-0.380)	(-0.006)	(0.860)	(1.487)	(-1.052)	(1.947)	(-0.681)
logged assets	-2.163**	-2.393**	-4.095	-3.222**	-0.449*	-3.638***	-3.556**	-0.262
	(-2.314)	(-2.077)	(-0.954)	(-2.088)	(-1.941)	(-3.441)	(-2.592)	(-0.050)
book leverage	3.415	4.419	-0.366	-1.086	3.166**	19.232**	10.462***	1.166
	(1.372)	(1.552)	(-0.075)	(-0.174)	(2.535)	(2.586)	(3.152)	(0.091)
market to book ratio	-0.006***	-0.006***	-0.003*	0.000	-0.002***	0.003	-0.000	-0.009
	(-3.882)	(-3.816)	(-1.841)	(0.103)	(-4.871)	(0.356)	(-0.082)	(-1.180)
hedge ratio	-0.531	-0.880	1.092	0.219	0.020	-4.445	1.053	-6.014
	(-0.581)	(-0.537)	(1.658)	(0.258)	(0.148)	(-1.130)	(0.572)	(-1.572)
rating	-0.836**	-0.897*	-1.260**	-3.338***	0.252	-2.311**	0.027	-4.778*
	(-2.075)	(-1.698)	(-2.003)	(-3.274)	(1.540)	(-2.583)	(0.088)	(-1.815)
oil_up	-3.420	-	-3.160*	-3.278	1.355***	-5.184**	-	-7.970
	(-1.629)	-	(-1.852)	(-1.580)	(6.926)	(-2.474)	-	(-1.423)
oil_down	0.870	-	0.092	0.023	0.070	-0.399	-	11.633
	(1.023)	-	(0.135)	(0.033)	(0.733)	(-0.177)	-	(1.084)
put option	-16.572***	-17.836***	-17.973***	-	-	-12.126***	-28.771***	-4.831
	(-13.401)	(-13.484)	(-13.883)	-	-	(-6.944)	(-16.293)	(-0.584)
convert option	1.250	1.275	-3.946	-	-	1.484	-21.435***	36.214
	(0.201)	(0.211)	(-1.051)	-	-	(0.309)	(-5.822)	(1.604)
covenants	-0.182	-0.028	0.358	-	-0.383	1.065	-1.065	3.927
	(-0.250)	(-0.036)	(0.422)	-	(-1.221)	(0.551)	(-1.294)	(1.092)
collateral	-0.767	-0.886	-1.117	-	0.447	-0.849	-0.221	-3.491
	(-0.928)	(-1.003)	(-1.302)	-	(0.884)	(-0.346)	(-0.136)	(-0.841)
senior	0.933	0.939	1.690	-	0.545**	2.625	-1.767	4.656
	(1.161)	(1.109)	(1.589)	-	(2.061)	(1.027)	(-1.377)	(1.213)
enhancements	-1.510	-1.815*	-1.504	-	0.297	-7.360***	-0.187	-9.453*
	(-1.653)	(-1.770)	(-1.505)	-	(1.052)	(-3.685)	(-0.229)	(-1.693)
call option	11.101***	12.383***	12.001***	-	2.735***	17.478***	26.999***	-15.942
	(2.817)	(3.334)	(3.557)	-	(5.684)	(6.932)	(10.997)	(-0.863)
corporate debenture	0.461	0.371	0.806	-	-1.516***	3.515	0.102	2.138
	(0.473)	(0.395)	(0.816)	-	(-3.299)	(1.167)	(0.053)	(0.466)
corporate convertible	25.015***	26.148***	30.148***	-	-	34.250***	54.654***	20.258
	(3.373)	(3.505)	(7.066)	-	-	(5.758)	(12.717)	(0.986)
asset backed security	-3.827	-4.084	-13.053***	-	-1.238**	-3.252	-	6.695
	(-1.593)	(-1.255)	(-2.674)	-	(-2.177)	(-1.000)	-	(0.546)
quarterly coupon	4.921***	4.984***	4.205***	-	-	7.034**	2.344*	15.159**
	(4.380)	(4.002)	(3.797)	-	-	(2.444)	(1.999)	(2.042)
Constant	17.155*	18.870*	14.503	65.304***	4.752*	13.323	7.132	33.557
	(1.825)	(1.766)	(0.379)	(3.352)	(1.934)	(1.053)	(0.561)	(0.578)
Year FE	No	Yes	No	No	No	No	No	No
Firm FE	No	No	Yes	No	No	No	No	No
Bond FE	No	No	No	Yes	No	No	No	No
Bond Ratings	All	All	All	All	≥ BBB-	< BBB-	All	All
Quarters Included	36	36	36	36	36	36	8	36
Truncation	1/99	1/99	1/99	1/99	1/99	1/99	1/99	No
Observations	26,398	26,398	26,398	26,952	15,815	10,583	5,624	26,976
R-squared	0.399	0.414	0.435	0.504	0.645	0.493	0.656	0.026

Table 12. Loan spread difference-in-difference results

The table reports the result of a difference-in-differences OLS regression of loan spreads on newly issued credit facilities for airlines. The dependent variable, *Spread*, is the spread above the comparable maturity LIBOR rate. The three difference-in-differences dependent variables are three indicator variables. *Delta* equals 1 if the Delta is the borrower and 0 otherwise; *post* equals 1 if the loan is issued after April 30, 2012 and 0 otherwise; and *Delta*Post* is the interaction between the two. Control variables include the facility's maturity, an indicator variable equal to 1 if the loan includes collateral and 0 otherwise, an indicator variable equal to 1 if the loan is a revolving loan and 0 if it is a term loan, the amount borrowed, the number of participants and a constant. Standard errors are clustered at the firm level. t-statistics are reported below estimated coefficients. ** and *** denote statistical significance at the 5 and 1 percent levels.

Variable	Spread
Delta*Post	-70.438**
	(-2.543
Delta	107.812**
	(2.913
Post	-87.404
	(-1.235
Maturity	-0.732
	(-1.602
Collateral	157.342***
	(6.590
D_Revolver	46.202
	(1.105
Amount	0.000**
	(2.471
Participants	-9.276
	(-1.114
Constant	265.896***
	(9.439
Observations	33
R-squared	0.616