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INTERNATIONAL BACHELOR ECONOMICS AND BUSINESS ECONOMICS

The effect of airline mergers on flight punctuality: Evidence from the US airline industry

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by

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ABSTRACT

In an attempt to expand the studies on the impact of airline mergers on the quality of service airlines offer, this bachelor thesis investigates the effect of airline mergers on the flight punctuality of the merged carriers. With evidence from the US airline industry, using a Difference-in-Difference model, four major airline mergers over the last two decades were studied to assess their effect on two punctuality metrics: the average arrival on-time performance and the average delay of late flights. The results show a significant improvement in the average arrival on-time performance of the merged airlines compared to non-merging ones after the merger occurs. However, no significant impact was observed on the average delay of late flights. These findings suggest that airline mergers may enhance punctuality, shedding light on how mergers can positively impact service quality. From a policy standpoint, it underscores the importance of oversight to prevent any decline in customer service resulting from reduced competition post-merger. The study also highlights areas for future research, including the investigation of the underlying reasons for the difference in the impact of the mergers on the two punctuality metrics.

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I. INTRODUCTION

The aviation industry plays a crucial role on the global economy. According to the Industry High Level Group Aviation Benefits Report (2019), the total economic impact of the aviation industry is estimated at USD 2.7 trillion, contributing approximately 3.6% to the world's gross domestic product (GDP). This impact is similar to the size and population of the United Kingdom as aviation supports 65.5 million jobs worldwide. Tourism and International Trade are two economic activities highly dependent on air transport due to its speed and convenience, combined with its ability to connect long distances and growing affordability. However, the role of airlines goes beyond economic activity: they create unique opportunities for the empowerment of people and countries throughout. Air travel is the safest and most effective form of long-distance mass transit. For many types of health and humanitarian aid, aviation is the only viable route. The same holds for accessing a better education since it may require going overseas. Aviation enhances people's leisure and cultural experiences, which improves their quality of life. Such improvement is also sought by migrants: one in six workers in high-income countries is from another country, according to the International Labor Office (2016).

Over time the sector has shown flexibility and resilience through the ability to grow despite various challenges, such as fluctuating fuel costs, economic recessions and worldwide health crises. Such challenges have pressured airlines to constantly seek strategic solutions to stay competitive and financially stable. From early consolidation efforts in the post-World War II era to the wave of mergers during airline deregulation in the late 20th century, airlines have worked on growing their competitive positions, expanding their reach, and thus adapting to a dynamic and demanding market (Merkert & Morrell, 2012). When airlines join forces with each other, they combine resources, expand their activities and expertise and reduce costs. This helps to operate efficiently by benefiting from economies of scale and reducing risks, while increasing their market share and capacity to withstand challenges (Borenstein, 1990). Airline mergers continue to be a global phenomenon with regulatory entities in several countries closely monitoring and intensifying remedies to ensure the compliance of antitrust laws and fair competition as airline consolidation through mergers has been proven to significantly affect consumers (Kwoka & Shumilkina, 2010; Espinoza & Georgiads, 2023).

Existent literature is dedicated to the analysis of the impact of airline mergers and acquisitions on consumers. Whereas customers may benefit from expanded networks and increased connectivity, there is a significant adverse impact on the airfares of the routes affected by the mergers as those tend to significantly increase (Kim & Singal, 1993). However, the service offered by an airline goes beyond its price. It includes a wide range of components such as in-flight and on-ground amenities and facilities, flight and booking options, environmental and social responsibility, safety, and reliability. While some

aspects are the topic of interest in existent research such as flight itineraries and connectivity (Ivy & Shaw, 1994), there seems to exist a gap in the literature on the topic with crucial components such as safety and reliability not being addressed as a possible effect of airline mergers.

As existing literature does not analyze the impact of airline mergers on the reliability of the companies, this research aims to analyze the punctuality of airlines when a merger occurs, building on the existent studies on the effects of mergers and acquisitions on the quality of service provided to customers. From the consumer perspective, the relevance of the topic lies in the direct impact that punctuality may have on the reliability of air travel, which is critical for passengers planning their schedules around flights. Delays can lead to missed connections, appointments, and other important occasions, causing much inconvenience. Moreover, the effect of mergers on the punctuality of flights may derive policy decisions and regulations aimed at maintaining fair competition and protecting consumer rights. According to Prince and Simon (2014), incumbent on-time performance worsens in response to entry, and even threats of other airlines entering. As many merger deals lead to lower competition and larger market shares and are therefore associated with an exit from the market with stronger consolidation rather than an entry, it seems pertinent to study how mergers in the airline industry affect the quality of service that airlines offer, specifically the punctuality of flights of the merged airlines. Thus, the research question of this study is formulated as follows:

To what extent do Mergers in the Airline industry
impact the punctuality of flights of the merged airlines?

To answer the research question, this study focuses on the strongly consolidated US Airline industry shaped by more than a handful of mergers over the last decades and where airlines must publicly disclose key performance figures regarding the reliability of the network such as the daily number of flights late or their average delay. Using data from the Bureau of Transport Statistics, part of the United States Department of Transportation, over the years between 2004 and 2020, four mergers are assessed through a Difference-in-Difference analysis. This method is adequate for estimating the additional effect on the punctuality of flights of merged airlines, beyond the changes that might occur across the rest of the industry and therefore understand the extent to which mergers in the Airline industry impact the punctuality of flights of the merged airlines. Not only does this approach allow for an individual study of the effects of each merger on the punctuality of flights, but also for an estimation attempt of a more general effect of mergers on punctuality based on all the mergers in that period. The findings suggest that the four airline mergers significantly impacted the average arrival on-time performance of the merged carriers, compared to the ones that did not merge. Nonetheless, such a significant effect was not found for the average delay of the late flights of the merged airlines.

II. THEORETICAL FRAMEWORK

1. Merger definition

The foundational concept of a merger, where two companies combine to form a single organization, sets the stage for examining the proposed research question. In corporate strategy, a merger represents a mutual agreement between companies to combine their assets, operations, and management structures. This contrasts with acquisitions, where a typically financially stronger company takes over another, often without a mutual agreement (Holmstrom & Kaplan, 2001). Despite the concept of a merger being often associated with acquisitions, with various sources referring to Merger and Acquisition (M&A) deals, the topic of this research implies the study of mergers alone. It is thus appropriate to discuss the differences between the existent types of mergers, which fall under three main categories: Horizontal, Vertical, and Conglomerate (Gugler et al., 2003). Whereas in a horizontal operation, the companies involved are direct competitors as they offer similar product lines and serve the same markets, in a vertical merger, the firms included are along the same industry's supply chain, producing different products that contribute to the same finished result. Conglomerate mergers, however, refer to the fusion of companies engaged in unrelated business activities. Existent literature also refers to two other categories: Market-extension and Product-extension (Stewart et al., 1984). The first is defined as the merger between organizations operating in different markets but selling similar products or services, and the second as the merger between entities serving the same market with distinct but related products or services.

By contextualizing the definition to the airline industry, mergers manifest as the consolidation of two or more airlines into a single company under a single operating certificate through a mutual agreement (Federal Aviation Administration, 2024). The organizations involved combine their operations, resources, fleets, route networks, and services under a unified management structure. This not only implies the fusion of different tangible resources but also of distinct intangibles such as different corporate structures or styles of operations, which increases the complexity of the whole process (Shaw & Ivy, 1994). Since the airlines in a merger offer similar products and services, the offer of passenger and/or cargo flights, the fusion of two or more airlines can be classified as a horizontal merger, if the airlines are direct competitors, or as a market-extension merger if those involved operate in different markets before the transaction. However, this distinction might not be as linear as it appears to be. Several airline merger events such as the United Airlines and Continental Airlines in 2010, saw airlines accessing new markets served previously just by one of the companies, while in others both airlines already operated (Kim & Singal, 1993).

The next sub-chapters offer an understanding of how and why the airline industry is currently shaped, also offering a brief historical approach to mergers in the industry.

2. Merger Motives

Companies can pursue mergers for the widest variety of reasons. Such a complex decision can result from a combination of several factors rather than just a singular one. Trautwein (1990) advanced with the most popular theories regarding the reasons for mergers. The efficiency theory views mergers as a strategic tool to achieve synergies, which refer to benefits arising from the combination of two or more organizations, greater than the sum of their individual parts. By merging, firms can reduce capital and operating costs and create more efficient and focused operations with superior planning, monitoring, and access to new markets and customer bases. Companies ultimately seek the achievement of economies of scale where their average production costs decrease despite output growth (Andrade et al., 2001). Companies may also merge to create market power, according to the monopoly theory, targeting a limit in competition or even the creation of a barrier to potential entrants, culminating in a monopoly or an oligopoly (Stigler, 1950). Other plausible theories for mergers according to Trautwein (1990) include the empire-building theory and the process theory. While in the first, mergers occur to maximize the manager's utility instead of shareholders', with the rise of significant agency costs, the second states that mergers happen to diversify companies´ opportunities and access to information and expertise possessed by each individual entity. The diversification of opportunities is also a means for companies to achieve greater financial stability, spreading risks and surviving the uncertainty derived from economic shocks and global or regional crises (Mitchell & Mulherin, 1996).

Concerning the airline industry, mergers are often motivated by the need to improve operational efficiency, expand market reach, and guarantee financial stability. According to Berry and Jia (2010), large fluctuations in air travel demand along with the supply shock caused by the expansion of low-cost carriers led to worse results for legacy carriers, which were already suffering from increasing fuel costs. Furthermore, unexpected events such as global emergencies or terrorist attacks disrupt the financial stability of airlines, which look at opportunities to strengthen and overcome such difficulties and demand shocks (Carter & Simkins, 2004). Faced with a very competitive and consolidated industry marked by several shocks, airlines seek in mergers their way to battle and survive. A merger opens a wide range of benefits to airlines that are perceived to outweigh the risks of the transaction (Merkert & Morrell, 2012). Similarly to corporate strategy, these firms target increased efficiency, cost reduction, and increased market share and revenues, besides the elimination of competition (Goetz, 2002). However, according to Merkert and Morrell (2012), there are motives specific to the industry. One is the access to airport slots and facilities, which can cost millions of dollars and unlock several profitable route opportunities to consolidate the network. Moreover, mergers between airlines can be motivated by the access to new aircraft, which usually takes many years between the order and delivery. A merger can therefore reduce these waiting times and provide a faster expansion either in routes or capacity and frequencies in existing ones. Finally, mergers enable the operation in more markets and the growth in

the frequency of flights since operations are combined. This appears as extremely attractive for customers, who can access a wider range of destinations and schedules and be part of more solid frequent flier programs.

Historically, airline mergers have been a strategic reaction to evolving challenges and opportunities in the sector. In the United States, a wave of consolidations characterizes the post-deregulation era of the late 20th century. For instance, Delta Air Lines and Northwest Airlines merged in 2008 and United Airlines and Continental Airlines followed the same path in 2010. According to Goetz and Vowles (2009), the goal of the first merger was to increase route networks and reduce operational redundancies. Similarly, the 2002 merger of Japan Airlines and Japan Air System was a major consolidation effort to improve competitiveness in Asia (Matsumoto, 2004). Despite having maintained their brands, Air France and KLM merger in 2004 shaped the European aviation industry as they combined their extensive networks to improve connectivity and achieve operational synergies (Merkert & Morrell, 2012).

3. Merger Effects

3.1 For Firms

Although the motives for engaging in a merger transaction are also often the intended effects of the operation, it is relevant to recover the discussion on some of those as they can turn out differently (Stewart et al., 1984). Some main already addressed motives for mergers were a higher operational efficiency through cost reductions and achievement of economies scale, together with increased market power and growth in scale, and consequent expansion in served markets and customers. Devos et al. (2009) show that mergers do create efficiency gains, mostly through better resource allocation rather than through the reduction of tax payments or the increase in market power. Borenstein (1990) had already approached the increase in market power as an effect of mergers in the airline industry with partial evidence of its impact on the price increase of air travel resulting from the high airport dominance of the merged carriers. This evidence was further analyzed by Kim and Singal (1993) with the introduction of the efficiency concept on airfares. The authors found a significant increase in prices for air travel on the routes served by merging airlines and attributed the effect to the increased market power exercised by the companies rather than the efficiency gains that resulted from the consolidation. According to Gugler et al. (2003), mergers generally, but not always, lead to a significant increase in profits despite a reduction in sales. This can be explained either by the enhanced market power due to reduced competition or the improved efficiency achieved. However, by assessing the specific case of aviation, Merkert and Morrel (2012) show that mergers in the industry can also lead to diseconomies of scale and decreased efficiency and found an optimal airline size for an efficient operation. Nevertheless, the authors do not discard that mergers that create a single airline beyond that size can

indeed be beneficial from a strategic point of view, with market and customer expansions outweighing efficiency losses.

Besides the price increase derived from the growth of market share that resulted from lower competition, mergers can also have an upward effect on prices through a rise in multimarket contact (Schmitt, 2018). Companies that merge have a new cost structure and may encounter the same competitors in new markets, which may lead to a price increase through explicit or implicit collusion agreements. However, Eckbo (1983) finds little evidence indicating that mergers would have collusive and anticompetitive effects, which may indicate that this subject may depend on the industry. Ciliberto and Williams (2014), nonetheless, have convincing evidence of tacit collusion facilitated by multimarket contact in the airline industry, where carriers serving many markets simultaneously sustain almost perfect coordination in price setting. Moreover, mergers also have a considerable impact on employees and on the size of operations and the combination of assets. The efficiency improvement through cost reduction can be reached through job redundancies, part of the restructuring inherent to a merger, together with the combination of resources (Siegel & Simons, 2010). A merger leads to a single firm, smaller than the sum of the sizes of the previous ones since it involves a restructuration that aims to maximize efficiency by cutting redundancies and capturing the best resources, assets, and expertise into a single entity (Maksimovic et al., 2011). In the case of airlines, the same seems to hold with access to new aircraft deliveries that allow for expansion and with layoffs and cuts in redundancies, routes, and services, having significant impacts on the network structures (Shaw & Ivy, 1994). Therefore, it seems pertinent to assess how airline mergers impact consumers, also discussing the already mentioned effects but from the customer perspective.

3.2 For Consumers

Mergers can have diverse effects on consumers and the airline sector seems to have very specific consequences for customers, both positive and negative. One already previously discussed but from the firms' perspective is the increase in the prices of airplane tickets. Customers can be severely harmed by the increase in market power of airlines resulting from less competition. Goetz (2002) addresses the negative impact of the airline market structure and additional mergers on airfares, with a substantially larger portion of customers paying larger prices despite the emergence of low-cost carriers. The increase in multimarket contact due to airline mergers further exacerbates the airfares increase with airlines engaging in tacit collusion agreements and setting higher prices as evidenced by Ciliberto and Williams (2014). Other negative effects can follow. Customers can face reduced choices, with fewer airline options to choose from, and even service reductions as airlines may eliminate redundancies by cutting routes and frequencies and dedicating to constructing hubs where passengers connect and developing feeding routes for those platforms while eliminating point-to-point services (Adler & Smilowitz, 2007). On the other hand, while some customers might be negatively affected by this network restructuration,

others may benefit from access to new markets and destinations, further connectivity through the airlines' hubs, and more modern aircraft which improve the overall flying experience (Merkert & Morrel, 2012). Besides, merged airlines often integrate their frequent flier programs, allowing consumers to accumulate and redeem points across a larger network.

Another crucial factor to consider regarding customer experience is the impact of mergers in the airline industry on the quality of the service that companies provide. It might be the case that mergers enhance service quality through the greater capacity that a single combined entity has to invest in customer service and the flow and organization of operations. On the other hand, the high market power and reduced competition may deteriorate service quality as firms are not as dependent on customer perspective and retention. According to Steven et al. (2012), market concentration decreases the relationship between customer satisfaction and airline profitability, with airlines being able to increase profits in those markets without providing for the same associated increases in customer satisfaction as airlines operating in more competitive markets. Borenstein (1990) had previously found evidence of substantial service cutbacks on routes earlier operated by merger partners. Furthermore, customers may also be negatively affected by the lack of innovation in the service offered, with De Man and Duysters (2005) pointing towards a neutral or negative effect of mergers and acquisitions on innovation despite the possibility of associated scale economies lowering the cost of innovation.

The complex dynamic effects of these mergers highlight the need for regulatory oversight to ensure that the impact on consumers, also in terms of service quality, is balanced in favor of the public interest. Before the Airline Deregulation Act of 1978, the American government had control over fares, routes, and market entry of new airlines, which limited competition and kept airfares high. After the act, the airline industry saw an increase in competition with lower airfares and more entry but saw some airlines facing financial instability (Shaw & Ivy, 1994). This led to a wave of mergers and acquisitions that revealed an industry with high economies of scale with a tendency toward consolidation (Goetz, 2002). Regulation on airline mergers is globally designed to ensure that the mergers do not harm competition and consumers. When an airline merger is proposed, the regulatory entities of each country assess its potential impact on market competition, considering the positive and negative effects for consumers regarding market share, route overlaps, impact on prices, and service quality. Antitrust laws aim to encourage competition and prevent monopolies. When assessing a merger operation, regulatory entities may find it to significantly reduce competition and violate antitrust laws. In that case, the operation may be blocked or require modifications to move forward. However, some remedies may generate controversy, might be deemed scarce and not to consider all factors as evidenced by Duso et al. (2011). The impact of airline mergers extends beyond market competition and consumer pricing; they can also affect the operational efficiency of airlines and the service offered, such as in terms of punctuality.

3.3 Punctuality & Hypotheses

The quality of the service offered by airlines usually goes neglected in existent studies of airline merger effects. The service an airline offers is a very broad concept that includes metrics such as the punctuality of flights, number of available seats, overall frequent flier satisfaction, and flight cancellations, for instance, besides the amenities such as the services provided on ground, on board, and customer support that research usually refers to when approaching service quality. The reliability of flights seems of great importance for customers as delays and cancellations can greatly affect a customer's journey, with significant impact both on private and work lives. Mergers might result in a temporary or even permanent decline in service quality from this perspective as airlines integrate their operations and different cultures, priorities, and operating methods. As previously mentioned, airlines depend less on customer satisfaction for their profits as the market consolidates (Steven et al., 2012).

Focusing on the punctuality of flights as a metric for service quality, there are to the best of my knowledge no studies on how it is impacted by mergers between airlines. Suzuki (2002) developed a new method relating the on-time performance of airlines and their market share and found passengers to be more likely to switch carriers once they experience flight delays, which were negatively associated with customers' experience. Furthermore, Prince and Simon (2009) examine the relationship between multimarket contact and service quality using on-time performance as a measure of service quality. They show that multimarket contact increases the frequency of delays, especially in more concentrated routes, which may lead one to expect that mergers between airlines can result in a decrease in the punctuality of flights of the merged carriers since mergers in the sector, as discussed before, lead, on average, to an increase in multimarket contact (Celibertos & Williams, 2014). Nonetheless, according to Prince and Simon (2014), incumbent on-time performance worsens in response to entry, and even entry threats of other airlines. Since mergers between airlines increase the market power and are associated with an exit from the market and lower competition as two airlines incorporate a single one (Borenstein, 1990; Kim & Singal, 1993), the last findings could make one predict that mergers positively affect the on-time performance of non-merging airlines since there would be an exit from the market. It remains to be seen, however, what the additional effect is on the airlines that join operations. Therefore, based on the multimarket contact increase approach the following hypothesis is developed:

Hypothesis 1a: Airlines that merge operations have a lower average arrival on-time performance after the merger occurs compared to airlines that do not merge.

Prince and Simon (2014) find stronger evidence for the on-time performance of incumbent airlines worsening when the entrant is a low-cost carrier. This seems to be an attempt by the incumbent companies to cut costs and compete with the lower fares of the new competitor. Therefore, it seems

logical to analyze a merger that includes one low-cost airline to understand if there is an additional effect on the on-time performance of those airlines merging compared to the impact of other airlines that merge. When a low-cost carrier exits the market, the other airlines may see less need to cut costs and services and thus readjust their operations to a new market condition without a low-cost airline, according to the reasoning of Prince and Simon (2014). When the low-cost carrier merges, the remaining airlines can work on improving their on-time performance, with the possibility of the deterioration of flight punctuality being thus greater for the new airline involving a former low-cost carrier than it is for other airlines in the sector. The following hypothesis will also be examined:

Hypothesis 1b: Low-cost airlines that merge operations have a lower average arrival on-time performance after the merger occurs compared to other airlines that merge.

As on-time performance is a relative measure that only considers a flight late if it arrives 15 minutes after the scheduled arrival time and does not discriminate the length of the delay, it seems appropriate to analyze the intensity of delay of the flights that arrive late. The previously described multimarket contact approach can serve as insight into the frequency of late flights since Prince and Simon (2009) use on-time performance as the metric of interest. Nonetheless, when airlines merge, they do not necessarily add their entire operations but instead restructure to optimize their joint network (Maksimovic et al., 2011), with operational synergies also enhancing operational efficiencies (Trautwein, 1990). Merged airlines join and optimize their route networks and adjust their schedules to ensure better alignment with airport slot availability. Furthermore, a reorganization of hub operations with joint resources reduces redundancies and improves the utilization of the fleet, resulting in shorter delays by improving the airline's controllable delay causes (Shaw & Ivy, 1994). Optimization of operations can thus be associated with shorter delays, which leads to the study of the following hypothesis:

Hypothesis 2: Airlines that merge operations have a lower average delay on late flights after the merger occurs compared to airlines that do not merge.

The three stated hypotheses have an associated null hypothesis stating that there is no effect of airlines merging operations on the metrics of punctuality beyond the one on the airlines that do not merge (hypothesis 1a and 2) or beyond the one on the airlines that merge (hypothesis 1b).

III. DATA

To assess the effect of airline mergers on the punctuality of airlines, four major airline merger events in the US will be studied, one of them involving a low-cost carrier. The US airline industry presents a compelling case for study due to its extensive history of airline mergers that have shaped the market landscape, combined with the existence of several airlines that did not engage in any similar operation, at least in the last decades. Besides, airlines in that country must publicly disclose relevant key information and data regarding the reliability of their operations such as the number of total and late flights, the average delays for both all flights and the late ones, and the average delay by cause such as weather, for instance. Data on these statistics available from the US Bureau of Transport Statistics, part of the United States Department of Transportation, was collected both on a monthly and annual basis over the period between January 2004 and March 2020. The chosen time frame includes four major airline mergers with data before and after each event. Three of them include six huge operators and the other includes a low-cost carrier and thus useful to study hypothesis *1b*. The period excludes two major demand shocks affecting the airline industry which could affect airline operations and their on-time performance such as the terrorist attacks of September 11th, 2001, or the global pandemic of Covid-19 in April 2020.

The first merger in the study is the one between Delta Airlines and Northwest Airlines announced in 2008. The companies started reporting together as Delta Airlines from 2010 onwards and created the biggest American airline company. In 2010, United Airlines and Continental Airlines announced their merger, with the companies combining their operations and reporting under the name of a new big company United Airlines from 2012 onwards. In 2013, American Airlines and US Airways merged to form the biggest US airline, under the name of American Airlines, even ahead of Delta Airlines. The reports include this mega company as of July 2015. The last merger to be analyzed is the one involving Alaska Airlines and the low-cost carrier Virgin America in 2016. Virgin America, as a single entity, only started appearing in the reports in 2012. The three mergers before only included legacy carriers, which were also bigger in size. As of April 2018, the merger between the two smaller legacy and low-cost carriers originated a single company in the reports: Alaska Airlines. In addition to the previously discussed airlines involved in the mergers, data was also collected on five others that were not involved in any of these mergers. One is the low-cost Frontier Airlines, only present in the dataset from May 2005 onwards; another is the low-cost JetBlue Airways; the regional SkyWest Airlines is also present; the two low-cost Southwest Airlines and Spirit Airlines close the list, with the last only reporting from 2015 onwards.

To study the impact of airline mergers on the punctuality of flights, the concepts of on-time performance and late flights must be discussed as those will constitute the measure of punctuality. According to the United States Federal Aviation Administration, a flight is delayed when it departs or arrives 15 minutes later than its scheduled departure or arrival time. Thus, indicators for late flights must exclude delays under 15 minutes. Moreover, a flight can have a departure delay and/or an arrival delay. It can be that a flight departs late but still arrives at its destination on time as flight time can be reduced under certain weather conditions, for instance, and airlines often plan their flight schedules with a safety time as a buffer against delays (Lederer & Nambimadom, 1998). Therefore, it seems adequate to focus only on the delays at arrival as those are the most inconvenient for passengers. The average arrival On-time Performance (OTP) will be one of the variables of interest in the study to measure the punctuality of an airline and can be computed using the previously collected data on airlines. It is defined as the percentage of flights that arrive on time to the gate and is computed as follows, for each airline, in each year, based on all the company's flights in the period:

$$(1) \qquad Average\ Arrival\ OTP\ (\%) = \frac{Number\ of\ Flights\ that\ arrive\ On\ Time}{Total\ Number\ of\ Flights} \times\ 100$$

In addition to the average Arrival On-time Performance, Table 1 presents the descriptive statistics of all variables used in the analysis, including control variables. The total number of flights ranges from 36,781 to 1,363,946 and the total number of late flights ranges from 5,236 to 299,133. On average, the delay of all flights is approximately 4.94 minutes, with a standard deviation of 4.24 minutes, and can range from -6.49 minutes to as late as 14.47 minutes. This points to the existence of flights arriving ahead of schedule, at least for a given airline in a given year as the minimum value is referent to an operational year. For the late flights, the average delay is 57.58 minutes, with a standard deviation of 8.87 minutes, spanning from 40 to 84.7 minutes. This is the second variable of interest in this study. The arrival on-time performance rate ranges from 70.74% to 91.9% and averages 80.8%, with a standard deviation of 4.34, indicating that on-time performance is consistent across records. Weather and National Aviation Security (NAS) are standardized variables of the average delay due to weather and the average delay due to national airport security, respectively. Both have a mean of approximately 0 and a standard deviation of 1. Overall, these statistics provide a comprehensive overview of flight operations, delays, on-time performance, and external factors affecting flights within the dataset, which includes 201 observations, with each observation referring to one airline in a given year. The restricted number of observations in the dataset can be considered a limitation of the analysis, with some airlines only establishing their operations during the period. Furthermore, airlines that merge their operations transform into a single carrier, meaning that one airline in each of the four mergers stops recording afterward. A solution for this issue is presented under methodology so the analysis can proceed.

Table 1 Descriptive Statistics regarding the 13 airlines in the period between Jan. 2004 and Mar. 2020

Variable	N	Mean	St. Dev	Min	Max
Total Number of Flights	201	484,083	331,142.6	36,781	1,363,946
Average Delay of all Flights	201	4.94	4.24	-6.49	14.47
Total Number of late Flights	201	90,885.3	61,570.14	5,236	299,133
Average Delay of late Flights	201	57.58	8.87	40	84.7
Arrival On-Time Performance	201	80.8	4.30	70.74	91.9
Weather	201	0.00	0.96	-1.74	3.09
National Aviation Security	201	0.00	0.96	-2.48	2.98

Note. The table presents the statistics based on each year between 2004 and 2020; the year 2020 only has information until 31st March; this table presents descriptive statistics for all continuous variables in the sample; "N" refers to the total number of observations; each observation refers to one airline in a given year; "St. Dev" refers to standard deviation; "Min" and "Max" refer to the minimum and maximum values recorded for each variable, respectively; Arrival On-Time Performance is collected as an average and is presented in percentage; Total Number of Flights and Late Flights are in units. Weather and National Aviation Security are standardized variables; all other variables are in minutes.

IV. METHODOLOGY

As the study aims to analyze the arrival on-time performance of airlines and the intensity of the delay of the late flights before and after the mergers take place, and as several airlines can be part of the control group, the Difference-in-Difference (DiD) method appears as an appropriate model for studying the three hypotheses. Difference-in-Difference estimates the effect of a specific intervention or treatment, in this case, the merger between two airlines, by comparing the changes in outcomes before and after the intervention, between the treated group, which is composed of the airlines that merged, and a control group of airlines that did not merge. DiD aims to estimate the causal effect of mergers on the average arrival on-time performance and on the average delay of late flights by comparing the changes in those two metrics before and after the merger for both treatment and control groups. This method estimates the average treatment effect on the treated (ATT), which, in this case, means the additional impact on average arrival on-time performance for merged airlines compared to the airline that did not merge. The same applies when analyzing the average delay of late flights through a single change of the dependent variable, which can also provide a robustness check. The method accounts for time-invariant unobserved factors that differ between the treatment and control groups and for factors that vary over time which affect the two groups in the same way. However, it cannot deal with time-varying factors that differ between the treatment and control groups.

Although the DiD method assumes that any time-varying factors affecting on-time performance do so equally for both the treatment and control groups, there may be time-varying factors that affect the treatment and control groups differently, leading to a violation of the crucial assumption of the

Difference-in-Difference method, the Parallel Trends Assumption (PTA), and bias the results. This assumes that, absent the merger, the average arrival on-time performance and the average delay of late flights trends of merging and non-merging airlines would have been similar. This assumption must hold in order to attribute the changes in the two variables to the merger itself rather than to other factors. Before the merger, the average arrival on-time performance and average delay of late flights trends of the airlines involved in the merger (treatment group) and the airlines not involved in the merger (control group) should be similar. If this holds, any deviation in those of the treatment airlines after the merger, as compared to the control ones, can be attributed to the merger. Although there is no guarantee that the Parallel Trends Assumption holds after the actual intervention, it is useful to build confidence. Thus, it seems pertinent to control for certain time-varying variables that can affect the punctuality of flights differently among the companies.

Variables such as fleet, number of employees, number of destinations, or total number of flights could affect the average punctuality of a given company and are indeed time-varying factors that differ among airlines. Nevertheless, those cannot be controlled for as they are influenced by a merger, which is the treatment in the model (Merkert & Morrell, 2012). Controlling for them would result in a biased estimation of the effect of airline mergers on the two measures of flight punctuality. However, weather conditions and airport congestion seem to affect the punctuality of flights as evidenced by Prince and Simon (2009), and are likely to differ between airlines and not be influenced by a merger. Adverse weather such as storms, fog, or snow can cause delays and intensify them. Its effect can vary significantly across regions and therefore between airlines as they do not operate the same number of flights out of the same airports. If not controlled for, weather variations could confound the relationship between mergers and flight punctuality metrics and thus are expected to improve airlines' on-time performance and reduce the intensity of delays when controlled for. Congested airports are also more likely to experience delays due to runway availability, gate availability, and air traffic control restrictions. Some airlines might operate in busier hubs, potentially affecting their on-time performance and intensity of the delays independently of mergers themselves. Similarly to weather, controlling for issues such as congested airports would reproduce an improvement in both airlines' on-time performance and the duration of the delays. Although it is not possible to control exactly for the factors above, there are variables available that can serve as a proxy for them. The Bureau of Transport Statistics discriminates for each airline reporting on-time data the average cause of delay in minutes. For weather, there is the average delay in minutes caused by extreme weather, which includes significant meteorological conditions (actual or forecasted) that, in the judgment of the carrier, delay or prevent the operation of a flight such as a tornado, blizzard, or hurricane. For airport congestion, there is the average delay in minutes caused by the National Aviation System (NAS), which includes delays due to a broad set of conditions, such as non-extreme weather conditions, airport operations, heavy traffic volume, and air traffic control, which all seem pertinent to control for, following the same

reasoning. Controlling for all those seems essential as they are time-varying and affect airlines in different ways while having an impact on the average arrival on-time performance of those companies. To avoid a mechanical correlation of these two variables with on-time performance but especially with the average delay of late flights as this last includes the values of the two controls in its computation, both variables were standardized to have mean 0 and standard deviation 1. The impossibility of controlling for all the variables that are time-varying factors and differ among airlines poses as one main limitation of the study.

The econometric analysis is performed with a Difference-in-Difference model similar to the one used by Hosken et al. (2017). They used a Difference-in-Difference estimator of several mergers in the US to analyze their impact on prices. The model in this study follows the same structure with average arrival on-time performance (OTP) and average delay of the late flights as the dependent variables on both the combined effect of the four mergers but also on the separate analysis of each of the four described mergers which occurred in the period between January 2004 and March 2020. It follows equation 2 where the average arrival OTP and average delay of late flights of airline *i* in year *t* are regressed on airline fixed-effects, where X_{it} is a dummy for each airline, time fixed-effects (γ_t) accounting for time-specific factors that affect all airlines equally, an indicator ($Merger_{it}$) set equal to one for merging airlines (*i*) from the year (*t*) when the companies start reporting as a single airline, and on the already discussed two control variables, capturing weather-related factors ($Weather_{it}$) and issues such as airport congestion (NAS_{it}) factors for airline *i* in year *t*.

(2) $$Average\ Arrival\ OTP_{it}\ or\ Average\ Delay\ of\ Late\ Flights_{it} = \alpha + \rho \cdot X_{it} + \gamma_t + \beta \cdot Merger_{it} + \theta \cdot Weather_{it} + \tau \cdot NAS_{it} + + \varepsilon_i$$, i = airline & t = year

To test the Parallel Trends Assumption (PTA), equation 3 is used, where β_1 represents the lead of the merger variable and must be zero if trends run parallel. The estimate for β_1 will appear as "Lead" under the results section.

(3) $$Average\ Arrival\ OTP_{it}\ or\ Average\ Delay\ of\ Late\ Flights_{it} = \alpha + \rho \cdot X_{it} + \gamma_t + \sum_{j=0}^{1} \beta_j \cdot Merger_{i,t+j} + \theta \cdot Weather_{it} + \tau \cdot NAS_{it} + + \varepsilon_i$$, i = airline & t = year

The analysis of the effect of all mergers on the average arrival on-time performance and on the average delay of late flights aims to identify a generalized effect of all mergers on the punctuality of flights and allows to answer the proposed research question with all collected observations by helping to determine whether there is a common pattern that emerges across different mergers in the US airline industry. Although each merger happens at different points in time, which can be characterized by certain economic crises, for instance, the method controls for time-varying factors affecting all airlines

in the same way. However, one major limitation of this analysis is that companies that merged previously cannot be part of the control group for the mergers which happen afterward as the merger dummy is equal to one from the moment the airline merges until the end of the studied period. The analysis of each merger independently allows for having already merged airlines as a control airline on the mergers that follow, against the limitations of having different results for each merger and the impossibility of a generalized effect of all mergers on the punctuality of flights. Moreover, each analysis assesses a distinct period of a different length to exclude the effects of previous and future mergers. This makes the study of the impact of these mergers on the metrics of punctuality very context-dependent as it provides a detailed examination of the effects specific to each case, helping to understand the unique circumstances, strategies, and outcomes associated with each merger. Additionally, each analysis has a different number of observations not only because the length of the periods is different, but also because some companies established their operations during the time window assessed. One characteristic of both combined and independent estimates which makes the assessment of the merger estimator possible is that when two airlines merge, the company that exits the reports continues to exist after the merger with the same data as the airline that absorbs it. However, for the independent analysis of each merger, in which two airlines already merged previously, it is possible to only include one reporting control airline rather than the two with repeated values.

Furthermore, to provide strong evidence against the null hypotheses, a result is considered significant if the p-value is inferior to 0.05, meaning that the result is at (at least) significant at a 5% significance level and that there is a low probability (less than 5%) that the result occurred due to chance. The null hypothesis associated with hypothesis 1a will be rejected if β is statistically different from 0 in the model relating the four mergers and average arrival on-time performance. Similarly, the null hypothesis associated with hypothesis 2 will be rejected if β is statistically different from 0 in the model relating the four mergers and the average delay of the late flights. Finally, the null hypothesis associated with hypothesis 1b can be rejected provided that β is statistically different from 0 in the model relating the merger of Alaska Airlines and Virgin America and the average arrival on-time performance, but β cannot be statistically different from 0 in the three models relating the other three independent mergers and the average arrival on-time performance.

Table 2 presents the means of the variables of interest for the study of the combined effect of four mergers on flight punctuality measures and Table 3 presents the same statistics for each of the four independent events, which are analyzed at different periods excluding the effect of the other mergers. The total number of observations varies among independent merger studies. The same applies to the observations in the treatment and control groups.

Table 2 Mean statistics of the variables of interest for the aggregate analysis of the four mergers.

	Treatment	**No Treatment**	**Total**
Arrival OTP	83.0	80.0	81.0
Total Average Delay	2.22	6.04	4.94
Average Delay of Late	61.87	55.85	57.58
Weather	0.36	-0.15	0.00
NAS	-0.82	0.03	0.00
N	58	143	201

Note. Arrival OTP is a percentage; NAS and Weather are standardized; the other variables are in minutes; "N" refers to the number of observations in each group.

Table 3 Mean statistics of the variables of interest for each different merger based on the method.

	Merger 1 (2004-2011)			**Merger 2** (2010-2014)		
	Treatment	**No Treatment**	**Total**	**Treatment**	**No Treatment**	**Total**
Arrival OTP	82.0	79.0	79.0	79.0	82.0	81.0
Total Average Delay	3.62	6.54	6.40	5.3	4.54	4.63
Average Delay of Late	54.44	52.52	52.61	60.05	55.12	55.73
Weather	0.73	-0.04	0.00	0.01	0.00	0.00
NAS	0.05	0.00	0.00	-0.11	0.02	0.00
N	4	83	87	8	57	65
	Merger 3 (Jul 2012 – Jun 2018)			**Merger 4** (Apr 2016 – Mar 2018)		
Arrival OTP	82.0	80.0	81.0	82.0	81.0	81.0
Total Average Delay	3.78	5.51	5.35	0.64	5,15	4.70
Average Delay of Late	60.34	59.77	59.82	50.71	66.08	64.54
Weather	0.37	-0.04	0.00	-0.75	0.08	0.00
NAS	-0.45	0.05	0.00	-0.03	-0.75	0.00
N	6	58	64	4	36	40

Note. Merger 1 refers to the merger between Delta Airlines and Northwest Airlines; merger 2 refers to the merger between United Airlines and Continental Airlines; merger 3 refers to the merger between American Airlines and US Airways; merger 4 refers to the merger between Alaska Airlines and Virgin America; when the aforementioned airlines are not involved in the merger, they are part of the control group either separate if before their merger or as a single company, after their merger; Virgin America and Spirit Airlines are not part of the control group in merger 1 as they do not appear on the reports; Spirit Airlines is not part of merger 2 for the same reason; arrival OTP is a percentage; NAS and Weather are standardized; the other variables are in minutes; "N" refers to the number of observations in each group.

V. RESULTS

This section presents the results of the effect of the four mergers on the measures of flight punctuality and the analysis of each of the four mergers independently, based on the previously stated methodology. The analysis of the effect of the four mergers in a single model aims at studying both hypotheses 1a and 2 as they refer to the impact that airline mergers have on the average arrival on-time performance and average delay of late flights, respectively. Furthermore, the model is used to analyze the effect of each merger independently, allowing for airlines that merged previously to serve as a control for mergers that happen afterward and thus understand the constitution of the aggregate effect of the four mergers, while also allowing to assess hypothesis 1b. This hypothesis specifies the impact of a merger involving one low-cost airline, which happens in the merger of Alaska Airlines and Virgin America. The four independent analyses are presented chronologically, and the Parallel Trends Assumption is tested in the five analyses. The average arrival OTP and the average delay of late flights are the dependent variables.

1. The aggregate effect of the four mergers

Table 4 Difference-in-Difference and Parallel Trends Assumption regression results for the relationship between the four mergers and the average arrival on-time performance; and the average delay of the late flights

	OTP (1)	**OTP (2)**	**OTP (3)**	**OTP (4)**	**AVG DELAY LATE (5)**	**AVG DELAY LATE (6)**	**AVG DELAY LATE (7)**	**AVG DELAY LATE (8)**
Merger	1.6**	1.7**	2.0**	3.0***	-1.92	-1.58	-0.53	3.22*
	(0.8)	(0.8)	(0.8)	(1.2)	(1.55)	(1.34)	(1.39)	(1.81)
Weather		1.1***	1.1***	1.2***		3.22***	2.94***	2.63***
		(3.0)	(0.3)	(0.3)		(0.62)	(0.54)	(0,58)
NAS			0.5	0.6			2.12**	2.01**
			(0.5)	(0.5)			(0.92)	(0.96)
Lead				-1.0				-4.85***
				(1.2)				(1.76)
Airline fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	81.8***	80.6***	80.6***	80.3***	50.30***	46.71***	46.65***	47.28***
	(1.2)	(1.2)	(1.2)	(1.2)	(2.25)	(2.35)	(2.23)	(2.21)
N	201	201	201	188	201	201	201	188

Note. Standard errors are in parenthesis; average arrival on-time performance (OTP) is a percentage; average delay of the late flights (AVG DELAY LATE) is in minutes; "N" refers to the number of observations used in the model; the table refers to the period from 2004 to 2020; columns 4 and 8 test the Parallel Trends Assumption (PTA); *p-value <0.1, **p-value<0.05, ***p-value<0.01.

Starting with the analysis of Table 4, there is, on average, a significant effect of the airline mergers on the average arrival on-time performance at a 5% significance level. The coefficient of merger is significant in columns 1 to 3 and increases when the variables controlling for weather and issues such as airport congestion are added to the model. Although only the variable Weather is statistically significant, both control variables support the reliability of the model as their positive signs align with the expectation of average arrival on-time performance increasing when controlling for factors beyond airlines' control. Based on column 3, with the two control variables, when airlines merge, the average arrival on-time performance significantly increases, on average, by 2 percentage points, compared to airlines that did not merge. The Parallel Trends Assumption (PTA) is satisfied since the lead coefficient is not significant, while the merger coefficient is still significant, in this case, at a 1% significance level, in column 4. This ensures that, in the absence of the merger, the merging airlines would have followed the same trend as the airlines that did not merge, making the observed difference in the average arrival on-time performance attributable to the merger. This significant statistical effect serves to reject the null hypothesis of no effect of airline mergers despite the sign of the effect being contrary to the negative effect anticipated by hypothesis 1a. When assessing the second punctuality metric, the effect of airline mergers on the average delay of late flights is not significant at a 5% significance level, even when the control variables are added to the model (columns 5 to 7). Thus, there is no strong evidence that the merger had on average a significant impact on the intensity of delay of the late flights of the merged airlines when compared to the non-merging companies. The positive significant estimates of both control variables, which control for factors beyond carriers' power, go against expectations since those were expected to have a negative sign, regarding their effect on the average delay of late flights. This may indicate that additional factors may be influencing these delays, evidence that is further supported by the fact that the Parallel Trends Assumption does not hold. As the lead coefficient is significant at a 1% significance level, there seems to exist variation in the average delay of the late flights before the mergers occurred. The fact that PTA does not hold would undercut any causal interpretation of a significant effect. The evidence is not strong enough to reject the null hypothesis of no effect of the mergers on the average delay of the late flights, associated with hypothesis 2.

2. The merger of Delta Airlines and Northwest Airlines

Table 5 Difference-in-Difference and Parallel Trends Assumption regression results for the relationship between the merger of Delta Airlines and Northwest Airlines and the average arrival on-time performance; and the average delay of the late flights

	OTP (1)	OTP (2)	OTP (3)	OTP (4)	AVG DELAY LATE (5)	AVG DELAY LATE (6)	AVG DELAY LATE (7)	AVG DELAY LATE (8)
Merger	0.3	-0.3	-0.2	-2.0	4.73***	5.08***	5.22***	5.60***
	(1.7)	(2.0)	(2.0)	(1.9)	(1.16)	(1.11)	(1.15)	(1.80)
Weather		1.8***	1.9***	2.0***		-1.07**	-0.90	-0.93
		(0.5)	(0.5)	(0.5)		(0.53)	(0.55)	(0.69)
NAS			1.9*	1.9			2.48	2.54
			(1.1)	(1.3)			(1.51)	(1.76)
Lead				-2.0*				0.45
				(1.2)				(1.34)
Airline fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	83.3***	83.0***	84.2***	84.2***	50.01***	50.19***	51.77***	51.80***
	(1.1)	(0.8)	(0.9)	(1.0)	(1.79)	(1.67)	(1.89)	(1.19)
N	87	87	87	76	87	87	87	76

Note. Standard errors are in parenthesis; average arrival on-time performance (OTP) is a percentage; average delay of the late flights (AVG DELAY LATE) is in minutes; "N" refers to the number of observations used in the model; the table refers to the period from 2004 to 2011; the two merging airlines started reported as one single company as of 2010; columns 4 and 8 test the Parallel Trends Assumption (PTA); *p-value <0.1, **p-value<0.05, ***p-value<0.01.

The analysis of the relationship between the merger of Delta Airlines and Northwest Airlines on the average arrival on-time performance of the merged airlines reveals that there is no significant effect, even when controlling for weather and issues such as airport congestion in columns 1 to 3 of Table 5. This means that there is no strong evidence that the merger had, on average, a significant impact on the average arrival on-time performance of the merged airlines when compared to the non-merging companies. The Parallel Trends Assumption appears to be satisfied and supports the previous finding as in column 4 neither the lead coefficient nor the coefficient of merger is significant at a 5%

significance level. In the three models of this analysis in columns 1 to 3, the control variables, although not both statistically significant, both have a positive sign as theoretically expected. When assessing the impact of the same merger on the average delay of late flights, columns 5 to 7 in Table 5.1 show evidence of a significant effect at a 1% significance level. While adding each control variable to the model, the coefficient of the merger increases and is still significant. Although the control variable Weather reproduces negative estimates as expected, the control variable NAS has positive coefficients, which is contrary to what was expected. Based on column 7, with the two control variables, the merger seems to significantly increase, on average, the average delay of the late flights by 5.22 minutes. The Parallel Trends Assumption also holds in this case as the lead in column 8 is not significant, while the merger indicator is still significant. This ensures that, in the absence of the merger, the merging airlines would have followed the same trend as the airlines that did not merge, making the observed difference in the intensity of the delay of the late flights attributable to the merger.

3. The merger of United Airlines and Continental Airlines

Table 6 Difference-in-Difference and Parallel Trends Assumption regression results for the relationship between the merger of United Airlines and Continental Airlines and the average arrival on-time performance; and the average delay of the late flights

	OTP (1)	**OTP (2)**	**OTP (3)**	**OTP (4)**	**AVG DELAY LATE (5)**	**AVG DELAY LATE (6)**	**AVG DELAY LATE (7)**	**AVG DELAY LATE (8)**
Merger	-2.6	-2.7	-4.7***	-2.9**	3.52	3.42	8.34**	5.53
	(1.6)	(1.6)	(1.7)	(1.4)	(2.19)	(2.49)	(3.30)	(3.36)
Weather		1.2**	1.6***	1.4*		2.10	1.07	-0.41
		(0.5)	(0.5)	(0.7)		(1.42)	(0.89)	(1.02)
NAS			-2.0***	-2.7**			4.80***	2.67*
			(0.7)	(1.0)			(1.46)	(1.57)
Lead				-4.4***				-0.41
				(1.6)				(4.14)
Airline fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	82.6***	83.2***	82.4***	81.6***	55.06***	56.19***	58.20***	56.11***
	(1.0)	(0.9)	(0.8)	(1.0)	(0.86)	(1.14)	(1.22)	(1.03)
N	65	65	65	53	65	65	65	53

Note. Standard errors are in parenthesis; average arrival on-time performance (OTP) is a percentage; average delay of the late flights (AVG DELAY LATE) is in minutes; "N" refers to the number of observations used in the model; the table refers to the period from 2010 to 2015; the two merging airlines started reported as one single company as of 2012; columns 4 and 8 test the Parallel Trends Assumption (PTA); *p-value <0.1, **p-value<0.05, ***p-value<0.01.

The merger of United Airlines and Continental Airlines appears to have had a significant effect, on average, on the average arrival on-time performance of these airlines, according to column 3 of Table 6, at a 1% significance level. However, the lead coefficient in column 4 is also significant at a 5% significance level, and therefore the Parallel Trends Assumption (PTA) does not hold, undermining the causal interpretation of the previous result. Without parallel trends, the difference in the average arrival on-time performance could be due to other factors or pre-existing trends rather than the merger itself. The signs of the coefficients of the control variables may also indicate an issue with the model reliability: whereas Weather has positive coefficients as expected, the contrary happens with NAS, which shows negative estimates. The assessment of the impact of the merger on the average delay of late flights also shows a significant effect, on average, at a 5% significance level, but only when including the two control variables for weather and airport congestion in column 7. Nevertheless, while PTA seems to hold through the analysis of the insignificant lead coefficient in column 8, the merger coefficient loses its significance. This suggests that the initial significant finding might not be robust and might have been a spurious finding or driven by omitted variable bias. In this analysis, both control variables show positive coefficients, which is contrary to what was expected based on the reasoning that both controls should be associated with improved delay estimates. This supports the uncertainty around the robustness of the results of this analysis.

4. The merger of American Airlines and US Airways

Table 7 Difference-in-Difference and Parallel Trends Assumption regression results for the relationship between the merger of American Airlines and US Airways and the average arrival on-time performance; and the average delay of the late flights

	OTP (1)	OTP (2)	OTP (3)	OTP (4)	AVG DELAY LATE (5)	AVG DELAY LATE (6)	AVG DELAY LATE (7)	AVG DELAY LATE (8)
Merger	0.2	-0.1	0.1	-0.4	1.97	0.77	0.75	0.48
	(1.3)	(1.6)	(1.2)	(1.5)	(2.42)	(1.24)	(1.26)	(2.21)
Weather		1.7***	0.9	1.1		5.92***	5.99***	5.24***
		(0.6)	(0.6)	(0.7)		(0.51)	(0.68)	(0.85)
NAS			3.2**	3.7**			-0.28	2.00
			(1.3)	(1.4)			(1.74)	(2.00)
Lead				0.2				0.94
				(1.6)				(2.30)
Airline fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	86.4***	83.7***	85.1***	84.9***	60.08***	50.46***	50.34***	52.07***
	(0.7)	(1.1)	(1.1)	(1.1)	(2.27)	(2.06)	(2.14)	(2.04)
N	64	64	64	53	64	64	64	53

Note. Standard errors are in parenthesis; average arrival on-time performance (OTP) is a percentage; average delay of the late flights (AVG DELAY LATE) is in minutes; "N" refers to the number of observations used in the model; the table refers to the period from July 2012 to June 2017; the two merging airlines started reported as one single company as of July 2015; columns 4 and 8 test the Parallel Trends Assumption (PTA); *p-value <0.1, **p-value<0.05, ***p-value<0.01.

Table 7 shows that the merger of American Airlines and US Airways did not have a significant effect, on average, on the average arrival on-time performance of these airlines, compared to the non-merging ones, as none of the models in the first three columns have a significant merger coefficient. The estimates for the control variables behave as expected since all present positive signs regarding the relationship with average arrival on-time performance. The Parallel Trends Assumption seems to be satisfied as the lead coefficient in column 4 is not significant and the merger estimator also keeps being insignificant at a 5% significance level. The same holds for the analysis of the effect of the merger on

the average delay of the delayed flights. The merger coefficient is not significant in the models in columns 5 to 7 and PTA appears to hold since both the lead and the merger coefficient are not significant in the model stated in column 8. Regarding the behavior of the control variables in the models, Weather shows positive significant coefficients, which is contrary to what was expected. Although insignificant, NAS behaves as expected with a negative estimate. The merger seems not to have had a significant effect, on average, on the average delay of late flights of the merging airlines, compared to the ones in the control group. Although trends seemed to be running parallel before the merger took place, the merger itself seems not to have significantly affected, on average, the two studied metrics of flight punctuality of these airlines, besides the effect on the non-merging airlines.

5. The merger of Alaska Airlines and Virgin America

Table 8 Difference-in-Difference and Parallel Trends Assumption regression results for the relationship between the merger of Alaska Airlines and Virgin America and the average arrival on-time performance; and the average delay of the late flights

	OTP (1)	**OTP (2)**	**OTP (3)**	**OTP (4)**	**AVG DELAY LATE (5)**	**AVG DELAY LATE (6)**	**AVG DELAY LATE (7)**	**AVG DELAY LATE (8)**
Merger	2.6	2.7	1.8	3.6	-4.73*	-3.24	-1.76	-1.49
	(2.5)	(2.6)	(2.4)	(3.6)	(2.74)	(2.77)	(2.05)	(3.51)
Weather		0.2	0.1	-0.1		3.38***	3.65***	3.64**
		(0.8)	(0.8)	(1.3)		(0.98)	(0.95)	(0.05)
NAS			-2.4	-2.0			4.10*	3.30
			(1.7)	(2.9)			(2.09)	(2.69)
Lead				-0.5				-1.15
				(2.7)				(3.62)
Airline fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	86.6***	86.3***	86.2***	86.8***	65.71***	61.10***	61.21***	61.13***
	(0.6)	(1.3)	(1.1)	(2.3)	(2.58)	(2.07)	(2.06)	(3.82)
N	40	40	40	30	40	40	40	30

Note. Standard errors are in parenthesis; average arrival on-time performance (OTP) is a percentage; average delay of the late flights (AVG DELAY LATE) is in minutes; "N" refers to the number of observations used in the model; the table refers to the period from April 2016 to March 2020; the two merging airlines started reported as

one single company as of April 2018; columns 4 and 8 test the Parallel Trends Assumption (PTA); *p-value <0.1, **p-value<0.05, ***p-value<0.01.

By analyzing Table 8, regarding the mergers of Alaska Airlines and the low-cost carrier Virgin America, none of the merging indicators is significant at least at a 5% significance level and the same holds for the two lead estimators. Although column 5 shows a negative merging coefficient significant at a 10% significance level, this does not present strong evidence of a significant effect according to the defined methodology. Furthermore, only the signs of the estimates of the control variable Weather behave as expected, positively, regarding the models on the average arrival on-time performance. Both control variables in the analysis of the average delay of late flights behave against expectations, with positive estimates. Based on the insignificant coefficients, there is no strong evidence that the merger had, on average, a significant impact on either the average arrival on-time performance or the average delay of the late flights of the merged airlines, when compared to the non-merging companies. The Parallel Trends Assumption holds in both studies as the leads and the merging coefficients are not significant in the models in columns 4 and 8, and thus adds credibility to the Difference-in-Difference models' findings. The null hypothesis of no effect associated with hypothesis 1b cannot be rejected as the merger including a low-cost airline did not produce a significant impact on the average arrival on-time performance of the two involved airlines compared to the airlines that did not engage in a merger operation in the assessed period. Thus, there is not enough evidence to conclude that a merger, which includes a low-cost carrier, has an additional effect on the average arrival on-time performance of the merging airlines compared to other airlines that also underwent mergers.

VI. DISCUSSION

This thesis aims to investigate the impact of airline mergers on airline punctuality metrics, more specifically, on the average arrival on-time performance and on the average delay of late flights. Through a Difference-in-Difference analysis using data on four major airline merger operations in the US over the period between 2004 and March 2020, the effect of the mergers, both cumulatively for all four mergers and individually for each merger, was studied by comparing pre- and post-merger punctuality metrics for the involved airlines against a control group of airlines that did not undergo a merger during the same period. Based on the combined analysis of all four mergers, it can be advanced that these mergers in the US airline industry had a significant effect on the average arrival on-time performance of the merged airlines compared to the non-merging airlines, which provides enough evidence to reject the null hypothesis of no impact of airline mergers on the average arrival on-time performance of these airlines, compared to non-merging ones. However, the same cannot be concluded regarding the relationship between the same four mergers and the average delay of the late flights of merging airlines against non-merging companies since the evidence was not strong enough to reject the

null hypothesis of no effect of the mergers on the average delay of the late flights. Additionally, the null hypothesis of no effect of Low-cost airlines merging on the average arrival on-time performance compared to other airlines that merge cannot be rejected after assessing the independent impact of each of the four mergers.

1. Implications

Whereas the null hypothesis of no effect of airline mergers on the average arrival on-time performance of merging airlines compared to the airlines that did not merge is rejected, the relationship seems to be contrary to the negative effect anticipated by hypothesis 1a. To the best of my knowledge, none of the initially stated hypotheses, including this one, have ever been addressed in the literature. However, Prince and Simon (2009) had previously found that multimarket contact in the airline industry increases the frequency of delays, especially in more concentrated routes. Additionally, as Ciliberto and Williams (2014) found that mergers in the airline industry lead on average to an increase in multimarket contact, one could expect airline mergers to have, on average, a negative effect on average arrival on-time performance of the merging carriers against non-merging ones as stated by hypothesis 1a. This negative relationship was further supported by the increase in market power achieved by mergers (Borenstein, 1990; Kim & Singal, 1993) and consequent less dependence on airline profits on consumer satisfaction, according to Steven et al. (2012). One reason for the findings on this relationship not being in line with hypothesis 1a and the logical reasoning behind it may be the enhancement in operational efficiency achieved through operational synergies and a restructuring of the two airline structures when merging into a solo company. The combination of resources of two merging companies aims primarily at maximizing efficiency through cutting redundancies, and costs and integrating the best resources and expertise of the two entities, according to Maksimovic et al. (2011). Moreover, these restructuration acts seem to largely impact airlines' network structures through the access to new destinations and aircraft, but also to new slots and operating resources with superior planning and monitoring, which allow for an optimization of the flight schedules and operations as perceived by Shaw and Ivy (1994) and, consequently, a reduction in the relative number of delays. Another reason that may justify the obtained results is the need for airlines to maintain service quality under regulatory scrutiny. As stated by Duso et al. (2011), regulatory entities may impose remedies regarding factors such as service quality, which, although controversial or perceived as scarce, merging companies must follow so that consumers are not negatively affected by the merger operation. These remedies could have driven airlines to prioritize on-time performance in terms of service quality and reliability thus concentrating their operation resources and efforts on reducing the percentage of flights late on their network after the fusion, which sheds light on the importance of regulation on merger operations.

The insignificant effect of airline mergers on the average delay of late flights prohibits the rejection of the null hypothesis stating that there is no effect of airline mergers on the average delay of late flights, associated with hypothesis 2, which stated that airlines that merge operations have a lower average delay of late flights after the merger occurs compared to airlines that do not merge. As this is obtained through the same model used to analyze the effect on average arrival on-time performance, but only with a change of the dependent variable, it can serve as a robustness check by testing the stability of the findings regarding average arrival on-time performance. The insignificant effect suggests that the impact of airline mergers might be specific to the average arrival on-time performance. Additionally, the model may be sensitive to that specific variable, prompting further investigation into potential model misspecifications or omitted variables. From a theoretical perspective, although operating efficiencies achieved through mergers could lead to shorter delays through better network development, optimization, and monitoring (Shaw & Ivy, 1994; Maksimovic et al., 2011), these improvements might not necessarily affect the length of delays when they occur and may be focused only on headline punctuality metrics such as on-time performance, compared to less frequent discussed metrics such as the intensity of the delay of the late flights. This could happen both for customer satisfaction purposes, but also for regulatory reasons which may solely focus on relative measures of punctuality and generate controversy (Duso et al., 2011). Furthermore, the length of each delay has a reason and aviation authorities do characterize each delay by motive (FAA, 2024), which can be varied and complex and even beyond airlines' control (Prince and Simon, 2009). While mergers can improve airline controllable factors, they do not significantly impact the uncontrollable factors that determine the length of delays. It is impossible to control for all of them, despite the model having already included proxies for weather and issues such as airport congestion. This could also be the reason for the estimates of the control variables behaving against expectations regarding the average delay of late flights. Additionally, the four assessed mergers might have different characteristics and impacts, which could be masked by aggregating them. Each merger could have different operational strategies, integration challenges, and market impacts as stated by Merkert and Morrell (2012), leading to varying effects on delays.

The study of each of the four mergers independently aims to provide an understanding of the specific characteristics unique to each operation, which would be otherwise hindered by the aggregate analysis. Additionally, the independent analysis allows to break down the aggregate effect, revealing how individual factors such as different operational strategies, integration processes, and market conditions affect punctuality in each operation and contribute to the overall effect. None of the four mergers revealed a significant impact of the merger operation on the average arrival on-time performance of the merged airlines in the independent analysis. This prevents the rejection of the null hypothesis associated with hypothesis 1b. While Prince and Simon (2014) advanced with the conclusion that the on-time performance of incumbent airlines worsens when the entrant in the market is a low-cost carrier, there is not enough evidence that the exit of a low-cost airline, through a merger operation, leads to a significant

change on average arrival on-time performance of these merging airlines when compared to non-merging carriers and even to other airlines that previously merged. These could happen for several reasons but, since all the results of the independent analysis of mergers on average arrival on-time performance are not significant and thus, not supportive of the aggregate effect estimate, the limitations of the model may have a crucial role in the lack of a significant estimate. Non-significant results do not imply that there are no effects. They rather imply that the study does not offer evidence of any effects in the sample. The study of each merger independently narrows the sample size by a third and greatly limits the period assessed, increasing the possibility of not capturing enough variance to show a clear impact on on-time performance metrics. Furthermore, the reduced period may be too short to capture the full effects, despite being the only possibility of this model studying each merger independently. Operational improvements or disruptions might take longer to manifest in measurable performance changes and short-term post-merger periods often involve integration challenges that can temporarily offset any potential gains in performance (Merkert & Morrel, 2012). Another explanation may be that the study of each merger separately involves unique economic and social characteristics that are specific to the period (Carter & Simkins, 2004), which are considered in the aggregate model, capable of controlling for time-varying characteristics similarly affecting carriers. For instance, the merger between United Airlines and Continental Airlines in 2012 happened in a period of a great economic crisis greatly affecting air travel demand in which airlines lowered their number of flights with a greater likelihood of a flight being on time. This could justify that the Parallel Trends Assumption does not hold in any of the models estimated in the analysis of this merger, as there was already a significant effect on the average arrival on-time performance before the merger.

2. Limitations

The analysis conducted in this thesis has some relevant caveats. While the study of each merger independently is very context-dependent and restricted in the number of observations, the analysis of the aggregate effect of all four mergers also lacks observations, especially in terms of control legacy airlines as most in this group are low-cost. Ideally, the study would be conducted at a route level and not at an airline-yearly level to overcome the restricted number of observations and control airlines and thus estimate a more reliable effect, but this would lead to millions of observations, not feasible for this bachelor thesis. Moreover, a major limitation of the model is how it treats airlines and their allocation into treatment and control groups. Whereas in the aggregate analysis airlines that merge cannot serve as a control for mergers that happen after, in the independent analyses this is overcome but with restrictions in the number of observations, the period assessed, and with a high context-dependency. However, this distinction of how and what each analysis considers treatment and control airlines and the repetition of the values for airlines that disappear from the results after merging raise some awareness both on how the results may be interpreted and on the quality of the support that the

independent studies give to the aggregate estimates. Although the Parallel Trends Assumption holds in most of the investigations, it seems unfeasible to control for all time-varying factors differently affecting the merging and non-merging airlines' punctuality metrics. This was also noted in the fact that in the analysis of the independent and aggregate effects of mergers, especially on the average delay of delayed flights, control variables revealed estimates with contrary signs to what was expected. The fact that a huge number of factors can affect the punctuality of a flight was already addressed by Prince and Simon (2009), with another restriction being the access to data on such various factors. This study uses proxies for weather and airport congestion as controls for punctuality, but the estimates may still suffer from omitted variable bias, with other variables interfering in the relationship. However, the Difference-in-Difference model continues to provide sufficient reliability provided that its main assumption, the Parallel Trends Assumption, holds. As it uses a natural experiment, the four mergers of US airlines in the past, its estimates are reliable when the main assumption holds. However, despite the high degree of internal validity of the model, the results obtained may not apply to other contexts such as other mergers in different parts of the world or even other mergers in the US industry. This is because it measures the average treatment effect on the treated (ATT) as the analysis has been deliberately conducted in the airlines affected by these merger operations and the effect is not based on a generalization to the whole set of airlines, not measuring the average treatment effect (ATE).

3. Future Research

Based on the findings of this thesis, but also on its limitations, mainly regarding the model, future research on the topic may extend the study to other mergers, also in other locations, to understand whether the obtained results regarding the effect of mergers on the punctuality of airlines hold or change in other contexts. The use of other approaches such as the study of the affected routes by mergers can provide more detailed and robust estimates with the study also benefiting from a higher number of observations. Such an increase in reliability could be achieved through the addition of other factors affecting airline punctuality beyond airline control such as maintenance or operational constraints. This would require access to more extensive and undisclosed data, which could not be collected and used in this thesis. More interestingly, and based on the obtained results on punctuality, future research can explore the role of regulation on the effects of mergers on the average arrival on-time performance. The idea that regulation could be the factor behind the increase in airlines' average arrival on-time performance was advanced as a possible remedy imposed on airlines to avoid negative effects on customers. Moreover, the study of the average delay of late flights by cause could indeed provide a complement analysis to the possibility of regulation only making airlines' efforts into the reduction of the percentage of flights late and not on the intensity of flights, which could be of much importance for policymaking as some imposed remedies may indeed be controversial or scarce (Duso et al., 2011).

VII. CONCLUSION

This bachelor thesis set out to investigate the impact of airline mergers on the punctuality of the flights of the merging carriers. With evidence from the US airline industry, the effect of four distinct major mergers over the last two decades on two airline punctuality metrics was assessed through a Difference-in-Difference model. The findings revealed that the four mergers had a significant positive impact on the average arrival on-time performance of these airlines, compared to non-merging airlines. However, such a significant effect was not found in the relationship between the same four operations and the average delay of the late flights of the merging carriers. These results suggest that airline mergers may have a positive impact on the punctuality of flights of the merging companies, contributing to existent research on the impact of mergers on the quality of service airlines offer to customers, although no existent study seems to address punctuality as the outcome. This is important from a policy-making perspective as regulatory entities must examine each merger operation, so customers are not negatively affected by the reduction in competition in the airline industry. However, it is not possible to conclude whether the presented results extend to other mergers. The fact that the assessed airline mergers had a significant effect on average arrival on-time performance but not on the average delay of the already late flights opens the space for future research to explore the motives for such distinction, also studying other merger operations in different environments and thus overcoming some limitations of this bachelor thesis. More interestingly, future studies may be dedicated to the study of the reasons for each delay, aiming to find whether existent regulation on airline mergers is behind such distinction.

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APPENDIX A: Common Abbreviations and Acronyms

The following is a glossary of the most common abbreviations and acronyms used in this bachelor thesis.

DiD The Difference-in-Difference method.

FAA The Federal Aviation Administration. The national aviation authority of the United States of America, part of the U.S. Department of Transportation, with authority to regulate and inspect all aspects of the American civil aviation.

NAS National Aviation System. In this thesis, it represents the delays attributable to the national aviation system that refer to a broad set of conditions, such as non-extreme weather conditions, airport operations, heavy traffic volume, and air traffic control.

OTP On-time Performance. It is used in the airline industry to measure delays. In this study, it represents the percentage of flights that arrive on time to the gate. The note below each table should be checked since the abbreviation may refer to the dependent variable on the tables under results.

PTA The Parallel Trends Assumption. The fundamental assumption of the Difference-in-Difference method.

US United States. It refers to the country unless it is followed by the word *Airways*. In that case, the study refers to the airline US Airways.