Determinants of profitability and recovery from system-wide shocks: The case of the airline industry

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Abstract

Purpose: Examination of the determinants of profitability in the U.S. domestic airline industry by considering operations strategy, productivity, and service measures, while focusing the attention on the effects of the 9/11 attack.

Design/methodology/approach: We propose a series of hypotheses regarding the effect of operations strategy, productivity, and service before and after the 9/11 attack. Using quarterly data between 1995 and 2007 we run empirical analysis using the Parks time series method.

Findings: Prior to 9/11, operations strategy, productivity, and service measures are significantly related to profitability. However, after 9/11, none of the service measures are significant. Further analysis suggests that after 9/11 passengers are more forgivable to service glitches or are associating lack of service with the intensified security measures imposed after 9/11. We also find that after 9/11, the profitability of full-service carriers is improving faster than that of focused carriers.

Originality/value: Our work extends earlier work in a variety of directions by accounting for more recent data, larger scope of variables, and the consideration of the 9/11 attack. We highlight an important link between an outside shock (9/11) and the importance of service that follows this shock.

Keywords: empirical analysis, 9/11, profitability, quality, operations strategy, airlines

1. Introduction

A large body of literature has been devoted to explore the determinants of profitability of firms operating in the service sector (e.g., Schefczyk, 1993; Dresner & Xu, 1995). Much of the literature has frequently considered a limited subset of measures types, often focusing primarily on productivity measures as drivers of profitability. In this research, an empirical model is conducted to understand the determinants of the profitability of U.S. domestic airlines (an industry which offers access to wealth of data), wherein we segment the contributing measures to three primary categories: operations strategy, productivity, and quality of service measures. This industry was critically affected by the 9/11 attack, as demand fell sharply and intensified security measures were introduced. Consequently, the profitability of airlines has dramatically declined and several airlines have entered Chapter 11 protection for lengthy periods of time. In the U.S., Chapter 11 defines the bankruptcy code that allows businesses to reorganize themselves and obtain protection from debtors (and sometime even reject contracts) during that time. In light of this dramatic system-wide shock, we pose the following question: how the determinants of profitability changed in the reality that emerged after 9/11?

Previous work that has studied determinants of profitability in the airline industry include the contributions by Dresner and Xu (1995), Oum, Fu and Yu (2005), Tsikriktsis (2007), as well as Weiss and Mahler (2009). Dresner and Xu focused their work on three customer service variables on customer satisfaction and further on firms' profitability; Oum et al. compared major North American airlines based on their residual total factor productivity, cost measures, and passenger yields; Tsikriktsis noted the significance difference between focused and non-focused airlines (where the former limit their service or operate only in a certain geographical area); and Weiss and Mahler incorporated operational hedging in their model. Of these studies, only the latter has accounted for post 9/11 data.

We argue that strategic decisions, operational performance, and quality of service bear significant importance on the financial performance of airlines, measured as the operating profit over operating revenue (OPOR). Indeed, similar to Tsikriktsis, prior to 9/11, we find the strategic decisions, as well as both operational and service performance measures are significantly related to profitability. However, after 9/11, none of the service measures are significant. This lack of significance is vital in the context of this research, and it necessitates further exploration of service measures.

Our work relates to Tsikriktsis', but we expand it in several directions:

- We enrich each of the measuring categories by considering additional important variables. Namely, we also account for average flight distance and the average number of seats per plane (corporate strategy measures as both decisions carry long term impact), productivity per employee (operational measures), as well as ticket oversales, i.e., overbooking, and consumer complaints (quality of service measures)

- We further consider control variables to account for the state of the economy and the bankruptcy status of the airline

- Importantly, we use more recent data and we segregate the time horizon into two epochs, pre and post 9/11, to gain insights into the performance of the industry and contrast the significance and magnitude of the different measures before and after 9/11.

Performing another set of time series regressions with consumer complaints as a dependent variable, we find that prior to 9/11 the only service measure that is significant is the amount of mishandled baggage. This measure is also significant after 9/11, but the magnitude of the coefficient drops by one third, providing strong indication that consumer complaints dramatically less due to baggage related issues. This could stem from passenger inability of distinguishing between baggage issues originating from the airline handling their baggage or by the enhanced security measures imposed on airlines and airports after 9/11. Alternatively, consumers might be more forgiving to baggage related issues understanding the increased handling efforts required by airlines, or are simply less disturbed by lower quality of service. At the same time, boarding denials emerge as a significant determinant after 9/11: with leaner fleets and pressure to feel up their planes, carriers may have increasingly overbooked their flights, which, ultimately have resulted with greater numbers of passengers who were denied boarding.

The paper is organized as follows. In Section 2 related studies—both airline and non-airline—are reviewed, and insights from these studies are synthesized. Section 3 describes the time series data that was collected and the different measures used for the empirical analysis. Section 4 outlines the method used for estimation. The cross-section time series analyses are provided in Section 5. The different behavior of the service measures before and after 9/11 necessitates the analysis of consumers' complaints in Section 6. Section 7 concludes with a summary of our findings, contributions, limitations of the model, and future research directions.

2. Industry background and determinants of profitability

The U.S. airline industry

Significant changes have occurred in the U.S. domestic airline industry since the industry was deregulated in 1978. This deregulation has eliminated the U.S. government control over fares. Competition has intensified as new

carriers entered the market, all of which have contributed to severe losses to major carriers. Most dramatically was the emergence of carriers focused on offering low-cost service. Consequently, the industry's competitive priorities have changed significantly and major air carriers discarded old operating models, which were based on competing mainly on flights frequency (Treacy & Wiersema, 1995). The importance of understating the drivers of success in this industry has already been recognized (Gudmundsson & Oum, 2004)

According to Tsikriktsis (2007), the U.S domestic airlines can be classified into two categories: Full-Service Carriers (FSCs) and Focused airlines. The former group of airlines, FSCs, uses hub-and-spoke flight structure, which has a wide coverage of many city-pairs, through the optimization of hub connectivity. FSCs operate both U.S. domestic and international markets, they use vertical product differentiation to capture various market segments, and have long adopted customer relationship management, known as frequent flyers program. The FSCs (in our data) are American, Continental, Delta, Northwest, United, and US Airways. It shall be noted that the airline industry is continuously changing and recently several mergers were announced: Delta-Northwest that took place in 2008 and Continental-United in 2010. Our data collection ended before these mergers.

The Focused airlines category is composed of Low-Cost Carriers (LCCs) and Regional Carriers (RCs)—they limit their operations to certain type of service and/or limited geographical area. The flight network structure of LCCs is usually point-to-point and the destinations are normally restricted to within the U.S. LCCs offer "no-frills" service (e.g., no meal service, no advanced seat selection, no airport lounges), resulting with very limited product differentiation. In most cases, the fleet is limited to a single type of airplane (such as the Boeing 737). Typical LCCs include American West and Southwest Airlines. RCs generally operate short-haul scheduled services. Usually, their aircrafts are of lesser capacity and often they fly under a code sharing agreement with FSCs to deliver passengers to major hubs from surrounding communities (e.g., SkyWest, which code shares with Delta Airlines and markets itself as "The Delta Connection"). According to Truitt and Haynes (1994) RCs have demonstrated the economic advantages of serving smaller markets with smaller, more fuel-efficient, aircrafts. We note that Alaska airlines can be classified both as an LCC and as an RC—it appears to be operating according to an LCC mode, focused on the Pacific coast. Either way, it belongs to the focused group of airlines.

In the following subsections, we briefly review studies that examine the impact of operations strategy, productivity and service quality, on profitability. Each subsection begins with literature review in service and manufacturing organizations, followed by specific studies related to the airline industry.

The impact of operations strategy on profitability

A growing body of literature addresses the impact of operations strategy on profitability. Boyer, Hallowell and Roth (2002) examines of three operations strategies available to e-services providers to expand offerings and streamline services. Boyer and Lewis (2004) consider the operations strategy trade-off between cost, delivery, flexibility and quality that advanced manufacturing plants make. Boyer and Lewis' (2004) finding constructs a strong link between operations strategies and profitability. Tsikriktsis (2007) provides review of additional studies that support the link between the notion of focused firms and their profitability level. Tsikriktsis' empirical analysis suggests that the focused airlines' business model outperformed non-focused airlines in terms of profitability between 1988 and 1998.

Notable in the airline sector, is the stark difference between Low Cost Carriers (LCCs) and Full Service Carriers (FSCs). The two operating modes differ in many aspects, as mentioned in the previous subsection. Belobaba (2009) indicates that the average cost per available seat mile (CASM) of FSCs is 50% higher than that of LCCs, overwhelming the revenue management advantage of FSCs. He also points out that the average flight distance and aircraft size represent specific airline operations strategies. According to Baltagi, Griffin and Daniel (1995), the deregulation of the industry in 1978 led to operating cost savings. They note that the deregulation has pronounced the effects of route structure. Baltagi et al. also show that while larger aircrafts provide more seating capacity, they could, in fact, be more expensive to operate and are more expensive to acquire than smaller ones. According to Borenstein (1989), the hub-and-spoke flight structure allows more efficient use of aircrafts and other inputs than

point-to-point flight system. Another advantage of hub-and-spoke strategy is in the form of revenue, as often they lead to airport dominance by single carriers, which appears to result in higher fares for passengers who fly to or from these airports. Borenstein also indicate that long-haul flights exhibit economies of scale resulting in lower per-passenger costs. In line with the empirical findings from Baltagi et al., Borenstein (1989) and Tsikriktsis (2007), in the context of the airline industry, we consider the following operations strategy decisions made by firms: whether to be focused or not, the stage length, and the seat density. We further elaborate on these measures in Section 3. Along similar lines, Cannon, Randall and Terwiesch (2007) show that operational variables (at both strategic and operational levels) carry additional information about airlines' earnings not provided in models based on earnings and accounting components only.

In line with the above literature, we state the following hypothesis:

Hypothesis 1: Operations strategy measures are significantly related to profitability.

The impact of productivity on profitability

Several literatures study the relationship between productivity and profitability in manufacturing and service operations. Hammesfahr, Pope, and Ardalan (1993) indicate that production capacity decisions have direct impact on firms' competitive positions and profitability, and that improving productivity is most efficient when the process is operated at full capacity. Banker, Chang and Majumdar (1993) study the impact of productivity, price recovery, product mix and capacity utilization on firms' profitability in U.S. telecommunications industry—an industry which has also gone through a deregulation process. They conclude that productivity is highly associated with changes in overall profitability, and show an increasing trend in productivity after the deregulation.

Heskett, Sasser and Schlesinger (1997) study service profit chain, which establishes the links between productivity and financial performance measure. An important finding from this study is that high employees' satisfaction leads to higher productivity and quality of service, which ultimately results in superior financial performance. The service profit chain from Heskett et al. (1997) is also related to "the resource-based model of sustained competitive advantage" discussed in Barney (1991, 1995). Anderson, Fornell and Lehman (1994) study the relationship between productivity, customer satisfaction, and profitability between different goods and services in Sweden. The findings indicate that both productivity and customer satisfaction are positively correlated with profitability for goods and services, yet the interaction between the two is positive for goods, but significantly negative for services. Hence, increasing both customer satisfaction and productivity simultaneously is likely to be more challenging in service industries. Other studies that highlight the importance of productivity and the links to profitability include, e.g., D'Aveni (1989) and Smith and Reece (1999).

Several studies specifically examine the impact of productivity on profitability in the airline industry. Using data envelopment analysis (DEA), Schefczyk (1993) validates that productivity is positively correlated with the return on equity, and further illustrates that productivity measures are one of the important factors in predicting overall performance. Oum et al. (2005) measure and compare the performance of ten major North American airlines, and one of their major finding is that productivity improvements result in greater operational profits. They indicate that airlines need to perform well in both productivity and pricing strategy to be financially successful. Tsikriktsis (2007) studies the impact of productivity and service quality measures on profitability using time-series regression analysis. An important finding from this paper is that productivity measures—loading factors and aircrafts' capacity utilization—are statistically significant and have positive coefficients when predicting profitability, with different magnitudes for FSCs and focused airlines. Weiss and Mahler (2009) add another insight to the importance of load factors: in their study on operational risk against adverse events, they find that load factors are positive and significant determinants of their hedging score, suggesting that high load factors indicate airlines that operate with small capacity cushion—a beneficial feature when demand declines.

In line with the findings from Banker et al. (1993), Schefzyk (1993), Oum et al. (2005), Tsikriktsis (2007), and Weiss and Mahler (2009), we have the following hypothesis.

Hypothesis 2: Higher productivity leads to higher profitability.

In the context considered in this paper, we account for loading factors, aircraft utilization, and available seat miles per employee—three measures that accounts for the seats productivity, plane productivity, and employee productivity, respectively. There measures are further elaborated in Section 3.

The impact of (quality of) service on profitability

Studies concerned with the impact of service on profitability are common within the marketing literature. Empirical results from the database of Profit Impact of Marketing Strategies (PIMS) established a link between customer satisfaction and economic return in the service industry (Buzzell & Gale, 1987). This has triggered research on the relationships between customer satisfaction, market share, and profitability. Reichheld and Sasser (1990) suggest that higher customer satisfaction results with greater profit through higher revenues, reduced costs to acquire customers, lower customer-price sensitivity, and decreased costs to serve customers familiar with a firm's service delivery system. Fornell (1992) indicates that the costs of attracting new customers are lower for firms that have already achieved a high level of customer satisfaction, and that satisfied customers are willing to buy goods and services more frequently. Similarly, Ittner and Larcker (1998) claim that service quality influence purchase behavior, and that it could significantly reduce the costs of customer retention and acquisition. Anderson et al. (1994) develop a model that transforms customer experience from the service and former service expectation into a customer satisfaction measure. They conclude that firms with high customer satisfaction benefit from superior economic returns in the long-run, but customer satisfaction fell as market share increased. Heskett et al. (1997) indicate that poor service quality lead to dissatisfaction among customers, and yield a negative impact on profit.

Rust, Zahorik and Keiningham (1995) present the "return on quality" approach that quantified the benefits in improving service quality in terms of financial measure. Their findings suggest that quality is an investment, but excessive spending on quality improvement may result in waste of resources. Voss, Tsikriktsis, Funk, Yarrow, and Owen (2005) focus on the customer satisfaction and profitability relationships in private sector organizations. Several studies focused on the interaction between service and profitability particularly in banking industry (e.g., Garvin, 1988; Hallowell, 1996).

Few literatures have study the impact of airlines' service quality on financial performance. Dresner and Xu (1995) examine the relationship between three customer service measures (On time performance, ticket oversales, and mishandle baggage) and consumer complaints and, in turn, on profitability of U.S. airlines. The results support the notion that increasing customer service raise customer satisfaction, which lead to improved financial performance. Tsikriktsis (2007) indicate that focused airlines perform better, in terms of profitability, than full-service airlines because of their operations strategy on service quality. The empirical results showed that the service measure late arrivals has a significant impact on profitability. Based on the above studies, we state the following hypothesis.

Hypothesis 3: Higher customer service leads to higher profitability.

In the empirical analysis conducted in this paper, we include airlines' on-time performance, mishandled baggage, passengers denied boarding (oversales), and consumers complaints, as we elaborate later in Section 3.

System-wide shock: the Effect of 9/11 on the Airline Industry

From the mid-1990s to the beginning of the millennium, the profitability of U.S. aviation industry was relatively stable. However, in the beginning of 2000, the economic slowdown resulted with lower demand, and the 9/11 attack in 2001 presented the industry with a major disruption. KLM's CEO, Leo Van Wijk, made the following statement after the terrorist attack: "…many passengers are cancelling their reservations and we can expect diminishing loading factors as a result. Demand is diminishing on various international routes and I do not expect this to change in near future…"

Following the terrorist attack on 9/11, the U.S. airline industry announced a total of 100,000 layoffs and employment in October and November fell by almost 8%. The U.S. airline sector had lost around 20% of its value, measured in the last quarter of 2001. Consequently, many FSCs were forced to make changes to their business structure, operations strategy, and considered other cost cutting measures. Major carriers have declared bankruptcy (Northwest, Delta, United, and US Airways) or were under tremendous financial pressures. US Airways and United announced code-share agreements, and a similar contract was developed by Continental, Northwest, and Delta. Southwest Airlines had taken an equity stake in the financially troubled low cost carrier ATA. Finally, US Airways was acquired by American West in 2005, and recently Northwest and Delta have merged.

Figure 1 exhibits the profitability of airlines before and after 9/11 segmented into full service and focused (Low cost and regional) carriers. It is evident that during the years prior to the incident the overall performance of the industry, in terms of profitability, was reasonable, and it was fluctuating, on a seasonal basis, between about 4%-15%. Indeed, shortly before the attack profitability decreased by several percentage points, but there is no doubt that in the quarters ensuing 9/11 profitability was catastrophic. Overall, profitability after 9/11 exhibits much lower level than before 9/11, for both focused (LCCs and RCs) and FSCs.
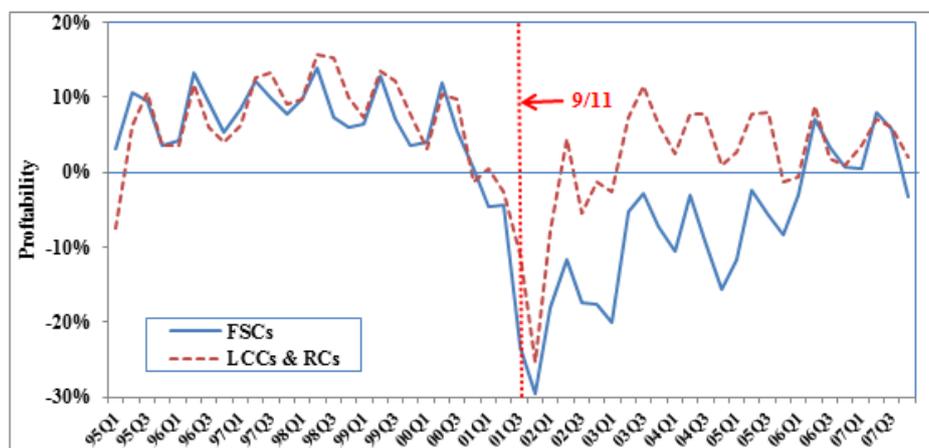

Figure 1. Profitability in the U.S. domestic airline industry

A limited number of studies examine the impact of 9/11 on the airline industry. Hatty and Hollmeier (2003) present a European view of the global airline crisis in 2001/2002. They discuss the change in operations strategy at Lufthansa German Airlines following the terrorist attacks. Due to the drop of air traffic demand, Lufthansa airline rapidly reduced its flight frequencies on long-haul flights, which helped to stabilize yield and corporate results. Alderighi and Cento (2004) also provide analysis of European carriers in the context of 9/11, focusing on their decision making. They segment the carriers into flexible and non-flexible, where the former are highly responsive and are driven by short-term goals, while the latter are typically driven by long-term goals.

Our interest, based on the findings from the above papers, is to find whether the three groups of measures mentioned above—operation strategy, productivity, and service—lead to similar insights before and after 9/11. After 9/11 most airlines scaled down their fleet and workforce, yet, despite the financial difficulties the airlines were facing, operations strategy and productivity should still play a major role in their profitability. We make the following hypotheses.

Hypothesis 1a: After 9/11, operations strategy measures significant affect profitability.

Hypothesis 2a: After 9/11, higher productivity leads to higher profitability.

However, after 9/11, service may present a completely different pattern. After 9/11, security measures have been altered immensely. Subsequently, procedures and processes took different shape, and often, it came on the expense of consumer service. That is, as security checking was intensified, passengers have experienced reduced service, such as prolonged waiting. As service has deteriorated, it is reasonable to assume that in most cases passengers could not distinguish between the real sources of the various delays encountered (of an exception is probably the infamous case of JetBlue, whose operations has completely given way on Valentine's Day in 2007). As passengers expect to encounter lower service levels, they may also be more forgivable to other airlines' service failures, and often associate lack of service to intensified security measures. Consequently, we hypothesize that after 9/11, higher customer service measures do not necessarily lead to higher profitability.

Hypothesis 3a: After 9/11, higher customer service does not lead to higher profitability.

We recognize that in their analysis of the informative value of operational measures in addition to accounting components on airlines' earning between 1998 and 2005, Cannon et al. (2007) find that different operational variables are relevant when predicting periods of positive and negative earnings. Particularly, they find that after 9/11 service quality variables (on-time arrival and involuntary overbooking) became irrelevant and fleet/flight structural variables (flight length and seats per flight) became relevant. Hence, our hypothesis regarding customer service measures is in line with (and further expand) Cannon et al. Yet, while Cannon et al. merely state this result, herein we further seek to provide intuition for these estimation outcomes, as we also analyze determinants of consumers' complaints in Section 6.

3. Sample and methods

Sample

Data on several U.S. domestic airlines, six of which are FSCs (American, Continental, Delta, Northwest, US Airways, and United) was collected. Prior to 9/11 we consider the following three focused carriers: Alaska, American West, and Southwest, while post 9/11 we replace American West with American Eagle. We shall note that altogether we have gathered data on 21 airlines; however, only those with complete data for either before or after 9/11 are included in our final analysis. Data is obtained from two main sources: *Air Carrier Financial Reports* and *Air Carrier Summary Data* for operational data, and *Air Travel Consumer Report* for service measures. Both data sources are available through the Department of Transportation (DOT). The data is collected from the first quarter of 1995 to the fourth quarter of 2007 to study profitability before and after 9/11.

Measures

Profitability measure

Similar to Tsikriktsis (2007) and Dresner and Xu (1995), our dependent variable is a percentagewise measure of operating profit over operating revenue (OPOR), calculated for each airline on a quarterly basis. This measure only considers the financial report from transporting passengers, excluding cargo shipping. The OPOR measure is preferred over other profitability measures (such as net profits, or return on investment), as it overcomes differences in accounting measures concerning owning versus leasing airplanes, interest on loans, etc., and it removes the size effect of airlines. Hereafter, whenever we use the term profitability we refer to the above-mentioned relative profitability.

Operations strategy measures

Operations strategy measures are designated to differentiate carriers based on their operations structure. For example, focused airlines operate very differently than FSCs (the former mostly use Point-to-point, while the latter employ Hub-and-Spoke), or an airline's seating capacity and the average stage length could suggest something about the structure of the network and markets served (in general the last two measures are smaller for LCCs). We

account for the following five operations strategy measures: Focused, *FSC*Time*, *Focused*Time, Stage Length*, and *Seat Density*. Focused is a dummy variable that accounts for differences between focused and FSCs, and it takes a value of 1 when the airline is focused and a value of 0 otherwise (i.e., an FSC). The differences between these two airline types we covered earlier in Subsection 2.1. We expect focused and FSCs to behave and react differently over time to market changes. That is, in the spirit of Alderighi and Cento (2004), we investigate whether focused airlines are more responsive than FSCs. Hence, we consider the interaction variables *FSC*time* and *Focused*time*. In other words, we separate the time factor for the two types of airlines. The variable Stage Length accounts for the average distance flown in statute miles per aircraft departure. According to Belobaba (2009), operating large planes is expected to generate some economies of scale (reduction in unit costs with increased output) as its fixed costs are spread over a larger output of available seat miles (ASM—the domestic air miles flown in each inter-airport hop multiplied by the total number of seats available on that hop for revenue passenger use). Therefore, we consider the variable *Seat Density*, which measures the average seating configuration of an airline's operating fleet, and it is derived by dividing total available domestic seat miles flown by the number of aircraft miles flown.

Productivity measures

Airline productivity measures are used to evaluate the firms' usage efficiency. We have three productivity measures which reflect three levels of productivity within the operations of airlines: seat usage of the plane (*Loading Factor*), time usage of the planes (*Aircraft Utilization*), and employees' productivity (*ASM per Employee*). *Loading factor* is the capacity utilization in terms of passengers, and it is determined by dividing *revenue passenger miles* (*RPM*—the summation of the products of revenue aircraft miles flown on each inter-airport hop multiplied by the number of revenue passengers carried on that hop) over *ASM*. *Aircraft Utilization* is the percentage of total block hours that aircrafts operate in the air, discarding on-ground services. *ASM per employee (ASME)* is the ASM produced by each employee in the firm. Note, that all productivity measures in this study consider passengers related aspects only, and do not account for cargo.

Service measures

We consider four service variables in this study: On-*Time Flight, Mishandled Baggage, Ticket Oversales, and Consumer Complaints*. *On-Time Flight* is the percentage of airline on-time performance. A flight is counted as "on-time" if it arrives to the airport not later than 15 minutes after its scheduled time (from the carriers' Computerized Reservation Systems). All cancelled and diverted flights are also counted as delayed. *Mishandled Baggage* counts the lost, damaged, delayed or pilfered baggage per 1000 passengers every month for each airline. Since the DOT reports the above two measures on a monthly basis, we convert them into quarterly basis to align with the other measures.

Tickets Oversales are the total number of passengers denied boarding per 10,000 enplanements and it also consists of both voluntary and involuntary categories of overbooking. *Consumer Complaints* is the number of complaints filed per 100,000 passengers. We maintain this measure in its aggregated basis, though it can be broken down into categories of complaints (flight problem, baggage, reservation, boarding, customer service, refunds, disability, frequent flyer program, fares, discrimination and advertising).

We realize that that Consumer Complaints may be an outcome of the other three service measures. Table A 4 and Table A 5 in the Appendix reveal potentially minor concern of multicolinearity. 2SLS is not available with the Parks methods used in this study. However, regressing the empirical models separately where service measures include only the first 3 measures vs. only Consumer Complaints, we find that the coefficients and significance levels are very similar to those reported in this study. That is, the results reported are not driven by multicolinearity.

Control variables

As mentioned earlier, the decline in airlines' profitability may have started prior to 9/11, potentially caused by the bursting of the dot com bubble. With the sharp decline in stock markets the economy has contracted. To account

for variations in the state of the economy, we add a control variable that measures the performance of the stock market. Namely, we use the *S&P500* as an indicator for the economy. We note that replacing *S&P500* with the GDP does not alter the quality of results of variables of interest. We prefer the *S&P500* as it aggregates anticipations regarding the direction of the economy.

Airlines that enter a bankruptcy stage may be subject to different set of rules as they are under bankruptcy protection and go through a major reconstruction and reorganization shift. To account for different behavior during this stage, we add a dummy *Bankruptcy*, which takes a value of 1 when the airline is in a bankruptcy status during the corresponding quarter, and 0 otherwise.

Descriptive statistics of the variables are summarized in Table A1 and Table A2. These tables reveal that the focused airlines were more profitable both before and after 9/11, and both suffered after 9/11, though FSCs appear to have been more affected. Focused airlines have a shorter stage length (likely stemming from their point-to-point network configuration) and a lower seat density (namely, they usually operate smaller aircrafts). Prior to 9/11, focused airlines appear to have been more productive in terms of aircraft utilization and ASME. However, after 9/11, FSCs have closed these productivity gaps. Service measures seem to have been similar for both focused and FSCs prior to 9/11. Though complaints have dropped for both after 9/11, focused airlines attracted a much smaller number of them after 9/11.

4. Model

Following Tsikriktsis (2007), we use the time-series method developed by Parks (1967), which accounts for the following effects: autocorrelation (that may occur due to the nature of time-series data), heteroscedasticity (as variances of different airlines may be different due to their different scales), and contemporaneous correlation (due to potential relationships between airlines). This method is facilitated through the time-series cross section regression (TSCSREG) procedure in SAS (SAS/ETS 1993). Let u_{it} denote the random errors, with $i=1,2,...,N$, and $t=1,2,...,T$, where N represents the total number of airlines studied and T represents total time period analyzed, then the errors u_{it} have the following structure:

$$u_{it} = \rho_i u_{i,t-1} + \varepsilon_{it} \text{ (Autocorrelation)},$$

$$E(\varepsilon_{it}^2) = \sigma_{ii} \text{ (Heteroscedasticity)},$$

$$E(\varepsilon_{it}\varepsilon_{jt}) = \sigma_{ij} \text{ (Contemporaneously correlated)},$$

The following model is used for testing the coefficient and significance of the different measures.

$OPOR_{it}= \alpha_o + \alpha_1 Focused_i + \alpha_2 FSC\ Time_{it} + \alpha_3 Focused\ Time_{it} + \alpha_4 Stage\ Length_{it} + \alpha_5 Seat\ Density_{it} + \alpha_6 Loading\ Factor_{it} + \alpha_7 Aircraft\ Utilization_{it} + \alpha_8 ASM\ per\ Employee_{it} + \alpha_9 OnTime\ Flight_{it} + \alpha_{10} Mishandled\ Baggage_{it} + \alpha_{11} Ticket\ Oversales_{it} + \alpha_{12} Customer\ Complaints_{it}$

5. Empirical results and discussion

Pre 9/11 analysis

The estimation results are provided in Table 1. The model explains 63% of the variations in profitability. The empirical results provide some interesting insights with regard to the impact of the independent variables on profitability.

- Operations strategy measures. We find that the dummy variable Focused is not significant, and that the profitability of both types of airlines was decreasing over time (both Focused*Time and FSC*Time are

significant and negative). A distinctive operational aspect between focused and FSCs is that they employ point-to-point and hub-and-spoke networks, respectively. Since so, it is important to identify the role of the supporting operation strategy measures. In that respect, we find that Stage Length is significant and negative, implying that serving longer haul destinations does not necessarily lead to the expected revenues and/or cost savings, as suggested by Belobaba (2009). This negative effect could be driven by certain costs that may increase more than linearly with stage length (such as labor cost), and by the fact that long-haul flights are usually operated by senior pilots that have higher wage rates. Interestingly, seat density has no predictive power. Overall, we find several operations strategy measures with significant explanatory power. As expected, operations strategy measures are important factors in explaining profitability and we conclude that Hypothesis 1 has been validated. In the appendix we further explore the relative importance of the various categories. Therein we find the operations strategy is the single most important category in predicting profitability.

- Productivity measures. We find that Loading Factor has a positive and a significant coefficient in predicting profitability—the more seats are sold, presumably, the greater is the revenue, and hence the profitability. Higher loading factors further indicate overall operational success. That is, the airline manages to identify markets with sufficient demand and the revenue management of the firm works well in predicting the demand for the flights. Indeed, higher loading factors can be manipulated by offering heavily reduced fares, but such a strategy is not sustainable in the long term, as passengers will learn to expect such behavior and will wait for the lower fares to be available. In that respect, when an airline manages to fill the planes in a consistent manner it sends a clear message to consumers: there is sufficient demand for this flight, hence, the plane can be easily filled up without offering heavy discounts. Consequently, consumers do not develop expectations regarding possible last minute discounts and their motivation to wait diminishes. High fill-rates further sends a signal to investor and financial markets that the airline is properly matching demand with supply and well manages its portfolio of destinations, frequencies, and capacities.

  Quite surprisingly, we don't find Aircraft Utilization and ASME to be significant prior to 9/11. According to Gittell (2003), one of Southwest Airlines' success drivers is the higher aircraft utilization, due to the significantly lower turnaround time. At Southwest, this amounts to about 20-30 minutes compared with approximately 1.5-2 hours at most network airlines at their connecting hubs, since these airlines need to ensure flight connections for passengers and baggage. Belobaba (2009) recommends airlines to improve aircraft utilization by reducing the turnaround time. He further suggests increasing the number of seats on each aircraft without switching to a larger plane size (e.g., by replacing first/business class seats with more economy-class seats, or by reducing the distance between adjacent rows of seats). This, however, may be detrimental, as discussed above, if the airline does not manage to fill up these additional seats (and recall, that we don't find seat density to be a significant driver of profits).

  Overall, we find that the single most important productivity measure in the context of US domestic airlines before 9/11 is the seat productivity. The other two productivity measures—plane productivity (i.e., aircraft utilization) and employee productivity—are not significant prior to 9/11. Thus, Hypothesis 2 has been partially supported.

- Service measures. Quite naturally, the more consumer complaints are associated with a particular airline, the less likely they are to return and fly with this airline again in the future, and through word-of-mouth their bad experience may further percolate. Indeed, we find Consumer Complaints to be negative and significant in predicting profitability. Though, consumer complaints are affecting airlines in the long term, our finding reveals that they are harming airlines also in the short term.

  This notion of the link between consumer complaints and profitability is further corroborated by the "zone of tolerance" argument by Zeithaml, Berry and Parasuraman (1993), which states that the zone of tolerance is tighter for the service quality dimension which is most critical to firms' financial success. In the airline industry, passengers experience is a major competitive strength, which has a narrow zone of

tolerance for unsatisfactory services that is then transformed to consumer complaints and is reflected on airlines profitability. This argument regarding service "zone of tolerance" is certainly valid in the pre 9/11 era. Yet, over time the competition in this industry appear to have shifted from service-focused to price-focused, possibly due to the emergence of low cost carriers. This change is revealed in the next sections.

Consumer complaints could also serve as an indication for other underlying operational problems with the airline that are causing consumers to be unsatisfied. Overall, with lower quality of service airlines suffer both in the short run (as they need to compensate those unhappy passengers) and in the longer run (as these consumers may defect to other airlines). Altogether, the results support Hypothesis 3.

	Variable	Before 9/11		After 9/11	
		Unstandardized Coefficient	T-stat.	Unstandardized Coefficient	T-stat.
Operations Strategy Measures	Focused	-4.07E-02	-1.46	**0.21***	4.84
	FSC*Time	**-1.85E-02***	-7.35	**5.11E-03***	1.84
	Focused*Time	**-1.59E-02***	-5.66	-3.38E-03	-1.24
	Stage Length	**-1.5E-04***	-3.74	**-2.9E-04***	-4.86
	Seat Density	2.7.E-04	0.60	-2.6E-04	-0.34
Productivity Measures	Loading Factor	**0.78***	5.36	**1.32***	9.36
	Aircraft Utilization	0.23	1.64	**0.2878***	2.15
	ASM per Employee	3.71E-07	0	1.27E-07	0
Service Measures	On-time Flight	2.04E-04	0.62	1.95E-03	1.33
	Mishandled Baggage	2.07E-03	-0.46	3.13E-03	0.82
	Ticket Oversales	3.5E-05	0.05	-5.6E-04	-0.48
	Consumer Complaints	**-2.04E-02**	-3.47	-5.92E-03	-0.35
Control Variables	S&P 500	**3.98E-4***	6.55	-2E-05	-0.27
	Bankruptcy	-	-	1.72E-02	0.9
	Intercept	**-0.77***	-6.68	**-1.15***	-5.61
	R^2		0.634		0.734
	Sample Size		243		225

Notes. Dependent variable: Operating Profit over Operating Revenue.
*Signified significant at 0.10 in a two-tail test, ** at 0.05. *** at 0.01

Table 1. Results of Parks method

Post 9/11 analysis

Before empirically testing the determinants of profitability (in Subsection 5.2.2), we first revisit the effect of 9/11 on the airline industry.

The Effect of 9/11 on airline industry revisited

To further verify that the drop in profitability is sustained after 9/11, even after controlling for all other factors, we conduct a fixed-effect time series analysis to verify the presence of an enduring post 9/11 effect. Namely, we test whether the observed differences in profitability pre and post 9/11 can be primarily related to time factors only, and not to other profound changes in the previously mentioned measures. The fixed-effect model permits two-way effects: cross-sectional firm and time-series effect with the independent error structure v_{it}, where $i=1,2,...,N$, and $t=1,2,...,T$, and identically distributed random variable with zero mean and variance of σ^2_v, where N is the number of cross sections (i.e., the number of airlines) and T is the length of the time series for each cross section. The two-way fixed-effect model is presented below.

$$OPOR_{it} = (\beta_o + \mu_i + \gamma_t) + \beta_1 FSC \cdot Time_{it} + \beta_2 Focused\ Time_{it} + \beta_3 Stage\ Length_{it} + \beta_4 Seat\ Density_{it} + \beta_5 Loading$$
$$Factor_{it} + \beta_6 Aircraft\ Utilization_{it} + \beta_7 ASM\ per\ Employee_{it} + \beta_8 OnTime\ Flight_{it} + \beta_9 Mishandled$$
$$Baggage_{it} + \beta_{10} Ticket\ Oversales_{it} + \beta_{11} Customer\ Complaints_{it}$$

The parameter β_o represents the intercept of the model, while μ_i and γ_t are non-random parameters for cross-sectional and time-series, respectively. The operations strategy, productivity and service measures are the same as those used in the previous section. The regression results of the two-way fixed-effect model are provided in Table 2.

Variable	Unstandardized Coefficient	T-stat.	Variable	Unstandardized Coefficient	T-stat.	Variable	Unstandardized Coefficient	T-stat.
Time-Series Effect			**Time-Series Effect**			**Cross Section Firm Effect**		
1995Q2	0.26***	4.82	2001Q4	-0.02	-0.56	Alaska	-0.02	-0.78
1995Q3	0.30***	6.35	2002Q1	-0.08	-1.69	American Eagle***	0.31***	3.25
1995Q4	0.29***	6.22	2002Q2	0.04	0.95	American	-0.02	-0.51
1996Q1	0.26***	5.12	2002Q3	0.07*	1.96	American West**	-0.07**	-2.2
1996Q2	0.25***	5	2002Q4	0.00	-0.13	Continental	-0.03	-0.69
1996Q3	0.29***	6.77	2003Q1	0.04	1.08	Delta	-0.04	-1.22
1996Q4	0.22***	5.38	2003Q2	0.03	0.73	Northwest	0.04*	1.77
1997Q1	0.23***	4.85	2003Q3	0.09**	2.56	Southwest**	0.06**	2.22
1997Q2	0.26***	5.42	2003Q4	0.11***	3.26	United*	-0.07*	-1.87
1997Q3	0.27***	6.48	2004Q1	0.10***	2.79	**Intercept**	-1.23***	-5.79
1997Q4	0.25***	6.11	2004Q2	0.07*	1.76		**Operations Strategy**	
1998Q1	0.27***	5.98	2004Q3	0.05*	1.67	FSC*time	2.16E-03***	3.73
1998Q2	0.29***	6	2004Q4	0.01	0.46	Stage Length	-9E-05	-0.92
1998Q3	0.27***	6.71	2005Q1	-0.01	-0.38	Seat Density	1.98E-03**	2.19
1998Q4	0.22***	5.79	2005Q2	-0.01	-0.23		**Productivity**	
1999Q1	0.25***	5.63	2005Q3	0.03	0.85	Loading Factor	0.95***	5.04
1999Q2	0.26***	5.72	2005Q4	0.01	0.3	Aircraft Utilization	0.43***	3.54
1999Q3	0.28***	7.07	2006Q1	0.00	0	ASM per Employee	9.14E-08	.
1999Q4	0.24***	6.16	2006Q2	0.00	0.11		**Service Quality**	
2000Q1	0.23***	5.51	2006Q3	0.05	1.49	On-time Flight	-2E-05	-0.07
2000Q2	0.23***	5.35	2006Q4	0.02	0.63	Mishandled Baggage	2.55E-03	0.84
2000Q3	0.17***	6.25	2007Q1	0.03	0.82	Ticket Oversales	-2.4E-04	-0.32
2000Q4	0.17***	5.42	2007Q2	0.04	1.09	Consumer Complaints	-6.24E-03	-1.09
2001Q1	0.10***	4.11	2007Q3	0.05	1.45		**Other Control Variable**	
2001Q2	0.17***	4	2007Q4	0.04	1.04	S&P500	0	0
2001Q3	0.10***	2.6				Bankruptcy	1.62E-02	0.93
R^2	0.737							

Notes. Dependent variable: Operating Profit over Operating Revenue (OPOR)
*Signified significant at 0.10 in a two-tail test, ** at 0.05. *** at 0.01
Table 2. Results of fixed two-way effects regression analysis all periods

Figure 2 visually depicts the time coefficients, γ_t, from the model between the second quarter of 1995 and the last quarter of 2007. It is evident that all of the quarterly coefficients prior to 9/11 are significant (at the 0.1 level) and positive. Further, during most of the pre-9/11, these coefficients exhibit stable seasonal pattern with the coefficients lying between 0.2 and 0.3. The first dent in the coefficients occurs in Q3 of 2000—corresponding to the burst of the dot-com bubble—and thereafter the coefficients drop significantly. After 9/11, the coefficients do not appear to follow any pattern any more, and as can be observed, most of the coefficients after 9/11 are not significant. Evidently, the US domestic airline industry has entered a turbulent period. The few significant coefficients suggest that between Q3 of 2003 and 2004 the airline industry has shown some signs of life. Overall,

the average coefficient before (resp., after) 9/11 was 0.228 (resp., 0.042). This analysis corroborates the long lasting impact of 9/11 on the U.S. airline industry.
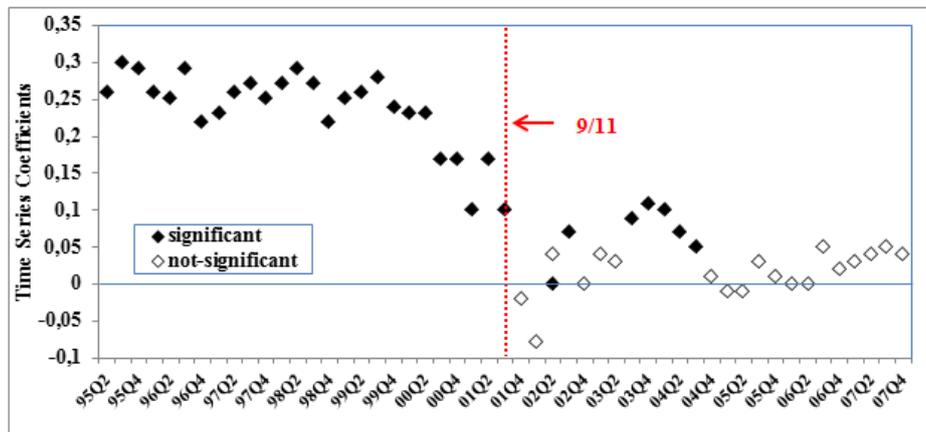

Figure 2. Time-series coefficients from two-way fixed-effects

Post 9/11 Analysis: Empirical results and discussion

Estimating the model from Subsection 4.1 using post-9/11 data, we find that Parks' method results explain 73.4% of the variations in profitability, as can be seen from Table 1. We find that focused airlines fared better after 9/11 as the variable Focused is significant and positive. Yet, over time, it is the FSCs that exhibit a consistent improvement in profitability, indicated by the positive and significant interaction term *FSC*Time. Stage length* persists with its negative and significant impact on profitability as before 9/11. Based on these findings, we conclude that accounting for operations strategy measures add significant value for the model after 9/11, i.e., Hypothesis 1a is supported.

In the appendix wherein we explore the relative importance of the various categories, we further find that operations strategy is the single most important category in predicting profitability also post 9/11.

We find that the productivity measure loading factor remains positive and significant as before 9/11. However, post 9/11, this coefficient has almost doubled, indicating that filling up the planes became a much more important task, and that the revenue management systems have definitely been adjusted to allow for higher loading factors. *Aircraft Utilization* is also positive and significant (recall it was not significant before 9/11), indicating that airlines, after retiring many of their planes, may have been paying more attention to overall efficiency of their assets. In line with Weiss and Maher (2009), airlines that operate leaner fleets are likely to suffer less when demand declines. Overall, we find that productivity measures remain significant post 9/11, namely, Hypothesis 2a is supported as well.

None of the service measures is significant after 9/11, which indirectly supports Hypothesis 3a. Service measures bear no power in predicting airlines profitability post 9/11. As Table A4 reveals, the correlation of *Consumer Complaints* with the other three service measures is very similar to that observed prior to 9/11. Yet, the coefficients and significance levels in our estimation results are very different than those prior to 9/11. As mentioned earlier, the lack of predictive power could stem from various causes. Consumers are likely more forgiven to service glitches, assuming that airlines are suffering and struggling from the intensified security measures, and, possibly, the consumers associate lack of service to security measures. We revisit this point in the following section.

Our empirical results also have some implications for managers post 9/11 attack. We see that 1% increase in the coefficient of *Loading Factor* could result in 1.3 percentage points increase in OPOR; whereas 1% increases in aircraft utilization would increase OPOR by 0.29%. Given that post 9/11 the mean of OPOR is -3.26%, one could

appreciate the magnitude of potential benefits for airlines. Airlines have definitely been paying attention to the importance of these factors. For example, as Figure 3 shows, the loading factors at both focused and FSCs have increased significantly over the years, and this increase is more profound before and after 9/11.
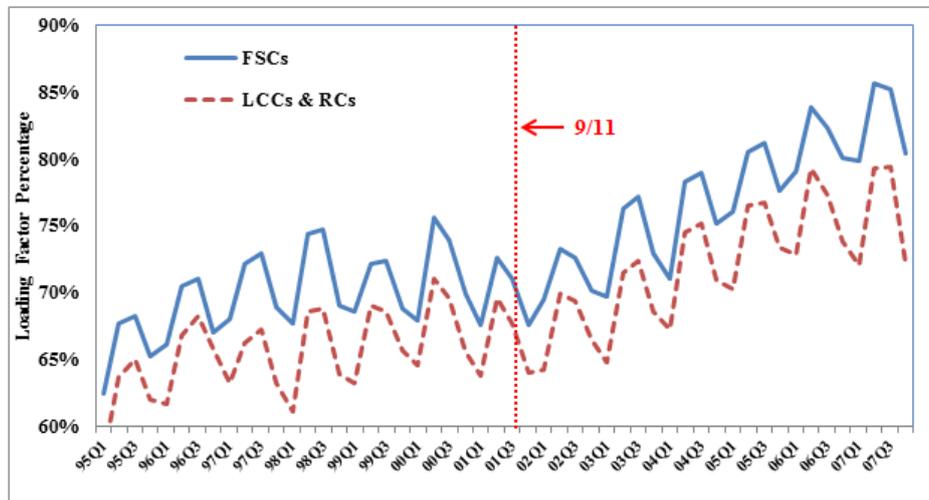

Figure 3. Loading factors in the U.S. domestic airline industry

Robustness

The analysis can be further segregated into studying the impacts of the various factors on focused and FSCs separately, by considering the following estimation:

$$OPOR_{it} = \alpha_o + \alpha_1 Focused_i + \alpha_2 FSC \cdot Time_{it} + \alpha_3 Focused \cdot Time_{it} + \alpha_4 FSC \cdot Stage\ Length_{it} + \alpha_5 Focused \cdot Stage\ Length_{it} + \alpha_6 FSC \cdot Seat\ Density_{it} + \alpha_7 Focused \cdot Seat\ Density_{it} + \alpha_8 FSC \cdot Loading\ Factor_{it} + \alpha_9 Focused \cdot Loading\ Factor_{it} + \alpha_{10} FSC \cdot Aircraft\ Utilization_{it} + \alpha_{11} Focused \cdot Aircraft\ Utilization_{it} + \alpha_{12} FSC \cdot ASM\ per\ Employee_{it} + \alpha_{13} Focused \cdot ASM\ per\ Employee_{it} + \alpha_{14} FSC \cdot OnTime\ Flight_{it} + \alpha_{15} Focused \cdot OnTime\ Flight_{it} + \alpha_{16} FSC \cdot Mishandled\ Baggage_{it} + \alpha_{17} Focused \cdot Mishandled\ Baggage_{it} + \alpha_{18} FSC \cdot Ticket\ Oversales_{it} + \alpha_{19} Focused \cdot Ticket\ Oversales_{it} + \alpha_{20} FSC \cdot Customer\ Complaints_{it} + \alpha_{21} Focused \cdot Customer\ Complaints_{it}$$

For brevity, the estimation results of this model are omitted, as they are consistent with the findings reported above. However, such an analysis reveals, e.g., that loading factor has greater impact on FSCs. Namely, 1% increase in loading factor for FSCs results in 1.70 percentage point increase in OPOR vs. 0.86% point increase for focused airlines. This may further explain why FSCs have pushed to improve their loading factors more than focused airlines, as is visible from Figure 3.

6. Determinants of consumers' complaints

In this section we isolate consumers' complaints from the other service measures and set it as the dependent variable. We repeat the empirical using the same model from the Section 4 (first subsection) (by replacing OPOR with *consumer complaints*)—we keep the operational and strategic measures to control for the firms' short and long term decisions, as well as the other control variables. Yet, our focus is on the remaining service measures. The empirical results are provided in Table 3.

		Before 9/11		After 9/11	
	Variable	Unstandardized Coefficient	T-stat.	Unstandardized Coefficient	T-stat.
Operations Strategy Measures	Focused	0.17	0.31	**-0.49***	-3.36
	FSC*Time	**4.80E-02***	1.73	-2.03E-02	-1.53
	Focused*Time	2.92E-02	0.75	**-2.15E-02***	-1.72
	Stage Length	**1.09E-03****	1.96	-2.6E-04	-1.15
	Seat Density	2.02E-03	0.38	**5.35E-03***	1.72
Productivity Measures	Loading Factor	0.86	0.56	**1.87****	2.47
	Aircraft Utilization	**-1.89***	-1.73	**2.19***	3.26
	ASM per Employee	**-2.75E-06****	-2.43	**-1.54E-06***	-2.84
Service Measures	On-time Flight	-3.54E-03	-0.91	**-1.55E-02****	-2.42
	Mishandled Baggage	**0.12***	2.67	**8.18E-02***	5.37
	Ticket Oversales	1.01E-02	1.38	**1.77E-02***	3.61
Control Variables	S&P 500	1.05E-3	1.56	**6.68E-04***	1.77
	Bankruptcy	-	-	-1.04	-1.33
	Intercept	-0.61	-0.46	-0.77	-0.82
	R^2		0.467		0.768
	Sample Size		243		225

Notes. Dependent variable: Number of Complaints.
* Significant at 0.10 in a two-tail test, ** at 0.05, *** at 0.01

Table 3. Results of Parks method on number of complaints

Prior to 9/11, FSCs and Focused carriers have comparable amount of consumer complaints, as can be visually observed from Figure 4 and as is indicated by the lack of significance of the variable *Focused*. Yet, during this period, focused airlines start opening a gap over FSCs in terms of complaints. This is evident from the positive and significant coefficient of *FSC*Time*: while proportions of complaints have increased at both focused carriers and FSCs, the rate of increase is faster and significant at FSCs. Figure 4 also reveals that consumers complaints, after peaking during 2000, start declining: the first step downward occurred in 2000, while the second major drop in complaints happened in conjunction with 9/11. Indeed, both *FSC*Time* and *Focused*Time* are negative after 9/11, but only the measure of the focused carriers is significant after 9/11. Again, focused carriers further widen the gap in terms of complaint between them and FSCs.
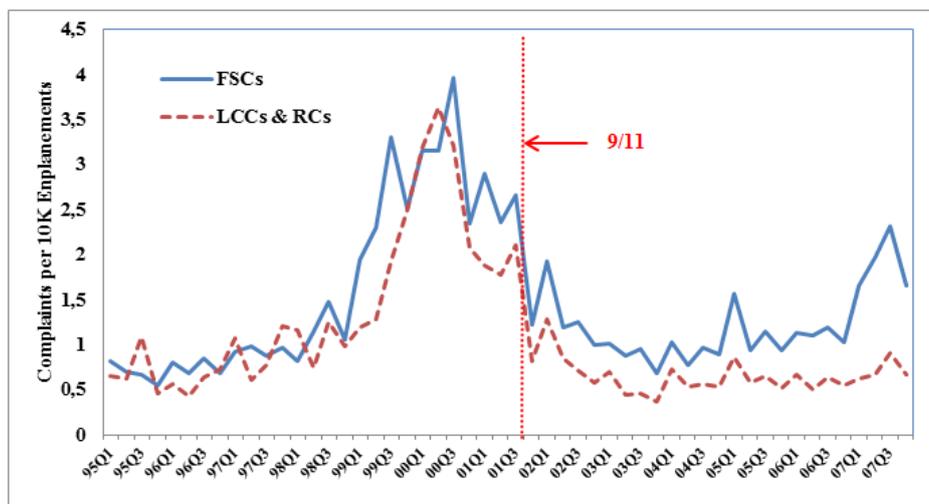

Figure 4. Consumers' complaints in the U.S. domestic airline industry

In practice, consumers in the airline industry complaint for a variety of reasons: flight problem, baggage, reservation, boarding, customer service, refunds, disability, frequent flyer program, fares, discrimination and advertising. In the regression conducted in Table 3, we account for three of those service categories: on-time performance (relates to flight problem), mishandled baggage, and ticket oversales (related to boarding).

Prior to 9/11, only *mishandled baggage* shows strong positive significance. Naturally, as more baggage is mishandled, consumers tend to complaint more. The other service measures, *on-time flight performance* and *ticket oversales*, emerge as insignificant determinants to consumer complaints. Post 9/11, all three service measure are significant. Most profoundly, *mishandled baggage* remains highly significant but the magnitude of this coefficient dropped by more than 30%. This is the strongest indication that after 9/11 consumers tend to complaint less due to mishandled baggage. While surprising, this could be associated with the enhanced security measures that were imposed on airlines and at airports. Specifically, with stringent baggage inspection, passengers are incapable of judging whether a mishandled baggage was due to lack of service by the carrier or due to baggage security measures. Similarly, passengers may be more forgivable to mishandled baggage as they understand the additional scope of work required by airlines due to these security measures.

The change in the coefficient of *mishandled baggage* stands in contrast to the change in the coefficient of *ticket oversales*. The latter, which is positive as expected, becomes significant after 9/11. We can provide two possible arguments. As consumers become more lenient to mishandled baggage, they pay closer attention to other service snafus, with ticket oversales being an easy target. Furthermore, after 9/11 airlines struggled to survive, many have retired large portions of their fleet thereby reducing the supply of seats over time, and faced pressure to fill up their planes. By doing so, they have potentially increased the amount of overbooking, which could have directly resulted with the increased complaint level due to ticket sales. This latter argument is further supported by the positive and significant coefficient of *loading factor* (note, however, from Table A4, that *loading factor* and *ticket oversales* are not significantly correlated), and to limited degree by *aircraft utilization* (which has increased, on average, by 0.3 after 9/11 in our sample) – the coefficient of which reveals a significant positive correlation with consumer complaints after 9/11.

Lastly, *on-time flight performance* also becomes a significant determinant to consumer complaints. Yet this measure turns out to have a negative magnitude. This result is surprising, unless it could also be an outcome of the enhanced security measures.

7. Concluding remarks

In this study, we examined the relationship between operations strategy, productivity, and service measures on profitability in the U.S. domestic airline industry. We find that before 9/11, all three types of measures are significant in explaining profitability. Full service carriers (FSCs) exhibit a declining profit trend over time. A negative impact on profitability is observed when the stage length increases. Both loading factors and aircraft utilization show strong impact, in terms of significant and large coefficients, on profitability. Consumer complaints is the only service measure that emerge as a significance variable in our model.

After 9/11, it appears that FSCs are slowly improving their profits. Increase in stage length continues to show negative impact on profitability. Moreover, loading factors are found to have a much greater impact on profitability than before 9/11, whereas aircraft utilization becomes significant after 9/11. Interestingly, service measures are not significant after 9/11.

Overall, we find support that operations measures and productivity measures are significant determinants in predicting airline profitability both before and after 9/11. However, service measures emerge as significant determinants only before the 9/11. Of interest is the consumer complaint measure that is significant before, but not after, 9/11. This has led us to further explore service measures after 9/11. The analysis of consumer complaints shows that the magnitude of the coefficient of mishandled baggage dropped by about 30%, suggesting that consumers complaint less due to baggage related issues: the enhanced security measures post-9/11 might

confound passengers' ability to distinguish between the cause of the service glitches. Additionally, post-9/11, boarding denials emerge as significant determinant of complaints: indeed, with leaner supply of seats, carriers fill up their planes, and possibly overbook more frequently, resulting with larger numbers of passengers who are denied boarding. This argument is corroborated by the significance of the loading factor after 9/11.

One of the main managerial implications relates to the importance of loading factors. Loading factors are found to be positive and significant in providing information about airlines' profitability, and, hence, airlines are recommended to improve their loading factors. Indeed, airlines have been dramatically improving their loading factors since 9/11, and FSCs have improved their capacity utilizations better than focused carriers. Though, gains can be achieved by improving these loading factors, there is a limit to the extent to which they can be improved. Indeed, as loading factors improves, carriers resort to overbooking to ensure greater fill-rates, and consequently they end up with more complaints stemming from oversales. This bears the potential of harming carriers in the longer run.

This work also suggests that it is important to understand the nature of a system-wide shock. In the case of the airline industry the shock has affected all carriers not only due to the decreased number of passengers but also due to the increased security measures imposed on airlines and airports. In this reality passengers possibly expect lower levels of service on several of the measures (specifically, mishandled baggage), and, indeed, they tend to complaint less. Corroborating this effect is the increasing role of low cost carriers in this industry, who train passengers to expect lower levels of service.

Our study is also subject to few limitations. First, the number of airlines in our study is limited, as in many other similar studies. Namely, due to insufficient information, we included only Alaska, American Eagle, American West, and Southwest Airlines in our focused airline group. This may create some bias in the results for focused airlines. Second, we have not considered fuel costs in our model, which are also known to have strong impact on airline profitability, since different airlines have different contracts to supply their fuel needs. Third, as the data is in the form of cross-section time series, we use Parks' method in SAS for analysis. However, due to the limitations of the built-in function in Parks' method, we only use the first-order of autocorrelation in the model. One should test the model up to fourth order of autocorrelation (i.e., a lag of one year) using Parks' method and choose the optimal order of autocorrelation for analysis.

Acknowledgments

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Appendix 1. Tables

	Variable	All Airlines (N = 243)		Full-Service Airlines (N = 162)		Low Cost Carriers (N = 81)		Data Source
		Mean	St. dev.	Mean	St. dev.	Mean	St. dev.	
Profitability	Op. Profit / Op. Revenue	6.59	9.17	5.71	9.42	8.35	8.44	Form 41 (P-52)
Operations Strategy Measure	Stage Length	755.74	172.02	803.24	156.65	660.75	162.56	Form 41 (T2)
	Seat Density	145.38	13.13	149.74	13.76	136.64	4.95	Form 41 (T2)
Productivity Measure	Loading Factor	0.69	0.04	0.70	0.03	0.68	0.04	Form 41 (T2)
	Aircraft Utilization	0.35	0.04	0.33	0.02	0.39	0.04	Form 41 (T2)
	ASM per Employee (in K)	441.07	541.21	422.51	448.60	478.19	521.30	Form 41 (P-10 & P-12)
Service Measure	On-time Flight	76.84	16.42	77.88	19.54	74.76	6.38	Air Travel Consumer Report
	Mishandled	4.99	1.19	5.07	1.07	4.83	1.38	
	Ticket Oversales	20.97	7.38	19.99	5.79	22.91	9.57	
	Consumer	1.59	1.42	1.65	1.20	1.46	1.78	

Table A1. Descriptive statistics for all variables before 9/11 (27 quarters prior to 9/11)

	Variable	All Airlines (N = 225)		Full-Service Airlines (N = 150)		Low Cost Carriers (N = 75)		Data Source
		Mean	St. dev.	Mean	St. dev.	Mean	St. dev.	
Profitability	Op. Profit / Op. Revenue	-3.26	12.25	-7.09	11.26	4.39	10.49	Form 41 (P-52)
Operations Strategy Measure	Stage Length	813.74	234.00	918.44	168.76	604.35	204.31	Form 41 (T2)
	Seat Density	137.73	34.19	153.30	10.76	106.57	42.79	Form 41 (T2)
Productivity Measure	Loading Factor	0.75	0.06	0.77	0.05	0.70	0.05	Form 41 (T2)
	Aircraft Utilization	0.35	0.06	0.35	0.05	0.35	0.07	Form 41 (T2)
	ASM per Employee (in K)	487.66	124.95	493.53	80.81	475.92	184.12	Form 41 (P-10 & P-12)
Service Measure	On-time Flight	77.77	5.01	77.99	4.93	77.33	5.18	Air Travel Consumer Report
	Mishandled	5.62	2.75	5.12	1.89	6.62	3.76	
	Ticket	14.17	5.16	15.29	5.02	11.92	4.72	
	Consumer	1.00	0.58	1.22	0.55	0.55	0.33	

Table A2. Descriptive statistics for all variables after 9/11 (25 quarters post 9/11)

	Stage Length	Seat Capacity	Loading Factor	Aircraft Utilization	ASME	Flight Delay	Mishandle Baggage	Tickets Oversales	Consumer Complaints	S&P500
LCC	-0.39[c]	-0.47[c]	-0.27[c]	0.69[c]	0.49[c]	-0.09	-0.09	0.19[c]	-0.07	0
Stage Length	1	0.40[c]	0.29[c]	-0.05[c]	0.12[a]	-0.05	0.19[c]	0.30[c]	0.42[c]	0.19[c]
Seat Capacity		1	0.19[c]	-0.18[c]	0.23[c]	0.05	0.21[c]	0.14[b]	0.11[a]	0.01
Loading Factor			1	-0.11[a]	0.11[a]	0.03	-0.12[a]	-0.02	0.30[c]	0.41[c]
Aircraft Utilization				1	0.45[c]	-0.05	0.01	0.19[c]	-0.04	0.01
ASME					1	0.06	-0.02	0.21[c]	0.10	0.06
Flight Delay						1	-0.17[c]	-0.16[b]	-0.21[c]	-0.17[c]
Mishandle Baggage							1	-0.02	0.14	-0.04
Ticket Oversales								1	0.25[c]	0.01
Consumer Complaints									1	0.60[c]
Bankruptcy										0
S&P500										1

[a] Signified significant at 0.10 in a two-tail test, [b] at 0.05, [c] at 0.01.

Note. The variable Bankruptcy is omitted, since prior to 9/11 none of the airlines in our sample were under bankruptcy protection

Table A3. Correlation matrix using Parks' method pre 9/11

	Stage Length	Seat Capacity	Loading Factor	Aircraft Utilization	ASME	Flight Delay	Mishandle Baggage	Tickets Oversales	Consumer Complaints	Bankruptcy	S&P500
LCC	-0.63 [c]	-0.65 [c]	-0.51 [c]	0.00	-0.07	-0.06	0.26 [c]	-0.31 [c]	-0.55 [c]	-0.29 [c]	0
Stage Length	1	0.73 [c]	0.59 [c]	0.37 [c]	0.40 [c]	-0.06	-0.46 [c]	0.12	0.29 [c]	0.18 [c]	0.13 [b]
Seat Capacity		1	0.44 [c]	0.52 [c]	0.65 [c]	0.13	-0.62 [c]	0.36 [c]	0.27 [c]	0.23 [c]	0.06
Loading Factor			1	0.33 [c]	0.38 [c]	-0.44 [c]	-0.03	-0.14	0.39 [c]	0.22 [c]	0.57 [c]
Aircraft Utilization				1	0.59 [c]	-0.16 [b]	-0.21 [c]	-0.03	0.09	-0.05	0.31 [c]
ASME					1	0.03	-0.37 [c]	-0.01	-0.16 [b]	0.22 [c]	0.28 [c]
Flight Delay						1	-0.50 [c]	0.25 [c]	-0.33 [c]	0.03	-0.66 [c]
Mishandle Baggage							1	-0.40 [c]	0.22 [c]	-0.13 [a]	0.41 [c]
Ticket Oversales								1	0.22 [c]	0.23 [c]	-0.30 [c]
Consumer Complaints									1	0.01	0.31 [c]
Bankruptcy										1	0.01
S&P500											1

[a] Signified significant at 0.10 in a two-tail test, [b] at 0.05, [c] at 0.01.

Table A4. Correlation matrix using Parks' method post 9/11

Appendix 2. On the relative importance of operations strategy, productivity, and service

We have studied the relationship between each category of measures (Operations Strategy, Productivity, and Service) and firms' financial performance. Combining all three categories, we argue that operations strategy, as a category, provides the greatest explanatory power in predicting profitability of airlines. Operations strategy decisions, as the title implies, reflect long-term strategic decisions made by the firm's decision makers. Since so, we expect operation strategy to exhibit the most important link to profitability. Among the remaining two categories, productivity and service, we suspect productivity to shed more light on profitability than service. We believe that some, and potentially even most, of the passengers may self-select themselves into airlines which provide certain levels of service. Namely, passengers may still choose to fly on a carrier offering lower fares even if they expect lower levels of service, and also even if they happen to experience service failures. Hence, service measures may take longer to affect airlines' profitability. On the other hand, productivity measures are directly linked to airlines' immediate financial performance. For example, increasing utilization of aircrafts implies more flights, and, consequently, greater profit. To summarize, we hypothesize that both before and after 9/11, operations strategy measures contribute greater explanatory power to profitability than productivity measures, which, in turn, provide greater explanatory power than service measures. We test this hypothesis by studying the R^2 of models wherein we account on for particular sets of measures. These are provided in Table A5, which supports our hypothesis.

		Operations Strategy	Productivity	Service	Operations Strategy & Productivity	Operations Strategy & Service	Productivity & Service	Operations Strategy, Productivity & Service
R^2	Before 9/11	0.519	0.325	0.175	0.604	0.594	0.365	0.634
	After 9/11	0.638	0.5623	0.047	0.705	0.630	0.448	0.734
tendency		increase	increase	decrease	increase	increase	increase	increase

Note. Dependent variable: Operating Profit over Operating Revenue (OPOR)
All models include the two control variables (S&P500 and Bankruptcy). Arrows indicate change in R^2 between before and after 9/11.

Table A5. R-Square comparison of the different sub-models before and after 9/11