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# ASYMMETRIC PRICING AND AIRLINE PERFORMANCE

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## Abstract

We study the relation of asymmetric pricing with operating performance and stock returns of U.S. airlines. We construct two proxies to measure the degree of asymmetric pricing: Degree of Asymmetry (DOA) and Peer-adjusted DOA, and then simultaneously test how the direction and magnitude of asymmetric pricing affect airline performance. We find that raising air ticket price, regardless of whether the fuel cost is increasing or decreasing, is associated with significantly higher sales growth and stock returns than reducing price in the same scenario. However, raising price above industry peers is two-edged: it may increase profit margin, but at the cost of a slowdown in sales growth. The results also suggest airlines that raise price show improved stock returns, especially for those airlines that raise price more than their industry-peers in response to fuel cost increases.

**JEL Codes:** G30, L11, L13, L93

**Keywords:** asymmetric pricing, operating performance, stock returns, degree of asymmetry.

## 1. Introduction

Firms tend to respond fast to input cost increases by raising prices but are reluctant to reduce prices when their costs fall. This phenomenon is known as "rockets and feathers" and has sometimes been used interchangeably with the term "asymmetric pricing" or "price asymmetry" (Tappata, 2009). The pattern has been documented in a broad range of markets (Peltzman, 2000) by extensive empirical studies, including gasoline (Karrenbrock, 1991; Borenstein, Cameron and Gilbert, 1997), bank deposit rates (Neumark and Sharpe, 1992; Jackson, 1997), and municipal bonds (Green, Li and Schürhoff, 2010).

Despite these empirical studies establishing the presence of asymmetric pricing, there exists little work studying the finance implications of this phenomenon. In this study, we aim to fill this void by examining the relation between asymmetric pricing and operating performance as well as stock returns.

More specifically, we contribute to the existing literature in three ways. First, using a comprehensive sample of all US airlines between 2001 and 2016 as a laboratory, we explore the relation of asymmetric pricing with operating performance and stock returns. Two explanations have been identified as the potential causes of asymmetric pricing: focal price collusion and consumer search.[1] The first explanation is focal price collusion. Borenstein et al (1997) suggest that firms would refrain from

[1] These two hypotheses do not exhaust the possible explanations for the price asymmetry, for example, Borenstein et al (1997) also suggest that production lags and finite inventories of gasoline imply asymmetric pricing.

reducing prices in response to an input cost decline and instead rely on past prices as a focal point for coordination. In contrast, if the input cost increases then firms would raise their prices to maintain a positive margin. The second explanation is consumer search. Consumer search models (Borenstein et al, 1997; Yang and Ye, 2008; Tappata, 2009; and Lewis, 2011) suggest that when consumers know that input costs are currently volatile, they tend to believe that a change in selling prices reflects input cost changes. Thus, the expected gain from search may be smaller and consumers search less. Firms realize that this implies a decline in the elasticity of demand and thus increases its margin, i.e. they do not reduce their selling prices in response to an input cost decrease, but they raise, sometimes even "overshooting" their selling prices in response to an input cost increase. A direct consequence of both explanations is that asymmetric pricing is associated with improved profit margin. We find evidence consistent with both explanations. In addition, we expand our analysis to other aspects of firm performances, i.e. sales growth and stock return.

Second, we construct two proxies to measure the degree of asymmetric pricing, *Degree of Asymmetry* (*DOA*) and *Peer-adjusted DOA*. While existing studies focus on the presence of asymmetric pricing, our paper extends the existing literature because we study not only the presence, but also the degree of asymmetric pricing. Third, we employ a novel methodology to test simultaneously how the direction (i.e. whether to raise or reduce the air ticket price in response to fuel cost changes) and the magnitude (i.e. how much to raise or reduce the price) of asymmetric pricing affect airline performance.

To examine the impact of asymmetric pricing on operating performance, we use two measures for operating performance: *Industry-adjusted Sales Growth* and *Profit Margin*. The first layer of results focus on the effect of the direction. We find that airlines that raise their prices, regardless of whether the fuel cost is increasing or decreasing, have a significantly higher sales growth than those that reduce their prices in the same scenario. We also find that airlines that raise their prices have higher profit margin than those that reduce their prices, but this occurs only when the fuel cost is decreasing. The second layer of results focus on the effect of the magnitude. We find that raising price above industry peers turns out to be a double-edged sword: it may increase profit margin, but at the cost of sacrificing sales growth. Another noteworthy fact is that, when fuel cost is increasing, the magnitude effect matters more than the direction effect for profit margin. The reverse is true when fuel cost is decreasing.

Lastly, we examine whether asymmetric pricing predicts stock returns using return regression approach. Regression results suggest that it will improve airlines' stock returns if they raise prices in response to fuel cost change (regardless of the direction of the change), especially for those airlines that raise prices more than their industry-peers in response to fuel cost increases.

The remainder of the paper is organized as follows. Section 2 describes the methodology and data used. The empirical results are presented in Section 3 and Section 4 concludes.

## 2. Methodology and Data Description

### 2.1 Methodology

Because airlines respond asymmetrically to fuel cost increases and fuel cost decreases, i.e. airlines raise prices in response to fuel cost increases, but are reluctant to reduce prices when fuel cost falls, we split the sample into fuel increasing vs. fuel decreasing subsamples. Within each sample, we run the regression specified as follows:

$$R_{i,t} = \beta_0 + \beta_1 D(P_{ir,t} - P_{ir,t-1} \geq 0) + \beta_2 DOA \times D(P_{ir,t} - P_{ir,t-1} \geq 0) + \beta_3 DOA + Controls + \varepsilon_{i,t}\,, \qquad (1)$$

The dependent variables $R_{i,t}$ are firm performance measures (operating performance or stock returns). The key explanatory variables are $D(P_{ir,t} - P_{ir,t-1} \geq 0\ )$, *DOA* and *DOA*× $D(P_{ir,t} - P_{ir,t-1} \geq 0\ )$.

$D(P_{ir,t} - P_{ir,t-1} \geq 0\ )$ is an indicator variable that equals one if $P_{ir,t} - P_{ir,t-1} \geq 0$, and zero otherwise, where $P_{ir,t}$ is the average airline ticket price per mile flown in year-quarter $t$ for a given carrier $i$ operating in market $r$, and market is origin-destination airport pair regardless of direction.

*Degree of Asymmetry (DOA)* is constructed to measure the extent to which airline ticket prices respond to changes of jet fuel cost. It is defined as the absolute value of the ratio of the percentage change in price to the percentage change in fuel cost:

$$DOA = Degree\ of\ Asymmetry = abs\left(\frac{(P_{ir,t}-P_{ir,t-1})/P_{ir,t}}{(C_{i,t}-C_{i,t-1}\ )/C_{i,t}}\right) \qquad (2)$$

Where $C_{it}$ is the average jet fuel cost per mile flown for carrier $i$ in year-quarter $t$. The denominator, $(C_{i,t} - C_{i,t-1}\ )/C_{i,t}$, measures the percentage change in fuel cost between year-quarter $t-1$ and $t$ . The numerator, $(P_{ir,t} - P_{ir,t-1})/P_{ir,t}$, measures the percentage change in airline ticket prices in the same period. Therefore, *DOA* measures the resulting percentage change in airline ticket prices for one percent change in fuel cost.[2] The greater the extent to which airline ticket prices respond to fluctuating fuel cost, the higher the value of DOA is, and vice versa.

Following Azar, Schmalz and Tecu (2018), Cannon (2014) and Scotti and Volta (2018), we include firm size, seats, population, and income as control variables. Firm size is defined as total assets. Seats is defined as the quarterly change in the number of available seats in a given market in year-quarter $t$. Population is the logarithm of the geometric mean of endpoint populations in millions. Income is the logarithm of the geometric mean of endpoint incomes per capita in thousands.

The benefits of Equation (1) are twofold. Firstly, it examines the direction effect of airlines' asymmetric pricing, i.e., whether raising price or reducing price in response to fuel cost changes affect airline performance. Specifically, $\beta_1$ measures the effect of price increases on airlines' performance relative to that of price decreases. Secondly, in addition to test whether the direction effect matters, Equation (1) can also test whether the magnitude effect matters, i.e., how much airlines raise or reduce prices (proxied by $DOA$) and its impact on firm performance. Specifically, $\beta_2$ measures the incremental effect of magnitude of asymmetric pricing on performance above and beyond the direction effect.

## 2.2. Data

### 2.2.1 Airline transportation and DB1B air ticket data

We collect airline statistics at the firm level, including fuel cost and revenue passenger-miles from TranStats Database of the Bureau of Transportation Statistics (BTS).

[2] We take the absolute value of the ratio of the percentage change in price to the percentage change in fuel cost in Equation (2) to ensure the consistency of what $DOA$ is capturing. For example, when fuel costs decrease and air ticket prices increase, without taking the absolute value, $DOA$ would be negative. The more air ticket prices increase in response to a given decline in fuel cost, the lower the value of $DOA$ is. This is the opposite to what we are trying to capture using $DOA$. Therefore, taking the absolute value is necessary.

We collect airline ticket data from Department of Transportation's Airline Origin and Destination Survey (DB1B) database between 2001:Q1 and 2016:Q4 and apply filters to our sample following the airline ticket pricing literature (Borenstein, 1989; Berry, 1990; Borenstein and Rose, 1994, 1995; and Dennis, Gerardi and Schenone, 2018). [3]As a result, we obtain 144,927 year-quarter-market-carrier observations in the initial sample. Information in the DB1B includes itinerary fares, miles flown, endpoint airports, passenger quantities, number of plane changes, fare class, number of seats available, and the identity of the ticketing and operating carrier.

**Table 1: Summary statistics**

| **Panel A: Fuel cost increasing periods** | | | |
|---|---|---|---|
| Variables | Mean | Std Dev | Median |
| *DOA* | 5.591 | 27.117 | 1.120 |
| *Peer-adjusted DOA* | -0.155 | 11.816 | 0.000 |
| *Industry-adjusted Sales Growth* | 5.123 | 2.998 | 4.633 |
| *Profit Margin* | 10.472 | 7.837 | 10.428 |
| *Stock Returns* | 0.049 | 0.206 | 0.048 |
| **Panel B: Fuel cost decreasing periods** | | | |
| *DOA* | 10.392 | 55.047 | 1.408 |
| *Peer-adjusted DOA* | 0.624 | 37.844 | 0.000 |
| *Industry-adjusted Sales Growth* | 5.393 | 3.276 | 4.674 |
| *Profit Margin* | 15.310 | 8.821 | 15.975 |
| *Stock Returns* | 0.054 | 0.209 | 0.047 |

This table reports summary statistics of key variables. The whole sample is split into Fuel cost increasing (Panel A) and Fuel cost decreasing (Panel B) subsamples. *DOA* is the absolute value of the ratio of the percentage change in price to the percentage change in fuel cost: $abs\left(\frac{(P_{ir,t}-P_{ir,t-1})/P_{ir,t}}{(C_{i,t}-C_{i,t-1})/C_{i,t}}\right)$. $P_{ir,t}$ is the average economy-class airline ticket price per mile flown in year-quarter $t$ for a given carrier $i$ operating in market $r$, market is origin-destination airport pair regardless of direction.; $C_{it}$ is the total jet fuel cost normalized by revenue passenger-miles for carrier $i$ during period ending at time $t$. *Peer-adjusted DOA* is the ratio of the percentage change in price to the percentage change in fuel cost minus the median of this ratio across all of its peers in the same market-quarter. *Industry-adjusted Sales Growth* is defined as (sales growth – industry-average sales growth) × $100$. *Profit Margin* is equal to sales minus costs of goods sold, divided by sales, times 100 ($\frac{SALE-COGS}{SALE} \times 100$). *Stock returns* is quarterly stock returns in year-quarter $t$. Average airfare data source is the Department of Transportation's Airline Origin and Destination Survey (DB1B) database, which is constructed by the Bureau of Transportation Statistics (BTS). Quarterly fuel cost and revenue passenger-miles are collected from TranStats Database of the Bureau of Transportation Statistics (BTS) between 2001 Q1 and 2016 Q4.

### 2.2.2 Operating performance and stock returns data

Operating performance data are obtained from Compustat database and stock returns data are from Center for Research in Security Prices (CRSP) database. Table 1 reports summary statistics of key variables in fuel cost increasing (Panel A) and fuel cost decreasing (Panel B) subsamples. The key variables include *DOA*, *Peer-adjusted DOA* (as defined in Equation (3)), *Industry-adjusted Sales Growth, Profit Margin and Stock Returns.*

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[3] The filters applied are summarized below. We eliminate tickets with more than 2 coupons and one-way tickets with two coupons, thus retain only nonstop flights. A coupon is a piece of paper indicating the itinerary of a passenger. We also eliminate tickets for which the ticketing or operating carrier is missing in one or more coupons or tickets with multiple ticketing/operating carriers. Tickets where the operating and ticketing carrier differ in one or more coupons are removed. We also eliminate tickets that include a surface segment. A surface segment is a part of the itinerary to which the plane does not travel. Tickets with non-reporting carriers or foreign carriers or involving coupons outside the lower 48 contiguous US States are removed. Charter and non-US airlines are excluded from our sample. We eliminate tickets flagged as "not credible" or with fare values less than \$20. Fare deemed "not credible" by the BTS means a questionable fare value based on credible limits. Fare values less than \$20 are eliminated from our sample as they are presumably key punch errors, or reporting of frequent flyer bonus trips, which is not done in any consistent way.

## 3. Empirical Results

**Table 2: Asymmetric pricing and operating performance**

| **Panel A: Fuel cost increasing periods** | (1) | (2) |
|---|---|---|
| Variables | *Industry-adjusted Sales Growth* | *Profit Margin* |
| $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ | 0.034*** | -0.055 |
| | (5.83) | (-1.22) |
| *DOA*× $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ | -0.001*** | 0.014*** |
| | (-3.23) | (7.62) |
| *DOA* | 0.001*** | 0.001 |
| | (5.63) | (0.84) |
| Controls | Yes | Yes |
| Observations | 66,027 | 58,321 |
| Adjusted $R^2$ | 0.964 | 0.864 |
| Market-carrier FE | Yes | Yes |
| Year-quarter FE | Yes | Yes |
| **Panel B: Fuel cost decreasing periods** | | |
| $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ | 0.076*** | 0.296*** |
| | (10.59) | (7.81) |
| *DOA*× $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ | -0.001*** | 0.023 |
| | (-5.20) | (0.59) |
| *DOA* | 0.001*** | -0.057*** |
| | (2.13) | (-4.84) |
| Controls | Yes | Yes |
| Observations | 51,817 | 42,871 |
| Adjusted $R^2$ | 0.964 | 0.880 |
| Market-carrier FE | Yes | Yes |
| Year-quarter FE | Yes | Yes |

This table reports the regression results of operating performance measures on airlines' asymmetric pricing in response to fuel cost changes. The whole sample is split into Fuel cost increasing (Panel A) and Fuel cost decreasing (Panel B) subsamples. In model (1), the dependent variable is *Industry-adjusted Sales Growth*, defined as (sales growth − industry-average sales growth) $\times 100$. In model (2), the dependent variable is *Profit Margin*, which is equal to sales minus costs of goods sold, divided by sales, times 100 ($\frac{SALE-COGS}{SALE} \times 100$). $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ is an indicator variable that equals one if $P_{ir,t} - P_{ir,t-1} \geq 0$, and zero otherwise. ($P_{ir,t}$)is the average economy-class airline ticket price per mile flown in year-quarter t for a given carrier $i$ operating in market $r$. *DOA* is the absolute value of the ratio of the percentage change in price to the percentage change in fuel cost: $abs\left(\frac{(P_{ir,t}-P_{ir,t-1})/P_{ir,t}}{(C_{i,t}-C_{i,t-1})/C_{i,t}}\right)$. Control variables include firm size, seats, population, income. Firm size is defined as total assets. Seats is defined as the quarterly change in the number of available seats in a given market in year-quarter $t$. *Population* is the logarithm of the geometric mean of endpoint populations in millions. *Income* is the logarithm of the geometric mean of endpoint incomes per capita in thousands. The coefficients are suppressed for brevity. The specification includes market-carrier and year-quarter fixed effects. Standard errors are clustered at market-carrier levels. T-stats are provided in parentheses. *** $p$ < 0.01, ** $p$ < 0.05, * $p$ < 0.10.

### 3.1 Asymmetric pricing and operating performance

Table 2 reports results from Equation (1), showing how airlines' asymmetric pricing in response to fuel cost changes affect their operating performance. Because airlines respond asymmetrically to fuel cost increases and fuel cost decreases, we split the sample into fuel cost increasing (Panel A) and fuel cost decreasing (Panel B) subsamples. We measure operating performance using *Industry-adjusted Sales Growth* (Model 1) and *Profit Margin* (Model 2).

Panel A shows results in two layers: the direction effect and magnitude effect of asymmetric pricing, respectively. First, on the direction effect, the coefficient on $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ is positive and significant at the 1% level in Model 1 and insignificant in Model 2, indicating airlines that raise their price in response to fuel cost increase have a significantly higher industry-adjusted sales growth than those that reduce their price in the same scenario. Second, on the magnitude effect, the coefficient on $DOA \times D(P_{ir,t} - P_{ir,t-1} \geq 0\ )$ is negative and significant at the 1% level in Model 1, and positive and significant at the 1% level in Model 2. This interesting result implies that raising price too much (proxied by high *DOA*) turns out to be a double-edged sword: it may improve profit margin, but at the cost of a slowdown in sales growth.

Similarly, in Panel B, we start with the direction effect of the asymmetric pricing. The coefficient on $D(P_{ir,t} - P_{ir,t-1} \geq 0\ )$ is positive and significant at the 1% level in both Model 1 and Model 2, indicating airlines that raise their prices in response to fuel cost decreases have a significantly higher industry-adjusted sales growth and profit margin than those that reduce their prices in the same scenario. Second, for the magnitude effect, the coefficient on $DOA \times D(P_{ir,t} - P_{ir,t-1} \geq 0\ )$ is negative and significant at the 1% level in Model 1 and insignificant in Model 2. This implies that raising price too much may cause airlines to decelerate their sales growth.

Another thing needs to be pointed out is that for profit margin, in fuel cost increasing periods, the magnitude effect matters more than the direction effect of asymmetric pricing strategy, i.e., how much to raise the price is more important than whether or not to raise the price. While in fuel cost decreasing periods, the direction effect matters more than the magnitude effect.

### 3.2 Peer-adjusted DOA and operating performance

The finance Literature has documented peer effects in corporate behavior (e.g. Leary and Roberts, 2014; Foucault and Fresard, 2014). If an airline raises price in response to fuel cost changes, but not as much as its peer companies do, then the impact of asymmetric pricing on performance might be minimal. To further explore the peer effects on the asymmetric pricing–operating performance relation, we construct a variation of the original *DOA*: *Peer-adjusted DOA*, defined as the ratio of the percentage change in price to the percentage change in fuel cost minus the median of this ratio across all of its peers in the same market-quarter.

$$Peer - adjusted\ DOA = \frac{\frac{(P_{ir,t} - P_{ir,t-1})}{P_{ir,t}}}{\frac{C_{i,t} - C_{i,t-1}}{C_{i,t}}} - Median\left(\frac{\frac{(P_{jr,t} - P_{jr,t-1})}{P_{jr,t}}}{\frac{C_{j,t} - C_{j,t-1}}{C_{j,t}}}\right) \tag{3}$$

Where $P_{jr,t}$ is the average airline ticket price per mile flown for a peer carrier $j$ operating in the same market-quarter as carrier $i$; $C_{jt}$ is the average jet fuel cost per mile flown for a peer carrier $j$ operating in the same market-quarter as carrier $i$. Other variables are defined as in Equation (1). If *peer-adjusted DOA* is positive (negative), it suggests the airline raises price beyond (below) its peer companies in the same market-quarter.

Table 3 reports the results showing how airlines' operating performances are associated with *Peer-adjusted DOA* in fuel cost increasing (Panel A) and fuel cost decreasing (Panel B) subsamples. Operating performances are measured by *Industry-adjusted Sales Growth* (Model 1) and *Profit Margin* (Model 2).

In panel A, the coefficient on *Peer-adjusted DOA* is negative and significant at the 1% level in Model 1, and positive and significant at the 5% level in Model 2. This result confirms the previous result found in Table 2 and implies that raising price beyond the industry-peers when fuel cost increases (proxied by high *Peer-adjusted DOA*) may increase profit margin but may impede the airline's sales growth compared to its peers.

In Panel B, the coefficient on *Peer-adjusted DOA* is insignificant in Model 1, and negative and significant at the 1% level in Model 2. This result indicates that raising price beyond the industry-peers when fuel cost decreases (proxied by low *Peer-adjusted DOA*) will improve profit margin. [4]

**Table 3: Peer-adjusted DOA and operating performance.**

| **Panel A: Fuel cost increasing periods** | | |
|---|---|---|
| | (1) | (2) |
| Variables | *Industry-adjusted Sales Growth* | *Profit Margin* |
| *Peer-adjusted DOA* | -0.001*** | 0.002** |
| | (-3.90) | (2.50) |
| Controls | Yes | Yes |
| Observations | 66,027 | 58,321 |
| Adjusted $R^2$ | 0.963 | 0.864 |
| Market-carrier FE | Yes | Yes |
| Year-quarter FE | Yes | Yes |
| **Panel B: Fuel cost decreasing periods** | | |
| *Peer-adjusted DOA* | -0.001 | -0.001*** |
| | (-0.09) | (-4.29) |
| Controls | Yes | Yes |
| Observations | 51,817 | 42,871 |
| Adjusted $R^2$ | 0.968 | 0.891 |
| Market-carrier FE | Yes | Yes |
| Year-quarter FE | Yes | Yes |

This table reports the regression results of operating performance measures on peer-adjusted DOA. The whole sample is split into Fuel cost increasing (Panel A) and Fuel cost decreasing (Panel B) subsamples. In model (1), the dependent variable is *Industry-adjusted Sales Growth*, defined as (sales growth – industry-average sales growth) $\times 100$. In model (2), the dependent variable is *Profit Margin*, which is equal to sales minus costs of goods sold, divided by sales, times 100 ($\frac{SALE-COGS}{SALE} \times 100$). *Peer-adjusted DOA* is the ratio of the percentage change in price to the percentage change in fuel cost minus the median of this ratio across all of its peers in the same market-quarter. Control variables include firm size, seats, population, Income. Firm size is defined as total assets. Seats is defined as the quarterly change in the number of available seats in a given market in year-quarter $t$. *Population* is the logarithm of the geometric mean of endpoint populations in millions. *Income* is the logarithm of the geometric mean of endpoint incomes per capita in thousands. The coefficients are suppressed for brevity. The specification includes market-carrier and year-quarter fixed effects. Standard errors are clustered at market-carrier levels. T-stats are provided in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

## 3.3 Asymmetric pricing and stock returns

We next examine whether asymmetric pricing predicts stock returns using return regression approach. Table 4 tests how asymmetric pricing predict airlines' stock returns using Equation (1). Similar to Table 2, we split the sample into fuel cost increasing (Panel A) and fuel cost decreasing (Panel B) subsamples. The results in Panel A suggest that when fuel cost increases, both direction effect and magnitude effect matter for asymmetric pricing on stock returns. For the direction effect, the coefficient on $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ is positive and significant at the 1% level, indicating airlines that raise their price in response to fuel cost increases have significantly higher stock returns than those that reduce their price in the same scenario. For the magnitude effect, the coefficient on *DOA*$\times$ $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ is also positive and significant at the 1% level, suggesting that among airlines that raises prices in response to fuel cost increases, those that raise more experience higher stock returns than those that don't raise

[4] In untabulated results, median of the ratio between price change and fuel cost change is 0.007 in fuel increasing subsample, and -0.015 in fuel decreasing subsample. Therefore, a high *Peer-adjusted DOA* in Panel A indicates an airline is raising price more than its industry peers in response to fuel cost increases. While a low *Peer-adjusted DOA* in Panel B indicates an airline is raising price more than its industry peers in response to fuel cost decreases.

price as much. Hence, we find strong magnitude effect on top of the direction effect of asymmetric pricing on stock returns.

**Table 4: Asymmetric pricing and stock returns: regression approach**

| **Panel A: Fuel cost increasing periods** | |
|---|---|
| Variables | *Stock Returns* |
| $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ | 0.006*** |
| | (3.69) |
| *DOA*× $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ | 0.006*** |
| | (3.86) |
| *DOA* | 0.002** |
| | (2.55) |
| Controls | Yes |
| Observations | 65,655 |
| Adjusted $R^2$ | 0.578 |
| Market-carrier FE | Yes |
| Year-quarter FE | Yes |
| **Panel B: Fuel cost decreasing periods** | |
| $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ | 0.007** |
| | (2.15) |
| *DOA*× $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ | 0.000 |
| | (1.00) |
| *DOA* | -0.000 |
| | (0.52) |
| Controls | Yes |
| Observations | 51,774 |
| Adjusted $R^2$ | 0.467 |
| Market-carrier FE | Yes |
| Year-quarter FE | Yes |

This table reports the regression results of stock returns on airlines' asymmetric pricing in response to fuel cost changes. The whole sample is split into Fuel cost increasing (Panel A) and Fuel cost decreasing (Panel B) subsamples. The dependent variable is stock returns in year-quarter $t$. $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ is an indicator variable that equals one if $P_{ir,t} - P_{ir,t-1} \geq 0$, and zero otherwise. $(P_{ir,t})$is the average economy-class airline ticket price per mile flown in year-quarter t for a given carrier $\boldsymbol{i}$ operating in market $r$. *DOA* is the absolute value of the ratio of the percentage change in price to the percentage change in fuel cost: $abs\left(\frac{(P_{ir,t}-P_{ir,t-1})/P_{ir,t}}{(C_{i,t}-C_{i,t-1})/C_{i,t}}\right)$. Control variables include firm size, seats, population, Income. Firm size is defined as total assets. Seats is defined as the quarterly change in the number of available seats in a given market in year-quarter $t$. *Population* is the logarithm of the geometric mean of endpoint populations in millions. *Income* is the logarithm of the geometric mean of endpoint incomes per capita in thousands. The coefficients are suppressed for brevity. The specification includes market-carrier and year-quarter fixed effects. Standard errors are clustered at market-carrier levels. T-stats are provided in parentheses. *** $p$ < 0.01, ** $p$ < 0.05, * $p$ < 0.10.

In Panel B of Table 4, only the direction effect matters when fuel cost decreases. The coefficient on $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ is positive and significant at the 5% level but the coefficient on *DOA*× $D(P_{ir,t} - P_{ir,t-1} \geq 0)$ is not significant. This result suggests airlines that raise their price experience significantly higher stock returns than those that reduce their price in response to fuel cost decreases. However, the magnitude effect is muted in this case. Overall, our results suggest airlines that raise price show improved stock returns, especially for those airlines that raise more in response to fuel cost increases.

## 3.4 Peer-adjusted DOA and stock returns

Using the *Peer-adjusted DOA* defined in Equation (3), we further explore the effect of peer-adjusted DOA on stock returns. The results are reported in Table 5. In panel A, the coefficient on Peer-adjusted DOA positive and significant at the 1% level, which suggests that raising price beyond the industry-peers when fuel cost increases (proxied by high Peer-adjusted DOA) may increase stock returns compared to its peers. In Panel B, the coefficient on Peer-adjusted DOA is insignificant. This result indicates that raising price beyond the industry-peers when fuel cost decreases (proxied by low Peer-adjusted DOA) will not affect stock returns. Overall, the results suggest airlines that raise price beyond the industry-peers show improved stock returns only when fuel cost increases.

**Table 5: Peer-adjusted DOA and stock returns.**

| **Panel A: Fuel cost increasing periods** | |
|---|---|
| Variables | *Stock returns* |
| *Peer-adjusted DOA* | 0.003*** |
| | (4.24) |
| Controls | Yes |
| Observations | 65,655 |
| Adjusted $R^2$ | 0.559 |
| Market-carrier FE | Yes |
| Year-quarter FE | Yes |
| **Panel B: Fuel cost decreasing periods** | |
| *Peer-adjusted DOA* | 0.001 |
| | (0.71) |
| Controls | Yes |
| Observations | 51,774 |
| Adjusted $R^2$ | 0.518 |
| Market-carrier FE | Yes |
| Year-quarter FE | Yes |

This table reports the regression results of stock returns on peer-adjusted DOA. The whole sample is split into Fuel cost increasing (Panel A) and Fuel cost decreasing (Panel B) subsamples. The dependent variable is stock returns in year-quarter $t$. *Peer-adjusted DOA* is the ratio of the percentage change in price to the percentage change in fuel cost minus the median of this ratio across all of its peers in the same market-quarter. Control variables include firm size, seats, population, Income. Firm size is defined as total assets. Seats is defined as the quarterly change in the number of available seats in a given market in year-quarter $t$. *Population* is the logarithm of the geometric mean of endpoint populations in millions. *Income* is the logarithm of the geometric mean of endpoint incomes per capita in thousands. The coefficients are suppressed for brevity. The specification includes market-carrier and year-quarter fixed effects. Standard errors are clustered at market-carrier levels. T-stats are provided in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

## 4. Conclusion

We examine the relation of asymmetric pricing with operating performance and stock returns in US airlines. To measure the degree of asymmetric pricing, we construct two proxies, *Degree of Asymmetry (DOA)* and *Peer-adjusted DOA*. We find that raising air ticket prices, regardless of the direction of fuel cost changes, is associated with significantly higher industry-adjusted sales growth and stock returns than reducing price in the same scenario. However, raising price above industry peers is double-edged, it may increase profit margin, but at the cost of losing industry-adjusted sales growth to peers. We further explore the effect of *DOA* and *peer-adjusted DOA* on stock returns. The results imply airlines that raise price show improved stock returns, especially for those that raise price more than their industry-peers in response to fuel cost increases.

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