Determinants of Profitability and Recovery from Shocks: the case of the U.S. domestic Airline Industry

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

This paper examines the determinants of profitability using operations strategy, productivity, and service measures in the context of the U.S. domestic airline industry. Data on ten carriers was collected on a quarterly basis between 1995 and 2007. An analysis is performed separately on data prior and post 9/11 attack. It is found that operations strategy and productivity measures are significant both before and after the 9/11 attack, whereas service measures are only significant before 9/11. Some managerial implications are provided. Additionally, it is found that the profitability of full-service carriers is improving faster than low-cost carriers after 9/11.

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Dedication

This thesis is dedicated to my beloved parents, George Wang and Virginia Tsui, and my dear sister, Karen Wang, for their endless patience, love and care.

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Chapter 1 Introduction

A large body of literature has been devoted in recent years to explore the determinants of profitability of firms operating in the service sector (e.g., Schefczyk, 1993, and Dresner et al. 1995). A commonly analyzed service provider is the airline industry, which offers access to a wealth of data. Much of the literature has frequently considered a limited subset of measure types, often focusing primarily on productivity measures as drivers of profitability. Naturally, profitability is not exclusively determined by operations measures, and a multitude of other measures also play a major role in airlines' profitability, such as service quality and operations strategy. In this study, we consider operations strategy, productivity and service measures in assessing the profitability of the U.S. airline industry before and after the tragic incident of 9/11.

In this research, we develop a rich contextual empirical model to understand the determinants of the profitability of U.S. domestic airlines, wherein we segment the contributing measures to several distinctive categories and we contrast their performance prior and after 9/11. The combined impact of both types of measures (operational performance and service quality) on profitability in airline industry has only been studied, to the best of our knowledge, by Tsikriktsis (2007), which is the closest contribution to our paper. In his empirical analysis, Tsikrktsis has considered several operational measures, two service indicators (late arrivals and lost baggage), and has categorized airlines into focused and non-focused groups.[1] The latter point is of significance and relevance to our study. While Tsikrktsis has focused the attention on a single corporate strategy decision—whether to be a focused airline or not—herein we extend the corporate decisions beyond the focus level decision. Namely, rather than limiting the strategic set of decisions to whether to be a focused or a non-focused airline[2], we incorporate additional strategic decisions, such as the average flight distance and the average number of seats per plane. In fact, we not only extend the spread of strategic operational decisions taken by the firm, we also enrich other measuring categories: operational and service measures, in our study, also account for ticket oversales and number of consumer complaints per 100,000 enplanements[3], respectively.

This paper reviews relevant studies from both airline and non-airline streams of literature, and utilize insights from these studies to develop a set of hypotheses to be tested. After forming

[1] While focused airlines limit their service to a restricted geographical area or to certain types of passengers, non-focused airlines offer the lot.
[2] In our analysis we refer to non-focused airlines as Full-Service Carriers (FSC) while focused airlines are limited to Low-Cost-Carriers (LCC). We elaborate on the airline types in Section 2.1.
[3] The issue of colinearity of complaints with respects to the other two service measures is handled in Dresner and Xu (1995).

our hypotheses, we provide implications and relevance for operations strategy, productivity, and service quality measures used in this study. We then describe the time series data collected to test the hypotheses. By adopting Parks' method, we conduct a cross-section time series analysis using three combinations of the different variable categories with respect to the airline operational profitability. The empirical results validate our hypotheses that all three categories of measures are significant in explaining profitability prior to 9/11. Namely, strategic decisions (types of airlines and average flight distance), productivity measures (loading factor and aircraft utilization), and service quality (number of consumer complaints) are significant in predicting profitability. Moreover, strategic decisions and productivity measures contribute roughly the same level of explanatory power to profitability, whereas service measures contribute the least.

The 9/11 incident has faced the airline industry with a serious issue as demand fell sharply and intensified security measures were introduced. Profitability of airlines declined. To further understand the impact of 9/11 we modify our hypotheses to post 9/11 environment and we contrast the behavior of industry before and after the incident. The analysis on post 9/11 data reveals resemblance to the results with data prior to the attack, with respect to strategy and productivity. However, service measures exhibit a different behavior—while prior to the 9/11 incidence service plays a major role in airlines' profitability; past 9/11 this appears not to be the case anymore. We argue that in the presence of intensified security measures, consumers may be referring lack of service or service failures to security incidences rather to the lack of airlines' performance and possibly increased popularity of Low Cost Carriers (LCCs) may lead consumers to accept lower levels of service.

Our research differs from previous studies in several ways. First, our study examines operations strategy, productivity and service measures when evaluating profitability. Second, it is different from the study by Roth and Jackson (1995) as they examined the service quality performance model using perceptual measures; instead, we use objective data. Third, we consider a new service variable, consumer complaints, and two additional operations strategy measures, stage length and seat density, in our model. Fourth, to the best of our knowledge in airline operations management research that none of the existent airline research has considered the structural breakdown, such as effect of 9/11, on evaluating profitability in U.S. domestic airline industry while we study the impact of 9/11 on profitability. Lastly, our study also explains contemporary financial performance using operational variables.

This study contributes to the operations management and strategy literature in several ways: (i) it examines the relationship between operations strategy, productivity, service and profitability; (ii) it considers more customer service quality and productivity measures than those used by, e.g. Tsikriktsis; (iii) it assesses the contribution of the different categories of measures in terms of explanatory power to profitability; (iv) and it extends the data analysis to post 9/11 attack and analyze the impact of the attack on profitability as well as the recovery of the different types of airlines thereafter.

The remainder of the paper is organized as follows: Section 2 provides an overview of the relevant literatures in operations management and hypothesis development. Section 3 develops the framework for different operations variables and the methodology of data collection. Section 4 describes our model estimation and empirical results discussion prior to 9/11 while Section 5 presents the findings post to 9/11. Section 6 concludes our findings, contributions, limitations of the model and future research directions.

Chapter 2 Literature Review & Hypotheses Development

2.1 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 routes were added by various service providers and new carriers entered the market, all of which has resulted with severe losses to major carriers. Most dramatically was the emergence of carriers who have 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 and Wiersema 1995).

The U.S. domestic airlines are typically classified into four different types: Full-Service Carriers (FSC), Low-Cost Carriers (LCC), Regional Carriers (RC) and Charter Carriers (CC). FSCs use hub-and-spoke flight structure, which has a full coverage of many city-pairs, through the optimization of connectivity in the hub. FSCs operate both U.S. domestic and international markets with mostly medium-, and long-haul flights from and to their hub airports. Often, these airlines form alliances with partner carriers to enlarge their service network and use vertical product differentiation to capture various market segments. Furthermore, they adopt customer relationship management, which is known as frequent flyers program to retain most frequent players. The "Big Six" U.S. domestic airlines, also known as FSCs, are American, Continental, Delta, Northwest, United, and US Airways.

LCCs are those airlines that generally operate aircraft in short-, and medium-haul scheduled passenger service between smaller communities and larger hub airports. Their flights network structure is usually point-to-point, which is developed from one or few airports, called 'bases', and the destinations are normally limited to within U.S. They attempt to keep their costs low by offering a "no-frills" service which implies very limited product differentiation, as well as no meal service, no advanced seat selection (for faster boarding), no airport lounges. They often offer only one class of seating: coach. In most of cases, their fleet is limited to a single type of airplane (such as the Boeing 737), as to keep training and maintenance costs down. The typical U.S. domestic LCCs include, American West, Southwest Airlines, and Alaska[4]. Overall, LCCs have a simple operating model around non-stop air travel to and from high-density markets.

[4] Alaska can be classified in various ways. Essentially, it appears to be operating according to an LCC mode, focused on the Pacific coast, with limited long-haul (Coast-to-Coast) service.

Franke (2004) pointed out the success factors of LCCs' point-to-point network configuration and their streamlined production process in relation to FSCs. By contrast, the FSC model is cost-penalized by the synchronized hub operations that implicitly accept the extra-time needed for passengers and baggage to make connections. Furthermore, the FSC business model relies upon sophisticated information systems and infrastructure to optimize its hubs (Cento 2009).

RCs are the airlines that generally operate aircraft in short-haul scheduled passenger service between smaller communities and larger hub airports, which has a similar definition to the LCCs mentioned above. However, the aircrafts of RCs are usually of lesser capacity (fewer than sixty seats) for U.S. domestic routes and they often fly under a code sharing agreement with FSCs to deliver passengers to major hubs from surrounding communities. One example of an RC is SkyWest, based in St. George, Utah, which has a code sharing agreement with Delta Airlines, and markets itself as "The Delta Connection". Some RCs are subsidiaries of FSCs, for example, Wings West is a wholly-owned subsidiary of American Airlines based in San Luis Obispo, California and markets itself as "American Eagle". Truitt and Haynes (1994) indicated that the regional carrier industry has demonstrated the economic advantages of serving smaller markets with smaller, more fuel-efficient, aircrafts.

A CC is usually defined as an airline company that operates flights outside normal schedules by a specific hiring arrange with a particular group of customer. Most of charter flights are to transport holidaymakers to tourist destination, and the tickets are mostly sold by tour operator companies who have chartered the flight. In general, charter flights are sold as part of a holiday package in which the prices includes flights, and other accommodations. The flights by CCs are normally operated on the basis of near 100% seat occupancy, and the standard of seating and service are sometimes lower than on schedule airlines. Mason et al. (2000) identified the sources of cost advantages of UK charter airlines: higher loading factors and aircraft utilization as well as lower distribution costs and aircraft leasing costs with respect to the two largest LCCs in Europe, easyJet and Ryanair. Tradewind Aviation is an example of U.S. CC operating between New York and New Jersey.

Within the context of this study, we focus primarily on two airline types, FSC and LCC. However, we also group American Eagle Airline, which was formerly defined as a RC, under LCC, since the airline had recently expanded its service to medium-haul schedule routes and its fleet capacity in most of the routes had exceeded the traditionally RC capacity of sixty seats. Thus, we have six FSCs (American, Continental, Delta, Northwest, United, and US Airways) and four

LCCs (Alaska, American West, American Eagle and Southwest Airlines) in our analysis.[5] In the following sections, we briefly review studies that examined the impact of operations strategy, productivity and service quality, on profitability in airline industry and develop our theory and hypothesis. Each section begins with general overview of literatures review in service and manufacturing organizations, followed by specific studies in airline industry.

In the remaining of this section, we elaborate on the various determinants of airlines' profitability. We group these determinants into three primary categories: operations strategy, productivity, and service. These categories have been studied by the literature to different degrees, as we elaborate below.

2.2 The Impact of Operations Strategy on Profitability

Over the past decade or two, there has been an abundance of research on the area examining the impact of operations strategy on profitability. Boyer et al. (2002) provide an examination of three different operations strategies available to e-services providers in order to expand offerings and streamline services while illustrating these approaches with a case study of Sothebys.com. Boyer et al. (2004) conclude that, even in the context of advanced manufacturing, manufacturing plants make operations strategy trade-off between cost, delivery, flexibility and quality. Overall, Boyer's (2004) finding constructs a strong link between operations strategies and profitability in manufacturing industry.

Within the airline sector, Lapre and Scudder (2004) conducted an empirical study on 10 major U.S. airlines to validate the Sand Cone model developed by Ferdows and De Meyer (1990). In summary, the Sand Cone model indicate that in order to reduce costs effectively, firms needs to first improve quality, then reliability and speed. The creation of value requires quality improvements to be made prior to the hunt for speed, reliability or cost reductions. The empirical results from this study reveal that airlines that have focused on the operations strategy of service quality ended up with superior quality-cost position than the initial position. Airlines that operate further away from the asset frontier [6] operation are able to improve cost and quality simultaneously. For instance, Alaska Airlines, which operated far from its asset frontier, was able to reduce operating cost without impairing quality by reducing turn-around time and adding seats to the aircrafts without reducing legroom (by adjusting closets and galleys). On the other hand,

[5] Alternatively, this classification could be viewed similarly to Tsikriktsis', wherein full-service airlines are categorized separately than focused airlines (LCCs and RCs).
[6] Asset frontier is formed by structural choices made by a company-investment in plant and equipment. This term is first introduced from "Theory of Performance Frontiers" by Schemener and Swink (1998).

airlines that operates close to the asset frontier operation need to consider the initial trade-off of improving quality at the expense of cost before reaching a better quality-cost position. The literature by Cannon, Randall and Terwiesch (2007) that has linked operations strategies measures to profitability is written with respect to revenue forecasting application, or predicting future earnings. That is, the relative performance with respect to the airlines and the overall pattern of the measures play a more relevant role in the analysis of profitability than simply the absolute levels.

Belobaba (2009) indicate 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 point out that the average flight distance and size of aircraft represent specific operations strategy to particular airlines. Baltagi, Griffin and Rich (1995) attribute the operating cost savings to the deregulation in 1986. They note that the deregulation had pronounced effects on route structure, as unit cost per mile reductions from increased stage length more than rising average operating costs from expanding points served. Baltagi et al.'s 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. Furthermore, the dominance of airports by single carriers 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 addition, Tsikriktsis (2007) divide the U.S. domestic airlines into two groups: focused and non-focused, where the latter group consists only of FSCs. In his analysis, Southwest, America West and Alaska airlines were categorized as focused airlines. The two groups have their distinct operations strategy, and different dimensions of operations performance drive different profitability. Tsikriktsis' empirical analysis suggests that the focused airlines' business model outperformed full-service airlines in terms of profitability between 1988 and 1998. In line with the empirical findings from Baltagi et al. (1995), Borenstein (1989) and Tsikrktsis (2007), we state the following hypothesis.

Hypothesis 1: *Operations strategy measures significantly affect profitability.*

2.3 The Impact of Productivity on Profitability

Several literatures study the relationship between productivity and profitability in manufacturing and service operations. Hammesfahr et al. (1993) indicate that production capacity decisions have direct impact on firms' competitive positions and profitability. They also pointed out that improving productivity is most efficient when the production process is operated at full capacity. If the improved production systems are operating at any level less than full capacity, then often they increased production costs. Banker et al. (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 had shown an increasing trend on airline productivity after the deregulation. Smith and Reece (1999) study the relationship between productivity and business performance through a field-based research against a wholesale distribution service setting. They test a conceptual model of business performance using productivity measures as mediating variable between the independent variables of business strategy and the dependent variable of business performance. The empirical results show that productivity variables are strongly correlated with financial performance of businesses.

Heskett et al. (1997) study service profit chain [7], which established the links for productivity and financial performance measure. An important finding from this study is that high employees' satisfaction leads to higher productivity and quality of service. This 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" which is discussed extensively in Barney (1991, 1995). The model of service profit chain suggests that the sources of sustained competitive advantage were firm resources which were valuable, rare, imperfectly imitable, and non-substitutable. Anderson et al. (1997) 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. D'Aveni (1989) defines three types of operational resources: financial, managerial and internal resource munificence. Financial resources reflect the unused borrowing capacity of a firm; managerial resources are used to capture the top manager's status of their educational and professional affiliations; internal resource munificence is defined as an interaction variable that combines the

[7] Service profit chain establishes relationships between profitability, customer loyalty and employee satisfaction, loyalty and productivity. The links in the chain are as follow: Profit and operations growth are driven by customer loyalty, which is a direct result of customer satisfaction. Satisfaction is influenced by the value of services provided to customers. Value is created by loyal, satisfied and productivity employees. In turn, high employee satisfaction results high quality of services to customers.

effect of both financial and managerial resources. D'Aveni further indicates that effective utilization of firms' resources increase both productivity and profitability simultaneously and save firms from bankruptcy.

Few literatures specifically examine the impact of productivity on profitability in the airline industry. Using data envelopment analysis (DEA), Schefczyk (1993) studied the impact of productivity on financial performance in the international airline industry. He validated that productivity was positively correlated with the return on equity and further illustrated that productivity measures were one of the important factors in predicting overall performance. Oum et al. (2005) measured and compared the performance of 10 major North American airlines in terms of productivity, cost competitiveness and average yields. Their major finding is that productivity improvements result in greater operational profits. They also indicated that airlines needed to perform well in both productivity and pricing strategy to be financially successful. Tsikriktsis (2007) studied the impact of productivity and service quality measures on profitability using time-series regression analysis. One important finding from this paper is that productivity measures—loading factors and aircrafts' capacity utilization—are statistically significant and with positive coefficients in predicting profitability, with different magnitudes for FSCs and focused airlines. Based on findings from Banker et al. (1993), Schefzyk (1993), Oum et al. (2005), and Tsikriktsis (2007), we state the following hypothesis.

Hypothesis 2: *Higher productivity leads to higher profitability*.

2.4 The Impact 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 service industry (Buzzell and Gale 1987). This has triggered research on the relationships between customer satisfaction, market share, and profitability. Reicheld and Sasser (1990) suggested that higher customer satisfaction created greater profit through rising 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) indicated that the costs of attracting new customers were lower for firms that have already achieved a high level of customer satisfaction, and that satisfied customers were willing to buy goods and services more frequently. Similarly, Ittner and Larcker (1998) claimed that service quality influenced purchase behavior, and that it could significantly reduce the costs of customer retention and acquisition. Anderson et al. (1994) developed a model that transformed customer experience from the service and former expectation towards the service into a customer satisfaction measure. They concluded that firms with high customer satisfaction benefited from superior economic returns in long-run, but customer satisfaction fell as market share increased. Heskett et al. (1997) indicated poor service quality led to dissatisfaction among customers, hence, yielded a negative impact on profit.

Several studies focused on the interaction between service and profitability particularly in banking industry. Garvin (1988) found that high customer satisfaction reduced price elasticity for existing customers. In other words, satisfied customers were more likely to tolerate price increases. This, ultimately, result in higher profit margins. Hallowell (1996) showed that in order to make up for a poor banking service; it took more than six excellent services to retain customers for repurchasing the service. Loveman (1998) examined the impact of employee and customer satisfaction on financial performance. His results showed significant positive relationship between customer satisfaction and financial performance, which was less significant than the relationship between employee satisfaction and financial performance. Rust et al. (1995) presented the "return on quality" approach that quantified the benefits in improving service quality in terms of financial measure. The findings suggested that quality was an investment, but it was also possible to spend too much effort on quality improvement resulting in a waste of resources. Voss et al. (2005) focused on the customer satisfaction and profitability relationships in private sector organizations and they concluded that managerial choice had a stronger impact than quality on both service quality and customer satisfaction.

Few literatures have studied the impact of airline service quality on financial performance. Dresner et al. (1995) examined 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 strongly supported that increasing customer service raised customer satisfaction, which led to improved financial performance. Particularly, improving performance on one customer service measure, mishandled baggage, was found to increase airline carrier profitability. The model also demonstrated how customer service can affect corporate performance directly through the mediating variable, customer satisfaction. Tsikriktsis (2007) has indicated that focused airlines were performing better in terms of profitability than full-service airlines because of their operations strategy on service quality. The empirical results showed that one service measure, late arrivals, had impact on profitability. Based on the above studies, we state the following hypothesis.

Hypothesis 3: *Higher customer service leads to higher profitability*.

2.5 On Operations Strategy, Productivity, and Service

Hypotheses 1, 2, and 3, separately state 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 firms, in general, and airlines, in particular. Operations strategy decisions, as the name imply, 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 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 state the following hypothesis.

Hypothesis 4: *Operations strategy measures contribute greater explanatory power to profitability than productivity measures, which, in turn, provide greater explanatory power than service measures*.

In sections 3 and 4 we outline the data collection and conduct the hypotheses testing. However, the analysis is performed on pre-9/11 data, the effect of which has not been considered so far in the paper. We separately elaborate on the potential effects of 9/11 in section 5, wherein we update the hypotheses to fit the post-9/11 reality. Corresponding analysis is conducted therein.

2.6 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, this did not last long. In the beginning of 2000, the economic slowdown caused fluctuations, and the September 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 (Wijk 2001):

> …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…
>
> (www.klm.com)

Following the terrorist attack on September 11th, 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 relative value measured in last quarter of 2001 since September 10. Consequently, many FSCs were forced to make changes to their business structure and operations strategy as well as other cost cutting measures. Two major air carriers (US Airways and United Airlines) have declared bankruptcy, while Delta, Northwest and American Airlines have experienced tremendous financial pressure. 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 and American West had recently proposed a merger.

Figure 3 below exhibits the profitability of airlines (broken into the two types of carriers, FSCs and LCCs) before and after 9/11. It is evident the prior to the incident the overall performance of the industry, in terms of profitability, was reasonable, and it was fluctuating between about 4%-15%. Indeed, shortly before the attack profitability was heading down, but there is no argue 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 LCCs and FSCs.

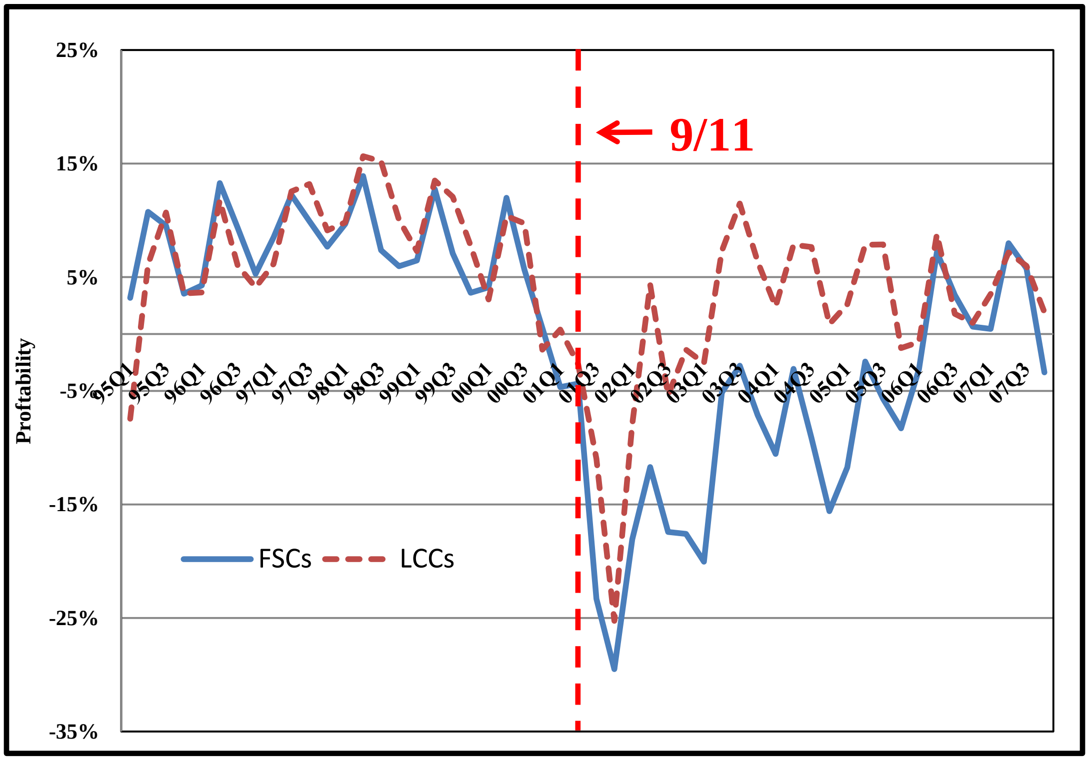

Figure 1: Profitability in the U.S. domestic Airline Industry

A limited number of studies have examined the impact of September 11th attack on the airline industry. Hatty and Hollmeier (2003) presented a European view of the global airline crisis in 2001/2002. They discussed 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 provided analysis of European carriers after September 11. Their decision making are as a mixture of short- and long-term goals, where the weights depended on firm-specific adjustment costs and financial situation. They further defined flexible and non-flexible carriers. Flexible carriers presented high responsiveness to both short- and long-term profitability and they were driven by short-term goals. On the other hand, non-flexible carriers presented low reaction to short- and long-term profitability and they were typically driven by long-term goals. Based on the findings from these papers, we would like to understand whether if our former hypotheses still hold after the incident of 9/11.

In the absence of reason to assume otherwise, we propose that the effect of operations strategy and productivity on profitability is as argued earlier. Specifically, we state:

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

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

However, we suspect that after 9/11, service may present a completely different pattern. Namely, after 9/11, security measures have been altered immensely. Subsequently, procedures and process took different shape, and normally, it came on the expense on consumer service. That is, as security checking were intensified, passengers have experienced, e.g., prolonged waiting. As service has deteriorated, it may be reasonable to assume that various forms of delays could not be traced by passengers to their real source.[8] 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 propose the following hypothesis:

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

Since service measures do not expect to affect profitability significantly, we set the following hypothesis:

Hypothesis 4a: *After 9/11, operations strategy measures contribute the greatest explanatory power to the model than productivity measures, which, in turn, provide greater explanatory power than service measures.*

[8] Of an exception is probably the infamous case of JetBlue, whose operations has completely given way on Valentine's Day in 2007

Chapter 3 Sample

To test our hypotheses, we use U.S. domestic airline industry data from the first quarter of 1995 to the fourth quarter of 2007. This choice of time framework is in order to study the impact of profitability before September 11st attack. We note that the airline industry is forced, through regulation, to disclose detailed operational data to public. Productivity and operations strategies data are retrieved from *Air Carrier Financial Reports* and *Air Carrier Summary Data*, a publication issued quarterly, while service quality measures can be collected from *Air Travel Consumer Report*. These reports are all issued by the Department of Transportation (DOT). The U.S. airlines studied in this research include Alaska, United, Northwest, US Airways, Delta, American, Continental, Southwest, and American West. In summary, six FSCs (American, Continental, Delta, Northwest, US Airways, and United) and four LCCs (Alaska, American West, and Southwest) are studied.

3.1 Measures

The 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. Similar to Tsikriktsis (2007), we choose this measure as our dependent variable over other profitability measures (such as net profits, or return on investment), because it is not confused by differences in accounting measures concerning owning versus leasing airplanes, interest on loans, etc.. Such a percentagewise measure is not subject to variations due to differences in accounting procedures and the effect of size is also removed. Given that our dependent variable is a percentage rather than an actual amount, the term profitability in the remaining of the paper refers to the relative profitability.

3.1.1 Operations Strategy Measures

We use the following five operations strategy measures: LCC, FSC*Time, LCC*Time, Stage Length, and Seat Density. We have a dummy that account for differences between FSCs, and LCCs. The dummy variable, LCC, takes a value of 1 when the airline is an LCC and a value of 0 otherwise (i.e., an FSC). The differences between these two airline types we covered earlier in section 2.1. Additionally, as we expect FSCs and LCCs to behave and react differently over time to market changes, we also consider the interaction variables FSC*time, and LCC*time. That is, we separate the time factor for the two types of airlines – these are used to control for the time trend of FSC and LCC profits over the study period and also account for any strategy and policy changes over time, which are not captured by the other operations measures. Another variables, stage length, accounts for the average distance flown in statute miles per aircraft departure and is calculated by dividing total aircraft miles flown by the number of total aircraft departures performed each quarter. The last operations strategy variable is seat density, which measures the average seating configuration of an airline's operating fleet and is derived by dividing total available domestic seat miles flown by the number of aircraft miles flown. Generally, FSCs operate large capacity aircrafts. Belobaba (2009) illustrated that a large airline, like a FSC, is expected to see some economies of scale (reduction in unit costs with increased output) as its fixed costs are spread over a larger output of ASM. That is, FSCs should have lower unit costs than LCCs. In overall, the operations strategy measures are designated to differentiate carriers based on their operations structure, Hub-and-Spoke for FSCs and Point-to-point for LCCs, for instance, the seating capacity of the fleet and the stage length of any given flight of LCCs are relatively smaller and shorter than FSCs.

3.1.2 Productivity Measures

Airline productivity measures are used to evaluate the firms' usage efficiency. We have selected three productivity measures which reflect three levels of productivity within the operations of airlines: space usage of the plane, time usage of the planes, and employees' productivity. We target these three factors by accounting for the loading factor, aircraft utilization, and available seat mile per employee, respectively. Loading factor is referred to capacity utilization for passengers and it can be determined by revenue passenger miles divided by available seat miles. Revenue passenger miles is a measure of passenger for an airline flight and it is calculated by taking 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. It is sometimes referred to as Revenue Per Kilometer, RPK. Aircraft utilization is the percentage of total block hours that aircrafts are operated by specific airline in the air, discarding on-ground services. Available seat mile per employee (ASME) is the available seat mile produced by each employee in the firm and it is calculated using total available seat mile from domestic routes over total number of employees. Available seat mile is a common airline output measure that is calculated using 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 and available seat mile is often referred to as Available Seat Kilometers, ASK. Note, that all productivity measures in this study consider passengers related aspects only, and do not account for cargo.

3.1.3 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 overall percentage of airline on-time performance. A flight is counted as "on-time" if it did not arrive the airport less than 15 minutes after schedule time shown in the carriers' Computerized Reservation Systems and all the cancelled and diverted flights are also counted as delay. This measure is calculated and reported as a monthly average for each airline by DOT. As the other operations and productivity measures in this study are all on quarterly basis, we convert this service measure into quarterly data as well. Mishandled baggage counts the lost, damaged, delayed or pilfered baggage based on mishandled baggage reports per 1000 passengers every month for each airline. As the number of mishandled baggage is also reported on a monthly basis, for the same reason as previous service measure, we also convert it into quarterly data. Tickets oversales are the total number of passengers denied boarding per 10,000 enplanements every quarter and it also consists of both voluntary and involuntary categories of overbooking. Voluntary overbooking is defined as passengers voluntarily gave up their seat on an oversold flight in exchange for compensation while involuntary overbooking refers to passengers, who are involuntarily bumped off the aircraft due to oversold. Consumer Complaints is a measures number of complaints files by consumers per 100,000 passengers. Originally, the data can be broken down into the categories of complaints (flight problem, baggage, reservation, boarding, customer service, refunds, disability, frequent flyer program, fares, discrimination and advertising), but we maintain the measure on the aggregated basis. Since Consumer Complaints may include the prior service measures defined in the paper, we verify that the measures are not correlated, through a correlation test is conducted to rule out the issue of multi-colinearity. The results from correlation tests can be seen in Table 3 in the Appendix.

Chapter 4 Pre 9/11 Analysis

4.1 Model Estimation

Figure 1 shows the overall relationship of the different measures considered above to profitability in the U.S. domestic airline industry. The unit of analysis of this study is a carrier's domestic operating unit. In order to test our hypotheses, we examine the impact of operations strategy, productivity and service on profitability using Parks' method, given in Model 1. We develop two models to examine our data.

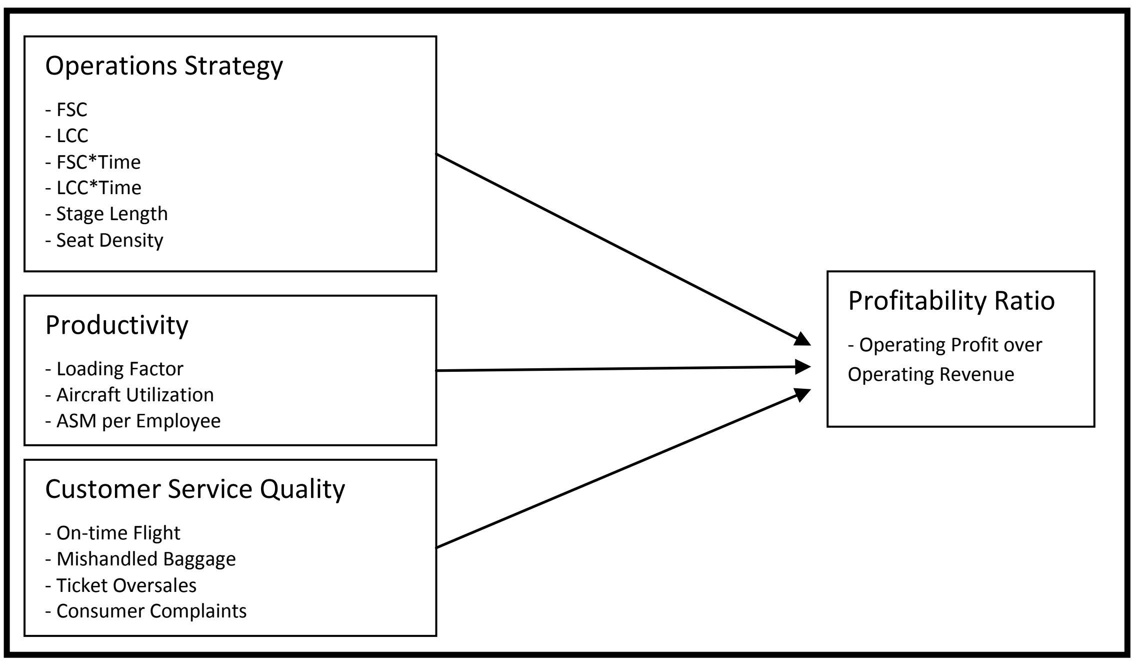

Figure 2: Relating Strategy, Productivity and Service to Profitability Ratio (inspired by Tsikriktsis 2007)

Our time-series data may exhibit the following effects: autocorrelation, heteroscedasticity, and contemporaneous correlation. Autocorrelation is to be expected in the model because of the nature of time-series data. Heteroscedasticity is also expected because observations for airlines operating at different scales could potentially result in different variance. Contemporaneous correlation between airline companies may be expected because of potential relationships between firms. For that end, we use a time-series method developed by Parks (1967) to analyze the data. In addition, Parks method has been used in studies analyzing time-series airline data (Tsikriktsis, 2007 and Heineke, 2004). Hence, similar to Tsikriktsis (2007), we also use the time-series cross section regression (TSCSREG) procedure in SAS (SAS/ETS 1993) for the analysis. An important advantage of Parks method is that it considers the first-order autoregressive with contemporaneous correlation between cross sections in which the random errors $u_{it}, i = 1,2,\ldots,N, t = 1,2,\ldots,T$, have the following structure, where N represents the total number of airlines studied and T represents total time period analyzed.

$u_{it} = \rho_i u_{i,t-1} + \varepsilon_{it}$ (First-order autocorrelation),

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

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

The following model is used for testing our hypothesis.

Model 1:

$$
\begin{aligned}
& Operating\ Profit\ over\ Operating\ Revenue_{it} \\
& = \beta_1 * LCC_i + \beta_2 * FSC * Time_{it} \\
& + \beta_3 * LCC * Time_{it} + \beta_4 * Stage\ Length_{it} + \beta_5 * Seat\ Density_{it} \\
& + \beta_6 * Loading\ Factor_{it} + \beta_7 * Aircraft\ Utilization_{it} \\
& + \beta_8 * ASM\ per\ Employee_{it} \\
& + \beta_9 * On-time\ Flight_{it} + \beta_{10} * Mishandled\ Baggage_{it} \\
& + \beta_{11} * Ticket\ Oversales_{it} + \beta_{12} * Customer\ Complaints_{it}
\end{aligned}
$$

This model provides important insights when testing our hypothesis. We examine the p-value of coefficient for each variable at 0.1, 0.05 and 0.01 level to conclude whether the variable is significant. The model also generates the overall fitness, R^2, and the correlation matrix among different variables.

To further understand whether the type of airline (FSCs vs. LCCs) interacts with the productivity measures or the service measures we define Model 1A as follows.

Model 1A:

$$
\begin{aligned}
& Operating\ Profit\ over\ Operating\ Revenue_{it} \\
& = \beta_1 * LCC_i + \beta_2 * FSC * Time_{it} + \beta_3 * LCC * Time_{it} \\
& + \beta_4 * FSC * Stage\ Length_{it} + \beta_5 * LCC * Stage\ Length_{it} \\
& + \beta_6 * FSC * Seat\ Density_{it} + \beta_7 * LCC * Seat\ Density_{it} \\
& + \beta_8 * FSC * Loading\ Factor_{it} + \beta_9 * LCC * Loading\ Factor_{it} \\
& + \beta_{10} * FSC * Aircraft\ Utilization_{it} + \beta_{11} * LCC * Aircraft\ Utilization_{it} \\
& + \beta_{12} * FSC * ASM\ per\ Employee_{it} + \beta_{13} * LCC * ASM\ per\ Employee_{it} \\
& + \beta_{14} * FSC * On - time\ Flight_{it} + \beta_{15} * LCC * On - time\ Flight_{it} \\
& + \beta_{16} * FSC * Mishandled\ Baggage_{it} + \beta_{17} * LCC * Mishandled\ Baggage_{it} \\
& + \beta_{18} * FSC * Ticket\ Oversales_{it} + \beta_{19} * LCC * Ticket\ Oversales_{it} \\
& + \beta_{20} * FSC * Customer\ Complaints_{it} + \beta_{21} * LCC * Customer\ Complaints_{it}
\end{aligned}
$$

4.2 Estimation and discussion

Descriptive statistics are summarized in Table 1 in the Appendix. It is evident that prior to 9/11, LCCs have a higher average of OPOR than FSCs. The average stage length of LCCs is shorter than FSCs, which is fairly intuitive as elaborated earlier due to the different network configurations (point-to-point vs. hub-and-spoke). LCCs also have a lower aircraft seat density comparing to FSCs. That is, LCCs usually operate smaller aircrafts than FSCs. In general, the two types of airlines have similar loading factors levels. Yet, LCCs have slightly higher aircraft utilization and the amount of ASME generated per employee than FSCs. Considering service quality, LCCs have lower proportions of mishandled baggage claims and consumer complains while FSCs exhibit a greater percentage of on-time flight performance.

The estimation of Models 1 and 1A are provided in Table 2 in the Appendix. These models explain at least 47.8 percent of the variations in profitability. The empirical results provide some interesting insight with regards to the impact of the independent variables on profitability.

Operations strategy measures. The intercepts of both models are negative and highly significant, while the dummy variable LCC is not significant; indicating the types of airlines entered the timeframe of the analysis making loses. From Model 1 we also observe that FSCs' losses were deepening over time (notice the significant and negative interaction term FSC*Time). Recall that we have identified these two types of airlines, FSCs and LCCs, as employing completely distinct operating models: hub-and-spoke and point-to-point, respectively. As such, it is important to identify the role of supporting operation strategy measures. In that respect, we find that stage length is significant and negative in Model 1 for both FSCs and LCCs. This may imply that serving longer haul destinations does not lead to the expected revenues and/or cost savings. Belobaba (2009) argue that an airline's operating costs are positively correlated with the size of its network and fleet, the average seat capacity of its aircraft and its average stage length. The operating costs are naturally greater for longer stage lengths as more fuel is consumed and more labors hours are required. In fact, long-haul flights are usually operated by senior pilots that have higher wage rates than the pilots for short-haul flights. Quite surprisingly, seat density has no predictive power in both models. Note that this is despite its low correlation with stage length. Overall, we find several operations strategy measures with significant explanatory power, which leads us to conclude that Hypothesis 1 has been validated. Moreover, note in Table 4, that when we account only for operations strategy variables, we obtain an R^2 of 0.29.

Productivity measures. In Model 1, both productivity measures, loading factor and aircraft utilization, show strong significance at the 0.01 level, while in Model 1A, wherein the productivity measures are segmented into their interaction term with FSCs and LCCs separately, in which case we find that loading factor has a greater coefficient for FSCs than for LCCs in terms of profitability. The descriptive statistics indicate that LCC has a higher average of aircraft utilization than FSC. This can be attributed to the different network models, schedule of flights and the efficiency in turning an aircraft on the ground between one arrival and next departure. The longer turnaround times will reduce the block hours per day for each aircraft. Gittell (2003) pointed out that Southwest Airlines, first LCC in U.S. airline, has made turnaround time with an average of 20 to 30 minutes, while the most network airlines have their turnaround time approximately 1.5 to 2 hours at a connecting hub. This is due to the fact that they would like to ensure the flight connections for passengers and their baggage. Large seat capacity aircrafts usually takes longer boarding time as well as the time for aircraft cleaning prior to boarding. Belobaba (2009) identifies two factors for airlines to improve their aircraft utilization. He suggests increasing the number of flight departures per day by reducing the turnaround time and/or by increasing the operation flights at off-peak departure times. Also, he recommends increasing the number of seats on each aircraft without switching to larger size of aircraft by replacing first or business class seats with more economy-class seats and/or by reducing the distance between adjacent rows of seats. ASM per employee in either model does not show any significance.

Overall, we have support for Hypothesis 2, as we find that productivity measures to contribute significantly to the model.

Service measures. Surprisingly, none of the service measures, on-time flight delay, mishandled baggage and ticket oversales, are significant in our model, except for consumer complaints, which is strongly significant with the estimate of -0.01471. This still supports our Hypothesis 3 that service measure is significant to profitability. Table 3 in the Appendix summarizes the correlation matrix of all measures in Table 1 and the results have sown that there is no significant correlation between the number of consumer complaints and the rest of service measures. A summary of R-squares using different groups of measures is presented in Table 4 in Appendix. Productivity measures appeared to have a slightly higher explanatory power on profitability than operations strategy while the service measures serve the least explanatory power. Consequently, our Hypothesis 4 is partial supported with that both operations strategy and productivity measures contribute the same level of explanatory power on profitability.

From service measures, we consider our findings for consumer complaints. The results indicate that consumer complaints have negative impact on profitability for both types of airlines and we use the "zone of tolerance" argument by Parasuraman et al. (1990) to explain this finding. The argument states that the zone of tolerance is tighter for the service quality dimension which is most critical to firms' financial success. In our studies, passengers experience is the major competitive strength in airline industry, which has a narrow zone of tolerance for unsatisfactory services that is then transformed to consumer complaints and is reflected on airlines profitability. Figure 3 shows that LCC consistently has relatively lower number of consumer complaints than FSC until 2000. More unsatisfactory services are observed on LCC and hence, in Figure 1, gap of profitability between LCC and FSC has narrowed, which indicates that LCC has been financially penalized. As the LCC slowly improved their service quality near the end of 2000, a new gap of profitability is once observed between LCC and FSC. This implies that LCC has been excellent airline service providers, who cannot tolerance low quality service as much as FSC.

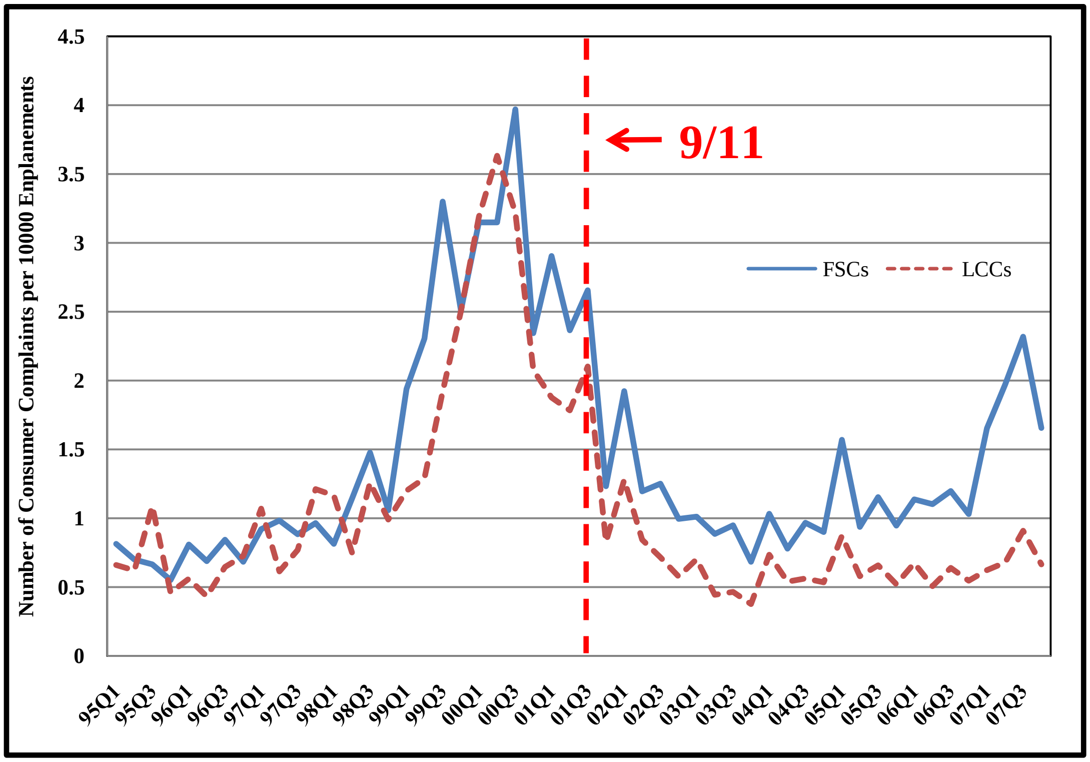

Figure 3: Consumer Complaints in the U.S. domestic Airline Industry

Chapter 5 Post 9/11Analysis

In order to examine the impact of September 11 on airlines' profitability, we extend our data collection to include all the measures up to the fourth quarter of 2007. The FSC studied post 9/11 remain the same as the prior 9/11 studies, but one of the LCCs, American West Airline, is replaced by American Eagle Airline due to too many missing data. In overall, six FSCs (American, Continental, Delta, Northwest, US Airways, and United) and three LCCs (Alaska, American Eagle, and Southwest) are studied post the attack.

5.1 The Effect of 9/11 on Airline Industry Revisited

To further verify that the drop in the profitability sustains even after controlling for all other factors, we perform the analysis below. Initially, we employ a fixed-effect time series model to verify the presence of an enduring post 9/11 effect. That is, before ensuing with the analysis, we want to make sure that the observed differences in profitability prior and post 9/11, can be related to time factors only, and not to other changes in the previously mentioned measures. Using a fixed-effect model[9], which had two-way effects, cross-sectional firm and time-series effect with the independent error structure $v_{it}, i = 1,2, \ldots, N, t = 1,2, \ldots, T,$ and identically distributed random variable with zero mean and σ_v^2 of variance, where N is the number of cross sections and T was the length of the time series for each cross section. We concluded our model was dependent on both cross-section and time-series effects with a series of F-tests. The two-way fixed-effect model is presented below.

Model 2:

$$
\begin{aligned}
&Operating\ Profit\ over\ Operating\ Revenue_{it} \\
&= (\alpha + \mu_i + \gamma_t) \\
&+ \beta_1 * FSC * Time_{it} + \beta_2 * LCC * Time_{it} \\
&+ \beta_3 * Stage\ Length_{it} + \beta * Seat\ Density_{it} \\
&+ \beta_5 * Loading\ Factor\ _{it} + \beta_6 * Aircraft\ Utilization_{it} \\
&+ \beta_7 * ASM\ per\ Employee_{it} \\
&+ \beta_8 * On - time\ Flight_{it} + \beta_9 * Mishandled\ Baggages_{it} \\
&+ \beta_{10} * Ticket\ Oversales_{it} + \beta_{11} * Customer\ Complaints_{it}
\end{aligned}
$$

[9] The panel data has several missing entries, and, thus, the random effect model cannot be adopted.

The parameter α, represents the intercept of the model, while μ_i and γ_t are non-random parameters for cross-sectional and time-series, respectively, to be estimated. Same operations strategy, productivity and service measures from previous Parks' method are also used in this model. The regression results for two-way fixed-effect model provided in Table in the Appendix.

Figure 4 depicts the trend of the time coefficients, γ_t, from the model between second quarter of 1995 and last quarter of 2007. It is evident that the coefficients are relatively stable until the fourth quarter of 2000; a significant decreasing trend is observed in the third quarter of 2001, which is the same quarter during which September 11 took place. A major drop in the time coefficients observed after the incident is approximately 0.25. The airlines managed to slightly recover from the attack starting in the first quarter of 2001, and it can be observed that this trend peaked in the fourth quarter of 2003. Overall, the averages of coefficients before and after September 11 were 0.228 and 0.042, which concludes the impact of 9/11 on the U.S. airline industry.

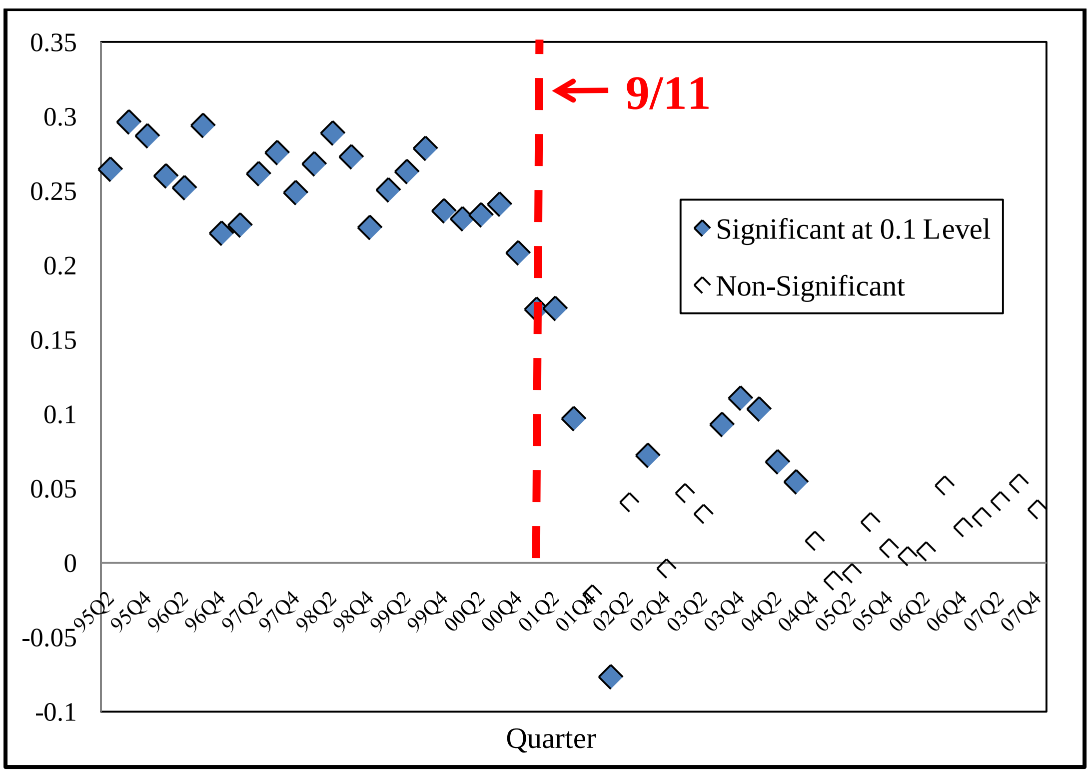

Figure 4: Time-Series Coefficients from Two-Way Fixed-Effects

By using the two-way fixed-effects model (Model 2), we had studied the impact of 9/11 on overall U.S. airline industry. We further investigate the impact of 9/11 on different types of operations strategy, FSC and LCC, by comparing OR employing two commonly used indicators: RPM and ASM. The plots in Figure 5 are the total ASM and RPM (i.e., combined for both FSCs and LCCs) between 2000 and 2004. The market has reached the similar level of ASM and RPM as before 9/11 in third quarter of 2002. Figure 6 plots the ASM and RPM broken into FSCs and LCCs. It is evident that both FSCs and LCCs have suffered from the attack in terms of ASM and RPM. However, it seems that FSCs have experienced a greater loss of both RPM and ASM than LCCs. The decline of ASM and RPM for FSC was approximately 14%, whereas the magnitude for LCCs is about 8%. Interestingly, ASM and RPM for LCCs appear to be trending upwards in post 9/11 data, while FSCs' ASM has stabilized and FSCs' RPM resonates that of LCCs.

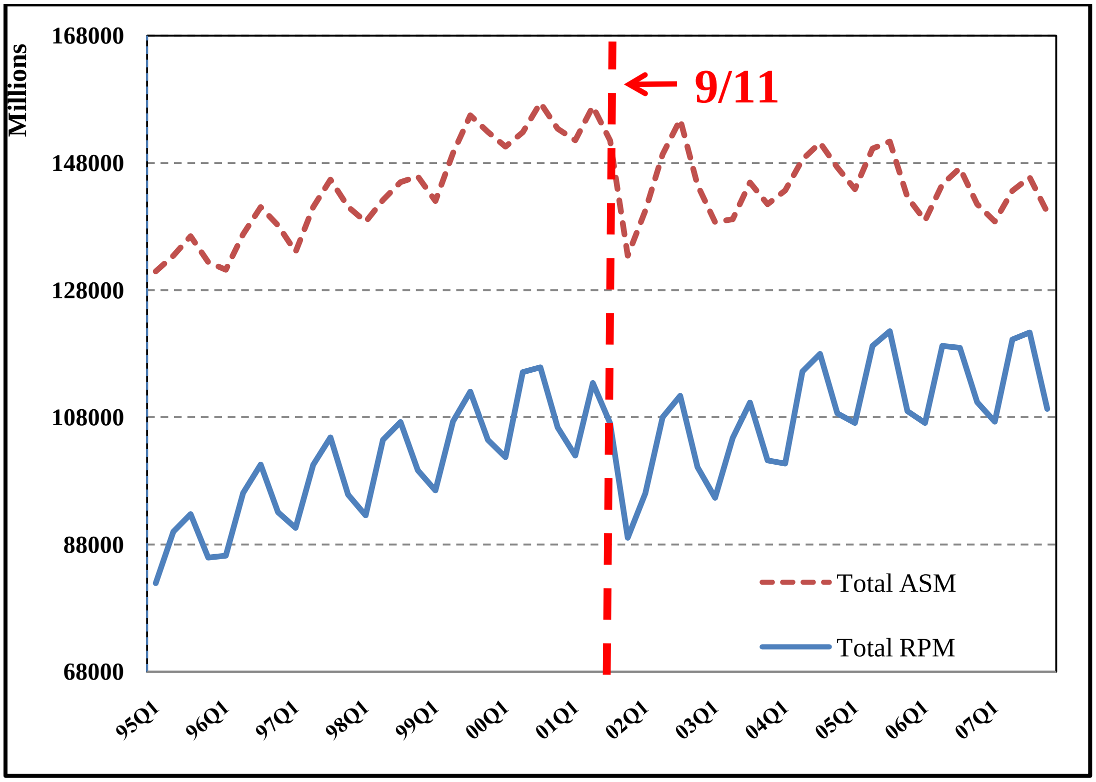

Figure 5: The U.S. domestic airlines' total ASM and RPM

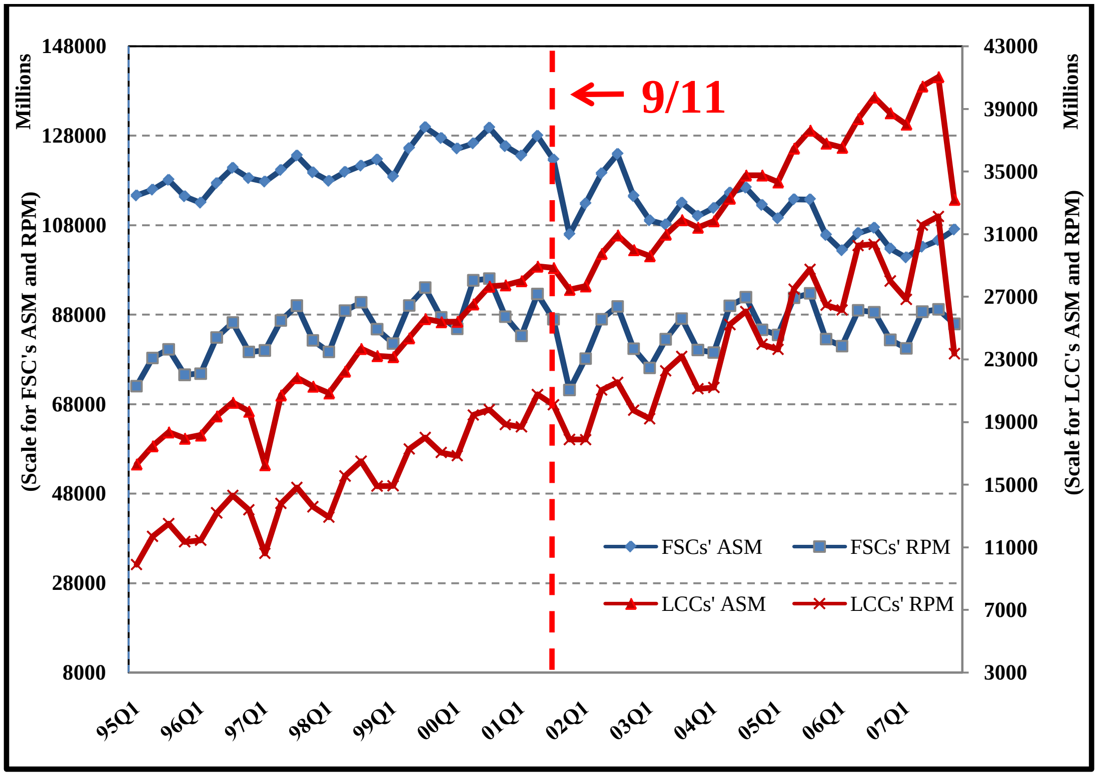

Figure 6: FSCs' and LCCs' ASM and RPM

5.2 Empirical Results and Discussion

Descriptive statistics post 9/11 attack is summarized in Table 6 in the Appendix. It is evident that the average of profitability for both FSCs and LCCs has decreased significantly after 9/11 to -7.09 and 4.39 respectively. Interestingly, FSCs appear to expand their stage length and increase the aircraft seat density post the attack, while LCCs have shortened their flight distance per trip and operate with smaller aircrafts than before. One noticeable improvement on productivity measure for FSCs is that the loading factor has increased from 70 to 77%. Regarding airline service quality after the attack, LCCs show a great improvement in all service measures, except for mishandled baggage. The on-time flight performance has increased from 74.76 up to 77.33% and the number of consumer complaints has dropped from 1.46 to 0.55 per 100,000 passengers. Similarly, the number of ticket oversales has dropped from 22.91 to 11.92 per 10,000 enplanement. At the same time, the corresponding service measures for FSCs have remained the same.

Post 9/11 attack, the model using Parks' method (MODEL 1) explains 74% of the variations in profitability, as seen from Table 7 in the Appendix. By conducting a t-test, we found

FSCs with a significant loss of profit, which can be explained by the former discussion on reduced RPM and ASM for FSCs after 9/11. However, an increasing trend of profitability for FSCs is observed, whereas LCCs experience a decreasing trend on profitability with a negative coefficient of -0.0041. Stage length remains negative impact on profitability; In Model 1A in Table 8 in the Appendix, the negative impact of stage length on profitability only exists for FSCs. Based on these findings, Hypothesis 1a is supported, i.e., operations strategy measures are still significant after 9/11. We find that the productivity measure loading factor has a greater weight in the model with a coefficient twice as large as before the attack, while the estimated coefficient of aircraft utilization has decreased slightly by 0.04 percentage points. Hence, Hypothesis 2a is also supported.

None of service measures is significant after 9/11, which also indirectly Hypothesis 3a that passengers are more forgiven to service glitches and associated lack of service to security measures. Table 9 in the Appendix shows no significant correlation between the number of consumer complaints and the rest of service measures. The R-squares with different groups of measures post 9/11 are summarized in Table 10 in the Appendix. Operations strategy measures have the greatest explanatory power on profitability than productivity while the service measures still serve the least explanatory power. In general, the good of fit of the models have improved significant. Consequently, our Hypothesis 4a is supported.

Our empirical results also have some implications for managers post 9/11 attack. We see that 1% increase in the coefficient of loading factor would result in 1.32 percentage points' increase in OPOR; whereas 1% increases in aircraft utilization would increase OPOR by 0.31%. Given that the mean of OPOR is -3.26% with a deviation of 12.25%, one could appreciate the magnitude of potential benefits for airlines. The impact of loading factor for FSCs is even more significant. The results have shown that 1% increase in loading factor for FSCs results in 1.70 percentage point increase in OPOR. Given that the mean of OPOR for FSC is -7.09 % with a standard deviation of 11.26%, this magnitude of benefit would actually mean almost 23.9% increase in their profitability. Similarly, 1% increase in loading factor for LCC results in 0.86% point increase in OPOR, which is approximately 19.6% of improvement in profitability. Figure 7, both types of airlines have shown their improvement on loading factor since 9/11 attack. The average difference at any given point of time between FSC and LCC is approximately 5 percentage points, which is almost identical to the difference of OPOR improvement on loading factor. Overall, managerial implications of our findings suggest that FSCs and LCCs might be better off by improving their loading factors and aircraft utilizations immediately, which, in turn, increases their profitability.

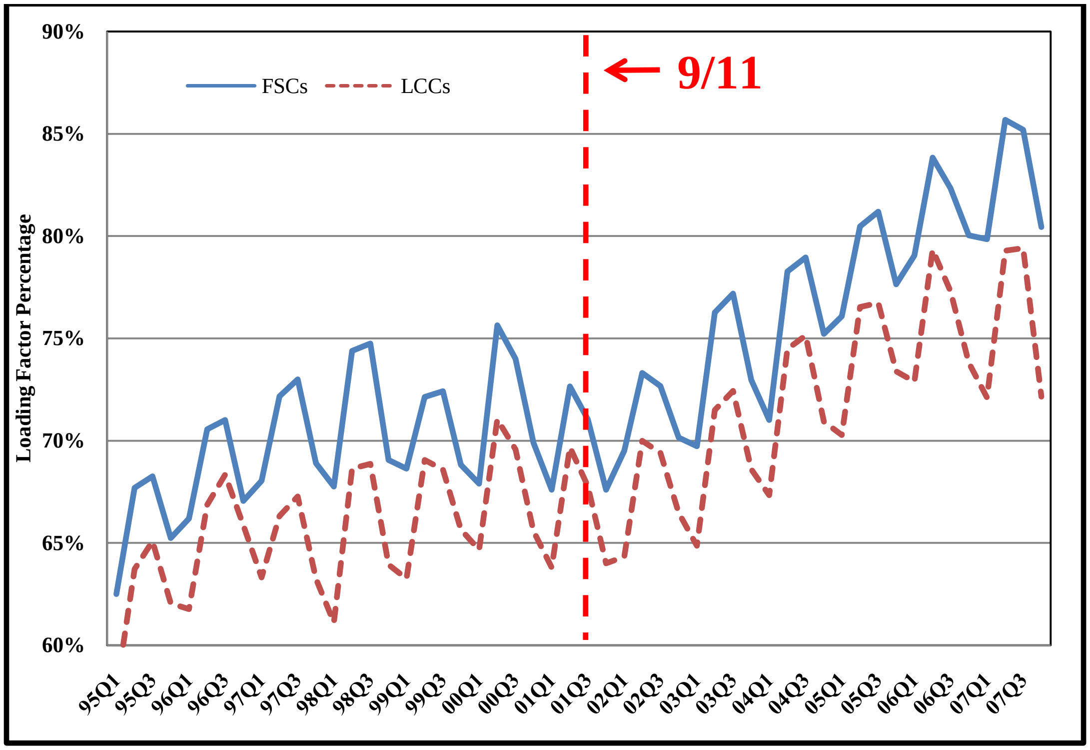

Figure 7: Loading Factors in the U.S. domestic Airline Industry

Chapter 6 Concluding Remarks

In this study, we examine the relationship between operations strategy, productivity, and service measures on profitability in U.S. domestic airline industry. We find that prior to 9/11 attack, all three types of measures are significant in explaining profitability. FSC is found with a declining trend on profits over time. A negative impact on profitability is observed when increasing stage length. Loading factor and aircraft utilization both show strong impact, in terms of significant and large coefficients, on profitability. Specially, the coefficient of loading factor of FSCs is almost double the coefficient of the loading factor of LCCs. Consumer complaints is the only service measure that shows significance in our model. Post 9/11 attack, it appears that FSCs are slowly improving their profits, whereas LCCs have a slightly decreasing trend with profitability over time. Increase in stage length continues to show negative impact on profitability especially for FSCs. Moreover, loading factor is found to have an even greater significance and impact on profitability than before 9/11, whereas the significance for aircraft utilization has slightly decreased.

Overall, we find support for Hypotheses 1 (operations measures are significant on airline profitability), 2 and 3 (higher productivity and service quality lead to greater profitability). However, we have only found partial support for our Hypothesis 4 (operations measure contribute greatest explanatory power on profitability) that productivity measures also contribute the same level of explanatory power as operations measure. Post 9/11 attack, we also find support for Hypotheses 1a, 2a, 3a (higher service measure does not lead to greater profitability) and 4a (operations measure contribute greatest explanatory power on profitability).

We also discuss the reasoning behind the fact that LCCs have higher aircraft utilization than FSCs using Belobaba's (2009) argument and findings from Gittel (2003). Moreover, we have also found evidence to support the "zone of tolerance" argument by Parasuraman et al. (1990) in airline industry that LCCs are penalized for providing low quality services in recent years as they were consistently excellent service carriers. Several managerial implications are made for airline operations management. Both FSCs and LCCs are recommended to increase their loading factors as their top priority to generate higher profits.

This research study also allows us to make several contributions to the operations management literature. We study the impact of operations strategy, productivity, service and profitability while using more customer service quality and productivity measures than those used by, e.g. Tsikriktsis (2007). We identified operations strategy measure being the greatest explanatory power on profitability. Moreover, we extend our data to post 9/11 attack and analyze the impact of the attack on profitability.

Our study is also subject to few limitations. First, we can only include Alaska, American Eagle, American West and Southwest Airlines as LCCs due to insufficient information on other LCCs in the U.S. This may create bias and inconsistency in the results for LCCs as we have only considered 4 of them. Consequently, more LCCs should be studied in the future studies. Second, we have not considered fuel cost in our model, which are also known to have strong impact on airline profitability, since different airlines have different contract 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 can 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.

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Appendices

Table 1: Descriptive Statistics for All Variables Before 9/11 (27 quarters prior to 9/11)

	Variable	All Airlines (N = 243) Mean	All Airlines (N = 243) St. dev.	Full-Service Airlines (N = 162) Mean	Full-Service Airlines (N = 162) St. dev.	Low Cost Carriers (N = 81) Mean	Low Cost Carriers (N = 81) St. dev.	Data Source
Profitability	Operating Profit / Operating 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 Baggage	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 Complaints	1.59	1.42	1.65	1.20	1.46	1.78	

Table 2: Results of Parks Method Before 9/11

	Variable	Model 1 Unstandardized Coefficient	Model 1 T-stat.	Model 1A Unstandardized Coefficient	Model 1A T-stat.
Operations Strategy Measure	Intercept	-0.79***	-5.73	-0.97***	-3.09
	LCC	-3.7E-02	-1.11	-0.25	-0.32
	FSC*time	-3.16E-03*	-1.99	-3.45E-03	-1.19
	LCC*time	-4.2E-04	-0.26	1.52E-03	0.71
	Stage Length	-1.6E-04***	-3.52		
	Seat Density	5.21E-04	0.81		
	FSC*Stage Length			-1.8E-04	-1.47
	LCC*Stage Length			-1.7E-04	-1.61
	FSC*Stage Density			-3.8E-04	-0.27
	LCC*Seat Density			3.51E-03	0.61
Productivity Measure	Loading Factor	0.95**	5.66		
	Aircraft Utilization	0.35**	2.34		
	ASM per Employee	3.29E-07	0		
	FSC*Loading Factor			1.08***	3.05
	LCC*Loading Factor			0.63**	2.04
	FSC*Aircraft Utilization			0.63	1.46
	LCC*Aircraft Utilization			0.242	0.84
	FSC*ASM per Employee			5.92E-07	0
	LCC*ASM per Employee			1.22E-07	0
Service Measure	On-time Flight	2.91E-04	1.26		
	Mishandled Baggage	4.8E-03	0.95		
	Ticket Oversales	2.07E-04	0.23		
	Consumer Complaints	-1.47E-02**	-2.09		
	FSC*On-time Flight			1.76E-04	0.49
	LCC*On-time Flight			3.96E-03	1.54
	FSC*Mishandled Baggage			1.07E-02	0.81
	LCC*Mishandled Baggage			1.31E-02	1.37
	FSC*Ticket Oversales			1.45E-03	0.70
	LCC*Ticket Oversales			3.8E-05	0.02
	FSC*Consumer Complaints			-1.62E-02	-1.17
	LCC*Consumer Complaints			-1.44E-02	-0.83
	R^2	0.478		0.676	
	Sample Size	243		243	

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 3: Correlation Matrix Using Parks' Method Before 9/11

	LCC	Stage Length	Seat Capacity	Loading Factor	Aircraft Utilization	ASME	Flight Delay	Mishandle Baggage	Tickets Oversale	Consumer Complaints
LCC	1	-0.39***	-0.47***	-0.27***	0.69***	0.49***	-0.09	-0.09	0.19***	-0.07
Stage Length		1	0.40***	0.29***	-0.05***	0.12*	-0.05	0.19***	0.30***	0.42***
Seat Capacity			1	0.19***	-0.18***	0.23***	0.05	0.21***	0.14**	0.11*
Loading Factor				1	-0.11*	0.11*	0.03	-0.12*	-0.02	0.30***
Aircraft Utilization					1	0.45***	-0.05	0.01	0.19***	-0.04
ASME						1	0.06	-0.02	0.21***	0.10
Flight Delay							1	-0.17***	-0.16**	-0.21***
Mishandle Baggage								1	-0.02	0.14
Ticket Oversales									1	0.25***
Consumer Complaints										1

*Signified significant at 0.10 in a two-tail test, ** at 0.05. *** at 0.01

Table 4: R-Square Comparison Before 9/11

	Model A	Model B	Model C	Model A+B	Model A+C	Model B+C	Model A+B+C
	Operations Strategy	Productivity	Service	Operations Strategy & Productivity	Operations Strategy & Service	Productivity & Service	Operations Strategy & Productivity & Service
R^2	0.293	0.32	0.145	0.437	0.443	0.365	0.478

Notes. Dependent variable: Operating Profit over Operating Revenue (OPOR)

Table 5: Results of Fixed Two-way Effects Regression Analysis All Periods

Variable	Unstandardized Coefficient	T-stat.	Variable	Unstandardized Coefficient	T-stat.	Variable	Unstandardized Coefficient	T-stat.
Time-Series Effect						**Cross Section Firm Effect**		
1995Q2	0.26***	4.85	2001Q4	-0.02	-0.55	Alaska	-0.02	-0.87
1995Q3	0.30***	6.37	2002Q1	-0.08*	-1.67	American Eagle***	0.32	3.32
1995Q4	0.29***	6.25	2002Q2	0.04	0.95	American	-0.03	-0.74
1996Q1	0.26***	5.14	2002Q3	0.07*	1.95	American West**	-0.08	-2.37
1996Q2	0.25***	5.01	2002Q4	-3.83E-03	-0.1	Continental	-0.03	-0.94
1996Q3	0.29***	6.78	2003Q1	0.05	1.15	Delta	-0.04	-1.25
1996Q4	0.22***	5.39	2003Q2	0.03	0.8	Northwest	0.03	1.62
1997Q1	0.23***	4.86	2003Q3	0.09***	2.63	Southwest**	0.06	2.24
1997Q2	0.26***	5.46	2003Q4	0.11***	3.28	United*	-0.07	-1.93
1997Q3	0.28***	6.49	2004Q1	0.10***	2.8			
1997Q4	0.25***	6.13	2004Q2	0.07*	1.78	**Intercept**	-1.22***	-5.77
1998Q1	0.27***	6	2004Q3	0.05*	1.68	**Operations Strategy**		
1998Q2	0.29***	6.03	2004Q4	0.01	0.46	FSC*time	1.95E-03***	3.66
1998Q3	0.27***	6.73	2005Q1	-0.01	-0.35	Stage Length	-7.0E-05	-0.78
1998Q4	0.23***	5.82	2005Q2	-0.01	-0.21	Seat Density	1.86E-03**	2.08
1999Q1	0.25***	5.66	2005Q3	0.03	0.84	**Productivity**		
1999Q2	0.26***	5.77	2005Q4	0.01	0.3	Loading Factor	0.95***	5.03
1999Q3	0.28***	7.13	2006Q1	4.43E-03	0.14	Aircraft Utilization	0.41***	3.45
1999Q4	0.24***	6.19	2006Q2	0.01	0.23	ASM per Employee	1.22E-07	0
2000Q1	0.23***	5.55	2006Q3	0.05	1.56	**Service Quality**		
2000Q2	0.23***	5.41	2006Q4	0.02	0.73	On-time Flight	-4.0E-05	-0.13
2000Q3	0.24***	6.29	2007Q1	0.03	0.95	Mishandled Baggage	1.96E-03	0.66
2000Q4	0.21***	5.47	2007Q2	0.04	1.26	Ticket Oversales	-1.20E-04	-0.17
2001Q1	0.17***	4.15	2007Q3	0.05	1.58	Consumer Complaints	-6.56E-03	-1.15
2001Q2	0.17***	4	2007Q4	0.04	1.06			
2001Q3	0.10***	2.6						
R^2		0.736						

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 6: Descriptive Statistics for All Variables After 9/11 (25 quarters post 9/11)

	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	Operating Profit / Operating 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 Baggage	5.62	2.75	5.12	1.89	6.62	3.76	
	Ticket Oversales	14.17	5.16	15.29	5.02	11.92	4.72	
	Consumer Complaints	1.00	0.58	1.22	0.55	0.55	0.33	

Table 7: Results of Parks' Method After 9/11

	Variable	Model 1 Unstandardized Coefficient	Model 1 T-stat.	Model 1A Unstandardized Coefficient	Model 1A T-stat.
Operations Strategy Measure	Intercept	↓ -1.16***	-6.57	↓ -1.51***	-2.73
	LCC	↓ -0.20***	-5.26	-1.00	-1.47
	FSC*time	↑ 4.7E-03**	2.46	1.7E-03	0.33
	LCC*time	↑ -4.1E-03**	-2.29	-6.0E-03	-0.97
	Stage Length	↓ -2.9E-04***	-5.18		
	Seat Density	-3.7E-04	-0.53		
	FSC*Stage Length			↓ -2.6E-04**	-2.05
	LCC*Stage Length			-2.9E-04	-1.16
	FSC*Stage Density			1.2E-03	0.61
	LCC*Seat Density			-2.2E-03	-0.76
Productivity Measure	Loading Factor	↑ 1.32***	10.35		
	Aircraft Utilization	↓ 0.31**	2.55		
	ASM per Employee	1.36E-07	0		
	FSC*Loading Factor			↑ 1.70***	3.39
	LCC*Loading Factor			↑ 0.86***	2.48
	FSC*Aircraft Utilization			0.18	0.54
	LCC*Aircraft Utilization			0.67	0.79
	FSC*ASM per Employee			2.22E-08	0
	LCC*ASM per Employee			4.87E-07	0
Service Measure	On-time Flight	2.0E-03	1.49		
	Mishandled Baggage	3.0E-03	0.88		
	Ticket Oversales	-3.9E-04	-0.38		
	Consumer Complaints	-8.7E-03	-0.58		
	FSC*On-time Flight			8.9E-04	0.24
	LCC*On-time Flight			8.1E-05	0.02
	FSC*Mishandled Baggage			4.0E-03	0.35
	LCC*Mishandled Baggage			-1.1E-03	-0.10
	FSC*Ticket Oversales			5.3E-04	0.20
	LCC*Ticket Oversales			-2.4E-03	-0.56
	FSC*Consumer Complaints			-5.6E-03	-0.17
	LCC*Consumer Complaints			8.1E-03	0.11
	R^2	0.738		0.787	
	Sample Size	225		243	

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 8: Correlation Matrix Using Parks' Method After 9/11

	LCC	Stage Length	Seat Capacity	Loading Factor	Aircraft Utilization	ASME	Flight Delay	Mishandle Baggage	Tickets Oversale	Consumer Complaints
LCC	1	-0.63***	-0.65***	-0.51***	0.00	-0.07	-0.06	0.26***	-0.31***	-0.55***
Stage Length		1	0.73***	0.59***	0.37***	0.40***	-0.06	-0.46***	0.12	0.29***
Seat Capacity			1	0.44***	0.52***	0.65***	0.13	-0.62***	0.36***	0.27***
Loading Factor				1	0.33***	0.38***	-0.44***	-0.03	-0.14	0.39***
Aircraft Utilization					1	0.59***	-0.16**	-0.21***	-0.03	0.09
ASME						1	0.03	-0.37***	-0.01	-0.16**
Flight Delay							1	-0.50***	0.25***	-0.33***
Mishandle Baggage								1	-0.40***	0.22***
Ticket Oversales									1	0.22***
Consumer Complaints										1

*Signified significant at 0.10 in a two-tail test, ** at 0.05. *** at 0.01

Table 9: R-Square Comparison After 9/11

	Model A	Model B	Model C	Model A+B	Model A+C	Model B+C	Model A+B+C
	Operations Strategy	Productivity	Service	Operations Strategy & Productivity	Operations Strategy & Service	Productivity & Service	Operations Strategy & Productivity & Service
R^2	↑ 0.586	↑ 0.560	↓ 0.059	↑ 0.702	↑ 0.599	↑ 0.448	↑ 0.738

Notes. Dependent variable: Operating Profit over Operating Revenue (OPOR)

Table 11: Descriptive Statistics for All Variables (52 quarters)

	Variable	All Airlines (N = 468) Mean	All Airlines (N = 468) St. dev.	Full-Service Airlines (N = 312) Mean	Full-Service Airlines (N = 312) St. dev.	Low Cost Carriers (N = 156) Mean	Low Cost Carriers (N = 156) St. dev.	Data Source
Profitability	Operating Profit / Operating Revenue	0.02	0.19	-0.44	0.12	0.06	0.10	Form 41 (P-52)
Operations Strategy Measure	Stage Length	783.63	206.01	858.62	172.26	633.64	185.38	Form 41 (T2)
	Seat Density	141.70	25.78	151.45	12.52	122.19	33.37	Form 41 (T2)
Productivity Measure	Loading Factor	0.72	0.06	0.73	0.06	0.69	0.05	Form 41 (T2)
	Aircraft Utilization	0.35	0.05	0.34	0.04	0.37	0.06	Form 41 (T2)
	ASM per Employee (in K)	463.47	977.21	456.65	737.15	477.10	132.62	Form 41 (P-10 & P-12)
Service Measure	On-time Flight	77.29	12.33	77.93	14.47	76.00	5.96	Air Travel Consumer Report
	Mishandled Baggage	5.29	2.11	5.09	1.52	5.69	2.92	
	Ticket Oversales	17.70	7.25	17.73	5.91	17.63	9.39	
	Consumer Complaints	1.30	1.13	1.44	0.96	1.02	1.37	