The Role of Ancillary Fees in Shaping U.S. Airline Industry

Abstract

After a long period of deregulation, the U.S. Department of Transportation (DOT) has started re-regulating the airline industry through policies on family seating, cancellation and delay refunds, and transparency of ancillary fees. While economists generally argue against government intervention in free markets, certain circumstances may warrant regulation. This study seeks to answer whether ancillary fees necessitate such intervention. Traditionally, full-service airlines (FSAs) are assumed to generate higher revenue surpluses than low-cost carriers (LCCs) and ultra-low-cost carriers (ULCCs), as their passengers tend to be less price-sensitive. However, the growing use of ancillary fees—predominantly by ULCCs—may significantly impact revenue surplus, especially if base airfares do not decrease as anticipated. Using data from the U.S. airline industry from 2000 to 2019, this study examines the effect of ancillary revenues on airlines' revenue surplus, focusing on how these revenues shape the industry's competitive dynamics. The results show that ancillary revenues substantially impact revenues as ULCCs generate higher revenue surplus than FSAs and LCCs, despite offering lower base fares. This suggests that ancillary fees are not merely a cost-recovery mechanism but a critical revenue-generating tool for these carriers. Additionally, the analysis reveals that mergers play a significant role in determining revenue surpluses, with mergers contributing to higher surpluses.

1 Introduction

Due to the intense competition triggered by the Airline Deregulation Act of 1978, U.S. airlines grappled with the challenge of recovering substantial fixed costs. Consequently, the

aftermath of deregulation ushered in a protracted era of meager profits for the aviation industry (Borenstein, 2011). To avoid marginal cost pricing, they strategically employed various tactics, including price differentiation, product enhancements, code-sharing agreements, and mergers (Berry et al., 2019). In recent years, a novel opportunity for profit-making has surfaced within the industry: ancillary revenues. This approach involves airlines offering base fares and subsequently endeavoring to sell ancillary goods and services throughout the travel experience. While ancillary revenues are associated with ULCCs/LCCs, FSAs also began implementing this strategy by removing hot meals from domestic flights in 2001 (Henrickson & Wilson, 2016). After the Great Recession, there has been a notable upswing in ancillary revenues derived from services such as checked baggage, seat selection, extra legroom, and more (Boin et al., 2017). To illustrate, ancillary revenues have surged from approximately $40 billion in 2010 to $109 billion in 2019. This surge has seen ancillary revenue increase from 4.8% of overall carrier revenues to a substantial 12.2%[1].

A discussion regarding add-on pricing strategies pertains to their influence on revenue surpluses. On the one hand, Lal and Matutes (1994) argue that the revenue surpluses derived from add-ons will eventually be "competed away." As firms try to gain a competitive edge by offering add-ons and charging higher prices, other firms will adjust their strategies to offer similar add-ons. This increased competition is expected to lead to lower overall prices. In other words, the idea is that market forces will drive base prices down to a level where the profit margins are more in line with the costs of production, and any temporary advantage gained through add-ons will be eliminated over time. On the other hand, Ellison (2005) argues that

[1] https://www.forbes.com/sites/deandonovan/2019/12/03/ancillary-growth-makes-airlines-and-especially-ulccs-a-better-bet/?sh=18d2b5d025e2

when competing firms engage in second-degree price discrimination, there could be adverse effects that affect competition dynamics. It suggests that add-on pricing, where additional features or services are offered separately from the base product, may have a softening effect on competition. In other words, instead of intensifying competition and leading to lower prices for the base product, add-on pricing might make competition less aggressive. Furthermore, this softened competition could lead to higher equilibrium profits for the firms involved.

A short time ago, the U.S. DOT issued a final rule on the transparency of ancillary revenues. The final rule on ancillary fee transparency requires airlines and ticket agents to disclose certain fees, such as those for baggage and ticket changes/cancellations, at the time of booking to ensure consumers are aware of the full cost of air travel (14 CFR Parts 259 and 399, 2024). With this in mind, a fundamental question arises for the air transportation industry: Do ancillary revenues require a regulation? Passengers of FSAs are less price-sensitive than those of LCCs and ULCCs (Smyth & Pearce, 2008), indicating that FSAs would typically generate greater revenue surpluses. However, if ULCCs leverage ancillary revenues as a primary revenue-generating strategy rather than merely as a supplement to base airfares, they can potentially achieve greater revenue surpluses than FSAs. These fees with ambiguously set up can significantly affect the total travel prices in the airline industry. Our study examines the influence of ancillary revenues on revenue surpluses across different airline business models, highlighting the varied impacts on social welfare.

Firstly, it is essential to explain that ancillary goods and services are not simply the output of airlines. Therefore, we cannot associate inputs with ancillary goods and services. Therefore, unbundling these goods and services may help airlines to reduce airfares. While the price elasticity of demand for tickets is high, passengers are less price-sensitive to ancillary

products and services[2]. In addition, the demand for ancillaries is derived from passenger throughput. Therefore, airlines' primary goal is to increase the number of passengers. Leveraging lucrative ancillary revenues, airlines can offer diminished fares, strategically attracting price-sensitive customers (Brueckner et al., 2015). Consequently, airlines may gain a competitive edge in a highly fare-sensitive market (Boin et al., 2017). However, the discussion centers around the overall pricing level of the trip. Brueckner et al. (2015) investigated the correlation between unbundled baggage fees, base fares, and overall trip prices. Their findings revealed that the unbundling baggage fees led to a reduction in base fares. While this reduction in base fares occurred, it was outweighed by the added baggage fees, leading to an overall increase in total trip prices. It is crucial to highlight that Brueckner et al. (2015) assumed that airlines make decisions from a monopolistic standpoint.

A thorough comprehension of the specific influence of ancillary fees on social welfare requires a revenue surplus analysis that takes into account market dynamics. In line with this, we conducted a stochastic frontier model introduced by Kumbhakar et al. (2012) and extended by Mydland et al. (2022) by utilizing the data from U.S. airlines from 2000 to 2019. Our research reveals that ULCCs can generate higher revenue surpluses than FSAs and LCCs, despite offering lower base airfares. This is largely due to the role of ancillary revenues. As the share of ancillary revenues in total costs increases, airlines are able to achieve higher revenue surpluses. This suggests that ancillary fees are being utilized as a primary revenue-generating tool rather than merely covering costs not included in base fares. Additionally, mergers contribute to higher revenue surpluses.

[2] https://businessjournalism.org/2014/12/airlines-find-the-money-with-ancillary-revenues/

This paper is structured as follows: Section 2 provides an overview of the U.S. airline industry after the deregulation incorporating three business models. A comprehensive discussion of prior studies related to airline market power and ancillary revenues is presented in Section 3. Section 4 details the methodology, while Section 5 describes the dataset. Empirical results are deliberated in Section 6. Finally, Section 7 concludes the study with a discourse on policy implications and potential avenues for future research.

2 U.S. Airline Industry

2.1 Developments after Airline Deregulation

The Airline Deregulation Act of 1978 opened a new era that expedited the transition from government-centric to market-oriented decision-making within the aviation industry. Deregulation has led to the discernible elimination of regulatory price controls, resulting in a notable decrease in average prices. This change is, however, coupled with a substantial increase in price variation across the market (Borenstein & Rose, 2005). The evolution of the airline industry post-deregulation has been shaped by three crucial factors that substantially influenced airfares: (i) the establishment of the hub-spoke system, (ii) an increase in average load factors, and (iii) the rise of LCCs (Borenstein, 2011; Peterson, 2018). While LCCs offer lower airfares with a point-to-point service, legacy airlines countered this price competition by adopting the hub-and-spoke system, encouraging loyalty programs, and providing full service. This competition has had noteworthy repercussions, namely, between 1979 and 2018, a total of 180 airlines sought protection under Chapter 11 bankruptcy, and an additional 24 airlines filed for Chapter 7 bankruptcy[3]. Furthermore, a wave of mergers has become evident as a response to the

[3] http://airlines.org/dataset/u-s-bankruptcies-and-services-cessations/

harsh competition that ensued after deregulation. To illustrate, in 2012, a mere five airlines dominated 85% of the capacity, while a decade earlier, in 2000, ten airlines collectively held over 90% of the available seat mile capacity (DOT-Office of Inspector General, 2012).

The 2008 financial crisis was another cornerstone for the airline industry, triggering significant transformations within the aviation sector. These transformations involve the consolidation of airlines through mergers, leading to a highly concentrated market including a mere three FSAs. In addition, there was a noteworthy rise in code-sharing agreements between FSAs and regional airlines (RAs) (DOT-Office of Inspector General, 2012). This shift resulted from the limited space for further mergers among FSAs. As a result, the implementation of certain strategies enabled FSAs to enhance their capacity utilization rates (Karanki, 2023). This improvement, in turn, led to a reduction in the cost differential between LCCs and FSAs (Bitzan & Peoples, 2016). Furthermore, in the aftermath of the 2008 financial crisis, a new business model, ULCCs, emerged. This model, built on aggressive expansion into smaller airports and the adoption of lower pricing strategies, introduced an additional challenge to the airline market.

Over the past decade, the airline industry has undergone a paradigm shift in its revenue generation model, acknowledging the significant role played by ancillary revenues in augmenting overall income. Ancillary revenues emerged as an unbundling pricing strategy to address the challenge of high competition faced by airlines. In a landscape where ticket prices alone may not suffice to compete, unbundling may become a vital component in achieving higher market share. Beyond the traditional ticket fare, carriers now offer an array of supplementary services that cater to the diverse preferences of passengers. This includes fees for premium seating, providing travelers with the option to enjoy added comfort, priority boarding privileges, seamless access to Wi-Fi during flights, and other services that enhance the overall

travel experience. The integration of advanced technology has played a pivotal role in the efficient implementation and marketing of ancillary services. Online booking platforms and mobile applications have become powerful tools, empowering passengers to personalize their travel experience seamlessly. Travelers can conveniently add extras, such as baggage options, in-flight entertainment packages, and exclusive lounge access, during the booking process. However, their willingness to pay may differ across business models and ancillary services, i.e., short-haul, LCCs, and leisure passengers may show a higher inclination to buy food and drink while long-haul, FSAs, and business passengers may prioritize benefits like extra legroom (Warnock-Smith et al., 2017). As ancillary revenues continue to surge, an ongoing discourse has emerged surrounding the transparency associated with these supplementary income streams (Mumbower et al., 2023). To address this concern, the U.S. Department of Transportation (DOT) requires airlines to display ancillary fees to their passengers and all ticket agents before the booking process (14 CFR Parts 259 and 399, 2024).

2.2 Airline Business Models

The U.S. airline industry comprises four distinct business models: FSAs, LCCs, and ULCCs. The landscape of the aviation industry underwent a profound transformation in the immediate aftermath of deregulation, as existing carriers embarked on expansive endeavors and new entrants reshaped the sector's structure. The original cohort of eleven trunk carriers commonly referred to as "legacy" carriers, were initially authorized to provide regulated jet service before 1978. However, this relatively exclusive group experienced a substantial influx of LCCs in 1984 (Borenstein & Rose, 2005). While the first LCC, Southwest Airlines, made its debut in Texas in 1971 (Dresner et al., 1996), LCCs found a suitable environment for growth after the deregulation. Distinguishing themselves from LAs, LCCs can provide lower airfares

through a combination of strategic measures aimed at minimizing operational costs. To achieve this goal, they focus on point-to-point routes, avoiding the complexities and costs associated with hub-and-spoke systems, and simplify their fleets, opting for a single aircraft type, which reduces maintenance and training expenses (Gillen, 2006). Furthermore, the optimization of aircraft utilization, the implementation of efficient turnaround times facilitated by the absence of belly-hold cargo, and the negotiation of cost-effective agreements with secondary airports contribute to overall operational efficiency (Button & Ison, 2008; Yu et al., 2019). These carriers embrace a no-frills service model, where passengers are charged for extras such as meals and baggage. Through direct sales facilitated by online channels, distribution costs are eliminated, and the adoption of lean organizational structures further contributes to the reduction of labor expenses (Button & Ison, 2008). Initially, the cost gap between LCCs and LAs stood at 50% (Gillen, 2006). However, the cost advantage of LCCs has gradually diminished in recent years, primarily attributed to the higher load factors achieved by Legacy Airlines (Bitzan & Peoples, 2016).

The FSA business strategy is associated with the hub-spoke system in which an airport is selected as the hub or transfer point of several usually smaller airports (the spokes) (Smith & Cox, 2012). American Airlines pioneered the hub-and-spoke system by establishing Dallas Fort Worth International Airport (DFW) as its hub in 1979 (Peterson, 2018). This network model offers numerous advantages to airlines in terms of both operations and marketing (Pickrell, 2017), allowing them to reduce marginal costs through economies of density (Brueckner & Zhang, 2001; Caves et al., 1984). The hub-and-spoke configuration creates "agglomeration economies" that prove beneficial to both airlines and passengers (Starkie, 2002). By centralizing services at the hub, FSAs can offer more frequent flights to major cities, enhancing the network's scope and increasing flight frequency for the benefit of passengers. The cost efficiency of the

hub-spoke system was criticized by Gillen (2006) who argues that the model incurs higher capital, labor, and operating costs due to the complexity of hub-and-spoke operations. These complexities include extended aircraft turnarounds, connection slack, congestion, and the intricacies of managing personnel and baggage connections. On the price side, due to the logistical and economic limitations of supporting multiple large-scale hub operations at a single airport, competition at hub airports remained notably constrained. This lack of competition creates an inelastic demand which leads to higher output and prices for FSA services (Berry et al., 1996). Overall, the hub-spoke systems may allow LAs to charge high markups (Berry et al., 2019). Distinct price discrimination schemes further set apart LCCs and FSAs. LAs employ a price discrimination strategy hinged on trip restrictions, including obligatory return trips, mandatory Saturday stayovers, and minimum/maximum stay requirements. In contrast, LCCs have challenged this competitive advantage by adopting an intertemporal price discrimination model (Tretheway, 2004).

The emergence of ULCCs as a subtype of LCCs occurred in the aftermath of the 2008 financial crisis. Although the ULCC model was initially popularized by Spirit Airlines in 2010, other airlines such as Frontier Airlines and Allegiant Air have also been classified as ULCCs (Bachwich & Wittman, 2017). Similar to traditional LCCs, ULCCs adopt a lean cost structure and a focused service strategy to maintain the lowest possible cost structure through practices such as high aircraft utilization, the use of single-type aircraft, cost-driven scheduling, and a reduced emphasis on in-flight services (Nguyen et al., 2022). ULCCs distinguish themselves further by operating with lower costs compared to both LCCs and FSAs, boasting cost advantages of 18% and 31%, respectively (Nguyen et al., 2022). FSAs, with strong positions in key airports and limited alternatives for ULCC competition, have maintained higher fares

through strategic capacity discipline. Cost efficiency has been a crucial factor in ULCCs aggressively expanding their market presence, particularly by targeting smaller airports. Over the past decade, ULCCs have rapidly expanded, competing with LAs and traditional LCCs in the U.S. market. For example, Allegiant's airport network surged from 72 airports in 2008 to 126 airports in 2019. However, the aggressive expansion and substantial investments by ULCCs also pose challenges. Excessive investments may result in excess capacity, especially if new entrants or existing LCCs fail to achieve the anticipated output reached by the early pioneers of the LCC business model (Wojahn, 2012). The delicate balance between capacity expansion and market demand remains a critical consideration for ULCCs seeking sustained success in the highly competitive airline industry. During economic downturns, ULCCs are poised to gain market share by aggressive pricing to sustain load factors, while legacy carriers and traditional LCCs will need to protect fares. In addition, extensive reliance on ancillary revenues sets ULCCs apart from other business models. Specifically, approximately 30% of ULCCs' revenue is derived from ancillary sources, in stark contrast to the 6% and 10% shares attributed to ancillary revenues for LCCs and FSAs, respectively[1].

As the era of airline mergers began to lose steam, alternative forms of collaboration gained prominence. In the 1980s, major U.S. airlines pioneered partnerships with smaller commuter airlines, introducing joint ticket sales and creating a seamless experience for passengers transitioning between commuter airlines, major carriers' hubs, and other significant airports. This cooperative approach, emphasizing schedule coordination and "code-sharing," presented a unified airline ticket. In this context, RAs assumed a pivotal role, connecting smaller city airports to hubs on behalf of FSAs, with their significance growing notably after the 2008 financial crisis. To illustrate this, the proportion of flights operated by regional airlines for major

carriers like American, Delta, United, and US Airways increased from 40% in 2000 to 61% in 2011 (DOT-Office of Inspector General, 2012). This collaborative strategy not only facilitated a reduction in unused capacity for FSAs but also opened small city markets that were previously unprofitable. Thereby, code-sharing agreements with RAs became instrumental in allowing FSAs to reach these markets.

3 Literature Review

Keeler (1972) is a pioneering study that examines airline markups. In 1968, the study indicated a low markup of 20 percent on short-haul regulated routes and 95 percent on long-haul regulated routes. However, by 1972, the markup ranged from 45 to 84 percent. Despite Pacific Southwest Airlines consistently outperforming typical trunk airlines in profitability, it maintained lower fares. The trunk airlines, earning approximately normal profits, attributed their high costs to excess capacity. The study revealed a trend of maintaining a load factor substantially below that on unregulated California intrastate routes, indicating that with fares set at cartel levels, airlines compete through excess capacity rather than prices. The study also considered evidence that high-density routes may be more profitable than the aggregate airline rates of return suggest. Excess profits from these routes could potentially cross-subsidize less profitable, low-density routes. However, the extent of cross-subsidization in the present context remains uncertain, especially with trunk airlines being allowed to abandon low-density routes to local service carriers. The study questions the economic reasons supporting continued airline regulation. It challenges the argument that regulation prevents cutthroat competition leading to bankruptcy, citing historical instances that suggest otherwise.

Borenstein (1989) explored the significance of route and airport dominance in determining an airline's market power and pricing behavior. The author found that the airline's share of passengers on a route and at endpoint airports significantly influences its ability to set prices above cost. Dominant airlines exhibit high markups, but this doesn't create a beneficial "umbrella" effect for smaller carriers operating in the same markets. While acknowledging the efficiency gains of hub-and-spoke air transport systems over point-to-point systems, the results revealed that the dominance of major airports by one or two airlines, often resulting from hub formation, can lead to higher fares for consumers traveling to or from these airports. The article suggests that such strongholds insulate dominant carriers from competition, and the market power of a dominant airline does not substantially benefit other airlines serving the same airport or routes. This study, however, did not precisely determine the extent to which each factor allows a dominant airline to raise its prices. Berry et al. (1996) developed a model of airline competition that incorporates key industry features: product differentiation and economies of density. Consistent with Borenstein's (1989) research, their results demonstrate that hubbing airlines possess the capability to raise prices, especially for tickets that appeal to business travelers with a lower sensitivity to price fluctuations. These business travelers exhibit a preference for the origin-hub airline, even when confronted with a premium of approximately 20%. It is noteworthy, however, that this pricing influence does not create a pervasive "monopoly umbrella" effect for non-hub airlines. On the cost side, the findings provide evidence of economies of density on longer routes, endorsing the notion of cost efficiencies inherent in the hub-and-spoke system. This underscores the crucial role of hubs as indispensable tools for both production and marketing in the airline industry. The identified economies of density suggest substantial cost savings facilitated by hubs, with the ability to charge a hub premium being more

prominent, particularly for business travelers who are less responsive to price variations. Berry and Jia (2010) introduced a structural model of the airline industry and assessed the influence of demand and supply changes on profitability, particularly comparing the late 1990s with 2006. The study reveals that, in 2006, air travel demand was 8% more price-sensitive compared to the late 1990s. Passengers exhibited a stronger preference for direct flights, with a 17% higher connection semi-elasticity. Additionally, changes in marginal cost significantly favored direct flights. These factors, coupled with the expansion of LCCs, accounted for over 80% of the decline in variable profits for LAs. Despite the common focus on rising fuel costs and LCC competition, shifts in demand emerged as a crucial explanation for LAs' profit declines. Moir and Lohmann (2018) devised a tool to objectively measure the competitive advantage of airlines operating within the U.S. market. The results revealed a pattern where airlines with lower costs tended to have a higher competitive advantage. Spirit Airlines as an ULCC emerged as the competitive leader, while American Airlines was considered the least competitive. Interestingly, Frontier, another LCC, achieved the second lowest competitive score, emphasizing that creating value in the product offer conflicts with the airline's strategic proposition. Notably, Southwest was the only airline successfully implementing the proposed integrated strategy.

Bet (2021a) examined the impact of recent U.S. airline mergers on efficiencies and market power, using production and cost data from the U.S. airline industry to estimate marginal cost, productivity, and markups. The author found that, in most cases, mergers did not significantly improve merging parties' productivity, marginal costs, or technology. Some mergers, such as United-Continental and Southwest-AirTran, even reduced productive efficiency due to substantial integration costs. While the Delta-Northwest and United-Continental mergers did not notably increase markups, the Southwest-AirTran and American-US Airways mergers

saw post-merger markup increases, indicating a rise in market power. The increase in net profit rates following mergers, coupled with a lack of efficiency gains, suggests an overall increase in market power. In addition, Bet (2021b) investigated the U.S. airline industry's market power dynamics, particularly examining the repercussions of recent consolidations on markups and coordinating behavior. It reveals a cyclical pattern where market power weakens during economic downturns but swiftly regains strength as demand rebounds, with the past decade witnessing all-time high markups, primarily steered by dominant carriers (American, Delta, United, and Southwest). Notably, this study identifies a substantial increase in market power, marked by rising markups unrelated to fixed costs or scale elasticity. Counterfactual simulations underscore the impact, indicating a 17% reduction in consumer surplus and a 10% surge in prices compared to a scenario assuming no conduct alteration.

Nguyen et al. (2022) investigated revenue efficiency in three airline business models – ULCC, LCC, and NLC – using data from major U.S. airlines from 2015 to 2019. Employing a two-stage DEA approach, the findings reveal that, within their respective airline types, airlines showed relatively high and comparable revenue efficiency levels. However, ULCCs experienced a decline in revenue efficiency when considering all airline types, making them the least efficient, while LCCs and LAs maintained superior efficiency. The switch of technology references indicated that ULCCs forewent an average of 17.6% of potential revenue due to technological constraints. Factors such as service quality, operational size, and ticket price significantly influenced revenue efficiency, leading to implications for improving and sustaining airlines' financial performance. Karanki (2023) explored the issue of excess capacity in the US airline industry, particularly focusing on the impact of business models in the aftermath of the 2008 financial crisis. The results reveal that business models are significant determinants of

excess capacity, with LAs exhibiting higher capacity utilization rates followed by LCCs. The actions taken by LAs post-crisis offer insights into strategies for managing excess capacity. The author did not detect a significant relationship between mergers and capacity utilization.

In recent years, airline ancillary revenues have drawn the attention of researchers. O'Connell and Warnock-Smith (2013) investigated traveler preferences and acceptance levels for various airline ancillary products and services through an online passenger survey, analyzing booking preferences and attitudes towards a range of air and non-air travel components offered by airlines. By combining survey results with expert opinions gathered from an international conference and supplementary data, the authors established an acceptance ranking. Therefore, the research identifies key products, such as airport car parking and fees for checked baggage, with high acceptance and willingness to pay (WTP), guiding airlines in focusing on these lucrative areas. The insights also highlight differences between LAs and LCCs, urging a nuanced approach to developing ancillary revenue streams tailored to customer preferences and market dynamics. Warnock-Smith et al. (2017) took the literature further by conducting an online survey in November 2014 to understand the preferences and WTP for ancillary services based on the type of carrier, journey length, and purpose. The research uncovers significant variations in WTP for various ancillary services among LCCs and LAs passengers, short-haul and long-haul travelers, and those traveling for business, leisure, or visiting friends and relatives (VFR). Notable statistical differences were observed, such as LCC holiday-makers on short flights displaying a higher inclination to purchase food and drinks, while long-haul business travelers with full-service carriers showed a stronger preference for extra legroom. In essence, the study underscores a prevailing inclination among travelers to prioritize essential ancillary products and services deemed as 'necessities,' rather than those perceived as optional 'nice-to-have' extras.

Shaw et al. (2021) examined the willingness of passengers to purchase third-party ancillary services and explored potential offers that could enhance their willingness to buy specific services. The research employs a mixed methods approach, combining a passenger survey and interviews with nine industry experts. The findings suggest that passengers are open to paying airlines for specific third-party ancillaries, such as car hire, hotel accommodation, and airport parking. The authors underscore substantial opportunities for airlines to boost revenues by focusing on a new wave of third-party ancillary services beyond a-la-carte and frequent flyer offerings. The key to success lies in increasing customer awareness and conversion, with a crucial emphasis on collecting and utilizing customer data, including big data and digital platforms.

While past research has individually explored airline markups and ancillary revenues, the impact of ancillary revenues on airline markups remains uncertain. This study aims to fill this research void comprehensively. Besides, we introduce a pioneering approach through the application of a stochastic markup frontier model. Notably, this model is employed for the first time in transportation research. By addressing this critical gap, the study contributes novel insights to the field, shedding light on effective approaches for optimizing ancillary revenues within different business models in the airline industry.

4 Methodology

4.1 Modelling Revenue Surplus

Markups manifest in a market when the output price (P) surpasses marginal costs (MC), serving as a pivotal marker of market power. Nevertheless, it's imperative to recognize that

factors beyond the price-marginal cost dynamic can contribute to the calculation of markups. Following Kumbhakar et al. (2012), we identify the markup as follows.[4]

$$\frac{PY}{C} > MC\left(\frac{Y}{C}\right) = \frac{\partial C}{\partial Y}\frac{Y}{C} = \frac{\partial lnC}{\partial lnY} \tag{1}$$

where PY/C is the revenue share in total cost. Adding a non-negative one-sided error term to (1), the inequality can be re-specified as below:

$$PY/C = \partial lnC/\partial lnY + u \tag{2}$$

where u is a non-negative term that captures the revenue surplus[5]. In the interest of simplicity, PY/C is replaced by RS and $\partial lnC/\partial lnY$ (cost elasticity of output) is replaced by E_{cy} in (3).

$$RS = E_{cy} + u \tag{3}$$

The cost elasticity of output can be estimated from a cost function. However, the cost function requires accurate input prices. Considering this constraint, we use the input-oriented distance function which is the dual to cost function (Fare et al., 1994). Return to scale is reciprocal of the cost elasticity of output $(1/E_{cy})$, i.e., $E_{cy} = 1$ refers to constant return to scale while $E_{cy} < 1$ is increasing returns to scale (economies of scale).

[4] In the literature, various approaches exist for estimating markups, yet no consensus prevails on the optimal method. One commonly used technique is the Production Function Approach (PFA), introduced by De Loecker (2011) and De Loecker and Warzynski (2012). The PFA estimates markups based on production data by deriving a production function. This approach has often been adopted in recent studies (e.g., De Loecker, 2020). Another innovative method, introduced by Kumbhakar et al. (2012), draws on the Stochastic Frontier Analysis (SFA) methodology from the efficiency literature. This method is used in our study. In a comparative analysis by Koppenberg and Hirsch (2022) between the SFA and PFA methods, the results suggest that the PFA yields significantly higher mark-ups, resulting in more than three times higher welfare losses compared to the predictions by the SFA method.

[5] As we cannot split the costs of two outputs of airlines, we use an aggregate cost center. Therefore, we measure the revenue surplus in this equation.

4.2 Distance Function

Following Coelli and Perelman (2000), the input-oriented distance function can be defined as follows:

$$D_I(x, y) = \min\{\theta : (x/\theta) \in L(y)\} \quad (4)$$

where x is an input quantity vector in input set $L(y)$, and y is the output. The input distance function, $D_I(x, y)$, is nondecreasing, positively linearly homogenous and convex in x, and increasing in y (Lovell et al., 1994). The scalar θ is a distance measure. Accordingly, if x is an element of the feasible input set ($L(y)$), the distance function ($D_I(x, y)$) takes on a value greater than or equal to 1. That is, if $x \in L(y)$, then $1 \leq D_I(x, y)$. If x is on the boundary of input set, $D_I(x, y) = 1$.

Suppose there are $k = \{1, \ldots, K\}$ inputs to produce y. Applying panel data, the input distance function (4) can be specified in a translog functional form as follows:

$$\ln D_{Iit} = \beta_0 + \beta_y \ln y_{it} + \frac{1}{2}\beta_{yy} \ln y_{it} \ln y_{it} + \sum_k \beta_k \ln x_{kit} + \frac{1}{2}\sum_k \sum_l \beta_{kl} \ln x_{kit} \ln x_{lit} + \sum_k \beta_{ky} \ln x_{kit} \ln y_{it} \quad (5)$$

where y_{it} and x_{kit} are the output and input of the *i*th firm in year *t*. Following Lovell et al. (1994), the distance value and the inputs are divided by an arbitrarily chosen input (x_{Kit}) to satisfy the homogeneity degree +1 constraint in inputs, thus:

$$\ln(D_{Iit}) - \ln(x_{Kit}) = \beta_0 + \sum_k \beta_k \ln\left(\frac{x_{kit}}{x_{Kit}}\right) + \frac{1}{2}\sum_k \sum_l \beta_{kl} \ln\left(\frac{x_{kit}}{x_{Kit}}\right) \ln\left(\frac{x_{lit}}{x_{Kit}}\right) + \beta_y \ln y_{it} + \frac{1}{2}\beta_{yy} \ln y_{it} \ln y_{it} + \sum_k \beta_{ky} \ln y_{it} \ln\left(\frac{x_{kit}}{x_{Kit}}\right) \quad (6)$$

(6) can be arranged as follows,

$$-\ln(x_{Kit}) = \beta_0 + \sum_k \beta_k \ln\left(\frac{x_{kit}}{x_{Kit}}\right) + \frac{1}{2}\sum_k \sum_l \beta_{kl} \ln\left(\frac{x_{kit}}{x_{Kit}}\right) \ln\left(\frac{x_{lit}}{x_{Kit}}\right) + \beta_y \ln y_{it} +$$

$$\frac{1}{2}\beta_{yy} \ln y_{it} \ln y_{it} + \sum_k \beta_{ky} \ln y_{it} \ln\left(\frac{x_{kit}}{x_{Kit}}\right) - \ln(D_{Iit}) \quad (7)$$

$-\ln(D_{Iit})$ is interpreted as a one-sided error term (ε) (Coelli & Perelman, 2000; Lovell et al., 1994). In addition, a time trend (T) and its interactions is added to (7) to control for year-specific effects.

4.3 Empirical Model:

Based on Karagiannis et al. (2004) and Kumbhakar and Tsionas (2013), cost elasticity of output $(E_{cy} = \frac{\partial lnC}{\partial lny})$ is equal to partial derivative of input oriented distance function with respect to output $(-\frac{\partial \ln(x_{Kit})}{\partial lny})$. Thus,

$$RS = \beta_y + \sum_k \beta_k \ln\left(\frac{x_{kit}}{x_{Kit}}\right) + \frac{1}{2}\beta_{yy} \ln y_{it} + \sum_k \beta_{ky} \ln\left(\frac{x_{kit}}{x_{Kit}}\right) + \beta_{yt} T + u_{it} \quad (8)$$

Kumbhakar et al. (2012) suggest that markup can be influenced by other unobserved factors. Accordingly, we added a noise term (v_{it}) and a firm-specific unobserved heterogeneity component (μ_i). Thus, our model becomes a true random effect model. Mydland et al. (2022) extended the model to examine heteroscedasticity in revenue surplus resulting from environmental variables (z_{it}). Then, our model is specified as below:

$$RS = \beta_y + \sum_k \beta_k \ln\left(\frac{x_{kit}}{x_{Kit}}\right) + \frac{1}{2}\beta_{yy} \ln y_{it} + \sum_k \beta_{ky} \ln\left(\frac{x_{kit}}{x_{Kit}}\right) + \beta_{yt} T + \mu_i + v_{it} + u_{it}(z_{it}) \quad (9)$$

Since the stochastic frontier model is estimated by the maximum likelihood method, we need distribution assumptions. Following Kumbhakar et al. (2012), μ_i follows a normal distribution $N(0, \sigma_w^2)$, v_{it} is distributed $N(0, \sigma_v^2)$, and u_i follows a half-normal distribution $N^+(0, \sigma_u^2)$. $u_{it}(z_{it})$ can be related to revenue surplus by using (2):

$$\theta = \frac{P - MC}{MC} = u\frac{\partial lnY}{\partial lnC} = u\frac{AC}{MC} = u\frac{1}{E_{cy}}$$

(10)

Therefore, the revenue surplus can be estimated as follows:

$$\hat{\theta} = \hat{u}_{it}(z_{it})/(\beta_y + \sum_k \beta_k \ln\left(\frac{x_{kit}}{x_{Kit}}\right) + \frac{1}{2}\beta_{yy} \ln y_{it} + \sum_k \beta_{ky} \ln\left(\frac{x_{kit}}{x_{Kit}}\right) + \beta_{yt}T)$$

(11)

where $\hat{u}_{it}$ is the estimate of u based on Jondrow et al. (1982).

5 Data

5.1 Revenue Surplus Model Variables

Our research employs unbalanced panel data consisting of 255 observations from U.S. airlines spanning the period between 2000 and 2019. Our sample airlines are reported in Appendix A.1. Revenue share is the ratio of total revenues to total costs. The total revenues were obtained from the Bureau of Transportation Statistics Form 41, Schedule P-1.2. The total cost is the sum of operating expenses and the opportunity cost of capital. Operating expenses came from Form 41, Schedule P-6. By multiplying net property and equipment by the before-tax cost of capital, we calculated the opportunity cost of capital. The data on net property and equipment was obtained from Form 41, Schedule B-1 while before-tax cost of capital was extracted from Dr. Aswath Damodaran's webpage (https://pages.stern.nyu.edu/~adamodar/). The distance function includes one output, one fixed input, and two variable inputs. In line with Bitzan and Peoples (2016), Chow and Fung (2012), and Good et al. (1993), we adopt an aggregate output, calculated as the sum of revenue passenger ton-miles and revenue ton-miles. We derived passenger ton-miles by multiplying passenger miles by a factor of 0.1. The data on revenue

passenger miles and revenue ton-miles were sourced from T1: U.S. Air Carrier Traffic and Capacity Summary by Service Class. Additionally, the input data originates from Form 41 provided by the Bureau of Transportation Statistics. Fixed input, the number of seats was obtained from Form 41, Schedule B-43. In line with Barros et al. (2013) and Oum et al. (2005), one of our variable inputs is the total number of employees, including both pilots and non-pilot staff. Data on employees, segmented into pilots and other staff, was extracted from Form 41, Schedule P-10. The second variable input is fuel consumption in gallons which is sourced from T2: U.S. Air Carrier Traffic and Capacity Statistics. Fuel and the number of seats were divided by the number of employees to satisfy the homogeneity degree +1 assumption. To control the network and operation heterogeneity between airlines, we also added the average stage length and the number of airports served to the distance function. The data on the number of airports served was obtained from T3 U.S. Air Carrier Airport Activity Statistics while the average stage length is from T2: U.S. Air Carrier Traffic and Capacity Statistics. Table 1 depicts the descriptive statistics of revenue share, inputs, and output.

Table 1-Descriptive Statistics

		RS	**Output ($x10^9$)**	**Employees**	**Seats**	**Fuel ($x10^9$)**	**AirportServed**	**StageLength**
FSA	Mean	0.98	57.90	45920	96752	1.78	245.67	1139.46
	SD	0.09	38.10	28656	54354	1.09	117.31	254.11
LCC	Mean	1.01	21.70	15902	61297	0.65	79.38	912.95
	SD	0.12	21.70	16831	68114	0.64	63.20	318.93
ULCC	Mean	1.06	5.82	3112	11993	0.15	110.91	947.69
	SD	0.11	4.32	1564	8087	0.09	68.77	63.37

Table 1 provides a clear comparison of operational and financial characteristics across FSAs, LCCs, and ULCCs. FSAs, with the largest output (57.90 billion), workforce (45,920 employees), and seat capacity (96,752), dominate in terms of scale and serve the most airports (245.67), primarily focusing on long-haul routes, as indicated by their longest stage length (1,139.46 miles). However, despite their larger operations, FSAs generate the lowest average revenue surplus (0.98) compared to LCCs (1.01) and ULCCs (1.06). ULCCs, in particular, achieve the highest revenue surplus despite having the smallest output, workforce, and fleet size, reflecting their ability to optimize cost structures and maximize efficiency. Interestingly, ULCCs serve more airports (110.91) than LCCs (79.38), indicating a focus on underserved or secondary markets. Fuel consumption mirrors the operational scale, with FSAs consuming the most (1.78 billion) and ULCCs the least (0.15 billion).

5.2 Data on Ancillary Revenues and Mergers

As our overarching goal is to explain the relationship between ancillaries and revenue surpluses, we added *Ancillary Revenues to Cost* ratio which is the share of the ancillary revenues in the total costs. Ancillary revenues were obtained from Form 41, Schedule P-1.2. In addition, we also investigate another potential determinant of airline revenue surpluses, mergers. The impact of mergers on prices and costs has been extensively scrutinized in previous studies, with disputable findings. Given the decrease in market concentration to very low levels over the years, we incorporated mergers as an environmental variable to control for their impact. Information on airline mergers was gathered from Airlines for America (https://www.airlines.org/dataset/u-s-airline-mergers-and-acquisitions), highlighting nine significant mergers within our sample from 2000 to 2019. *Merger* in the model is represented by a dummy variable, where airlines that have undergone a merger are assigned a value of 1, while those that have not are assigned a value of 0.

Table 2-Descriptive Statistics Based on Business Models

		Ancillary Revenues ($x10^6$)	Ancillary Revenue to Cost Ratio
FSA	Mean	427	0.028
	SD	370	0.017
LCC	Mean	119	0.032
	SD	137	0.017
ULCC	Mean	146	0.115
	SD	164	0.072

Table 2 highlights the differing roles of ancillary revenues in the business models of FSAs, LCCs, and ULCCs. FSAs generate the highest ancillary revenues (mean of 427 million), yet these revenues contribute only a small portion to their overall costs, as reflected in their low ancillary revenue-to-cost ratio (0.028). LCCs, with lower ancillary revenues (119 million), show a slightly higher revenue-to-cost ratio (0.032). ULCCs, however, rely heavily on ancillary revenues, which contribute significantly to their cost coverage, as seen in their much higher revenue-to-cost ratio (0.115), despite lower average ancillary revenues (146 million). This indicates that while FSAs generate more ancillary revenue, ULCCs depend on it far more for profitability. The high variability in ancillary revenue for LCCs and ULCCs underscores the diverse ways airlines approach this revenue stream across the industry.

6 Results

6.1 Revenue Surplus Estimates

First, we estimated the input-oriented distance function. The estimates are reported in Appendix A.1. By using the coefficient in this model, we estimated the revenue surpluses and

change in the revenue surpluses by each business model based on (9). The revenue surplus estimates are shown in Table 3.

Table 3-Revenue Surplus Estimates

		Revenue Surplus	Revenue Surplus Change
FSA	Mean	0.028	0.114
	SD	0.002	0.036
LCC	Mean	0.017	0.040
	SD	0.001	0.050
ULCC	Mean	0.064	0.063
	SD	0.006	0.054

A closer examination of Table 3 reveals that ULCCs generate the highest revenue surpluses, despite offering the lowest airfares in the market. FSAs follow while LCCs show the lowest revenue surpluses. Over the years, FSAs have increased their revenue surpluses by 11.4%, whereas LCCs have seen only a modest 4% increase. Besides, Figure 1 illustrates the trends in revenue surpluses for FSAs, LCCs, and ULCCs from 2000 to 2020, highlighting distinct patterns across these airline categories. ULCCs consistently lead in revenue surplus likely due to their reliance on ancillary revenue streams. In contrast, FSAs exhibit more volatility, with sharp increases around 2008 and 2015, followed by notable declines, suggesting that while they have benefited from cost-cutting strategies and mergers, they are more sensitive to market fluctuations. LCCs, on the other hand, show the lowest and flattest revenue surplus growth, indicating that they may struggle to compete with ULCCs in terms of profitability. The

post-2016 period shows a decline in revenue surpluses for both FSAs and ULCCs, potentially due to increased competition or rising operational costs. Overall, the graph highlights ULCCs as the most successful in maintaining higher revenue surpluses over time compared to their competitors.

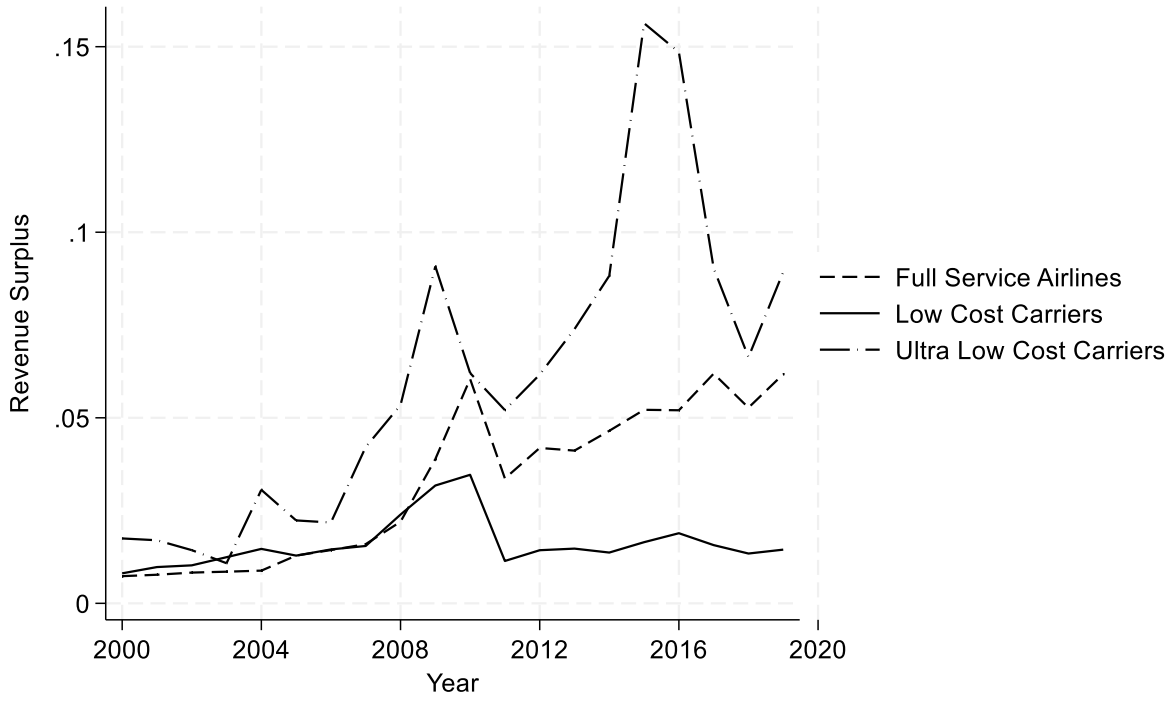


Figure 1-Change in Revenue Surpluses Over the Years

These findings challenge the conventional wisdom that FSAs should generate higher revenue surpluses due to their less price-sensitive customer base. This counterintuitive outcome led us to focus on ancillary revenues as a possible explanation. To explore this further, we utilized equation (11) to estimate the impact of ancillary revenues on revenue surpluses, while also considering the effects of mergers. The impact of ancillary revenues and mergers on revenue surpluses is reported in Table 4.

Table 4-The Impact of Ancillary Revenues and Mergers on Revenue Surpluses

	Estimate	S.E.
Ancillary to Cost	2.149***	0.626
Merger	2.705***	0.980
Intercept	-0.578	1.256

*,**, and *** represents 1%, 5%, and 10% significance level, respectively.
Number of obs.: 255
Wald chi2(1):14.83***
Number of Pseudo Random Draws: 250

The results in Table 4 reveal that *Ancillary-to-Cost* ratio is both significant and positively correlated with revenue surpluses. This indicates that an increase in ancillary revenues as a proportion of total costs leads to higher revenue surpluses. If there were cross-subsidization between ancillary fees and base airfares, or if they were a complementary relationship, we would expect revenue surpluses to decrease as airlines might lower base fares in response to higher ancillary revenues. However, the positive relationship suggests that ancillary revenues directly contribute to increasing overall revenue surpluses. This finding aligns with Brueckner et al. (2015), who highlight the importance of ancillary revenues as a key revenue-generating tool, particularly due to the high price elasticity of these services. Moreover, *Merger* is also found to be positive and significant, implying that they contribute to higher revenue surpluses. This can be attributed either to increased market power, allowing airlines to set higher prices, or to cost reductions achieved through economies of scale. Together, these results underscore the critical role of ancillary revenues and mergers in shaping the financial performance of airlines.

7 Conclusion

The findings of this study highlight the significant role ancillary revenues play in determining revenue surpluses across various airline business models. Contrary to the traditional belief that FSAs should generate higher revenue surpluses due to their less price-sensitive passenger base, the results show that ULCCs consistently outperform FSAs and LCCs in revenue surpluses. This outcome is largely driven by the effective use of ancillary fees as a revenue-generating tool. While FSAs and LCCs continue to incorporate ancillary fees, ULCCs have mastered the strategy, leveraging these fees to maintain lower base airfares while increasing total trip costs. Mergers also play a critical role in boosting revenue surpluses, providing airlines with economies of scale and market power to sustain profitability.

From a policy perspective, the U.S. DOT's re-regulation of the airline industry, including the introduction of the 2024 rule mandating transparency of ancillary fees, is a positive step toward ensuring that consumers are fully informed about the true cost of air travel. Transparency in pricing is essential to maintaining competitive market dynamics, particularly when ancillary fees significantly affect total travel prices. The findings suggest that, while ancillary revenues can provide substantial benefits to airlines, their ambiguous structure and potential for raising total travel prices highlight the need for regulatory oversight. Without adequate transparency, ancillary fees may lead to market distortions, reduce consumer welfare, and disproportionately affect price-sensitive passengers. In light of these findings, further regulation of ancillary fees could be beneficial to strike a balance between airline profitability and consumer protection. The challenge for policymakers will be to foster an environment where airlines can continue to generate ancillary revenues while ensuring that consumers are not misled by unbundled pricing structures.

Future research could focus on identifying the optimal level of ancillary fees that allows airlines to maximize revenue without negatively impacting social welfare. This research could involve developing models that consider the trade-offs between ancillary revenue generation and consumer welfare, examining how varying levels of fees influence passenger behavior, total travel costs, and overall market competition. Additionally, investigating how ancillary fees affect different demographic segments—such as price-sensitive travelers, business travelers, or families—could provide valuable insights into how fees might disproportionately affect certain groups.

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Appendix A.1. Sample Airlines

Model	Airlines
FSA	Alaska Airlines Inc.
	American Airlines Inc.
	Continental Air Lines Inc.
	Delta Air Lines Inc.
	United Air Lines Inc.
	US Airways Inc.
LCC	AirTran Airways Corporation
	JetBlue Airways
	Southwest Airlines Co.
	Virgin America
	Hawaiian Airlines Inc.
ULCC	Allegiant Air
	Frontier Airlines Inc.
	Spirit Air Lines

Appendix A.2. Distance Function Estimates

	Estimate	S.E.
Output	-0.950***	0.014
OutputxOutput	0.002	0.007
Seats	0.528***	0.063
Fuel	0.792***	0.080
SeatsxSeats	-0.710***	0.075
FuelxFuel	-0.298	0.246
SeatsxFuel	0.506***	0.109
OutputxSeats	-0.161**	0.013
OutputxFuel	0.159**	0.019
Time	0.015***	0.004

TimexTime	0.000	0.000
SeatsxTime	0.013***	0.003
FuelxTime	-0.030***	0.006
OutputxTime	-0.001	0.001
Airports	-0.039***	0.007
Stage	0.676***	0.042
Intercept	-0.126***	0.019

*,**, and *** represents 1%, 5%, and 10% significance level, respectively.
Number of obs.: 255
R-squared:0.987