New Revenue Management and Distribution Technologies in the Airline Industry: Legal, Regulatory, and Commercial Implications

by

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Abstract

IATA's New Distribution Capability (NDC) is a communication standard for the distribution of airline tickets. This new standard will take advantage of modern technology and give airlines the ability to transmit new information to intermediaries and passengers during the flight search and booking process. NDC will also allow for more advanced revenue management and pricing techniques like dynamic offer generation and has inspired researchers to develop and test these new techniques.

This thesis investigates the potential changes in the industry from the impending implementation of NDC. It considers potential legal, regulatory, and commercial barriers to NDC implementation and the implications of NDC adoption. The contributions of this thesis are three-fold. First, the history and development of airline revenue management and distribution are comprehensively documented. This documentation provides the context from which to understand how NDC may change the airline industry and is among the most thorough available in current literature. Second, NDC implementations are analyzed through a policy and legal lens. While this analysis is not comprehensive given the extent and variety of potential NDC implementations, the thesis offers one of the first attempts to understand the legal and regulatory issues that NDC implementation will raise. Finally, policies are explored that consider the current legal and regulatory landscape, the potential benefits of NDC to the industry, and the possible impacts on consumers from NDC implementation.

Thesis Supervisor: Peter P. Belobaba
Title: Principal Research Scientist of Aeronautics and Astronautics

Acknowledgments

Five years ago, I arrived at MIT with a plan to create a graduate program at the intersection of my interests in law and transportation. This thesis is the culmination of that effort. I am thankful to each and every person that facilitated my pursuit of an unorthodox graduate education, enriched my life, and contributed to my education during my time in Cambridge.

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Thank You to the faculty at MIT and Harvard Law School for providing me with the knowledge and skills necessary to undertake this research. This thesis relied heavily on my learnings in Urs Gasser's Comparative Digital Privacy course, Einer Elhaugue's Global Antitrust Law and Economics course, Peter Belobaba's Airline Industry course, and Adrian Vermuele's Administrative Law course.

Thank You to the many individuals in the airline industry that have offered their advice and fielded my questions over the last decade. Every morsel of knowledge was helpful in writing this thesis. Natalie Beck, Austin Young, and Patrick Quayle deserve special recognition for their continued willingness to engage in candid discussion about the industry and in providing opportunities for me to apply my knowledge to industry issues.

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Chapter 1

Introduction

For nearly a decade, the airline industry has been in a state of anticipated and actual change caused by the development of New Distribution Capability (NDC). NDC is a communication standard for sending and requesting information from airlines and is being developed by the International Air Transport Association (IATA). The standard is intended to replace the existing standard (called EDIFACT) which was developed before the internet and has limited functionality. The new standard would take full advantage of modern computer and internet technology and has the potential to lead to significant changes in how airlines price and sell tickets.

Since the NDC development process began in 2012, there have been significant, multi-disciplinary efforts in the industry to capture the benefits of the new technology. Airlines and airline technology companies have worked on implementing the new standard. Academics and researchers at private firms have explored the potential of the standard to facilitate new methods of airline revenue management. Policymakers have looked to ensure that the changes do not harm consumers or competition. These efforts have been part of a larger effort to modernize airline retailing. Despite the significant work, the industry remains in the early stages of adopting NDC.

NDC implementation may be at a turning point where the disposition of the industry moves from preparation and exploration of potential, to capturing benefits and addressing issues with the new technology. In the last two years, the future of NDC implementation was a major component of government action related to the merger of airline technology companies.[1] Private litigation between companies resulting from the implementation of NDC by airlines and its ramifications has also begun.[2]

In the United States, there may also be an increase in regulatory and government action related to NDC implementation. In the final months of the Obama administration, the Department of Transportation initiated a Request for Information for "Exploring Industry Practices on Distribution and Display of Airline Fare, Schedule, and Availability Information" inspired by complaints about the "practices by some airlines to restrict the distribution and/or display of flight information by certain online travel agencies (OTAs), metasearch entities that operate flight search tools, and other stakeholders involved in the distribution of flight information and sale of air transportation" (Department of Transportation, 2016).

The regulatory effort was suspended by the Trump administration in March of 2017 and canceled in December of 2020. Now, with implementation further along and a new administration, it is possible (and perhaps likely) that the Department of Transportation will undertake either investigation or rulemaking in the airline distribution space.

This thesis explores changes in the airline industry that have occurred or may occur as a result of IATA's New Distribution Capability and related enhancements in airline retailing. Three areas of impact are highlighted: changes in the way airlines publish and sell flights, the collection and use of passenger information, and the bundling of ticket fares and ancillary services. These changes are not the result of NDC, but NDC is inextricably tied to these changes and will impact the extent, speed, and types of changes in these areas. The goal of the thesis is to increase understanding

[1] Sabre and Farelogix.

[2] See e.g., Fareportal Holdings Inc. et al v. JetBlue Airways Corporation, Docket No. 1:21-cv-00061 (E.D.N.Y. Jan 05, 2021) which is discussed further in Chapter 3.

of the possible changes in these areas, identify barriers to change in current law or regulation, and describe policies that can capture potential benefit while addressing the concerns of consumers and policymakers.

The remainder of this thesis is as follows: Chapter 2 documents the history and evolution of airline revenue management and distribution. The focus of the chapter is understanding the context and identifying the extent of current change. The chapter also introduces the research framework for the remaining analysis in the thesis. Chapter 3 considers the airline distribution landscape and how responsibilities may shift between entities in the distribution process. It outlines the range of possible implementations of NDC in distribution from the perspective of airlines and other industry entities. Chapter 4 discusses the collection and use of customer data. It identifies how the growing body of privacy and data regulation might limit certain NDC implementations and explores where increased data collection may be beneficial to airlines and consumers and where it may be harmful or illegal. Chapter 5 explores the bundling of airline fares and ancillary services and issues related to the display of bundles to consumers, issues in bundling taxable and non-taxable components in a single price, and antitrust issues.

Each of chapters 3, 4, and 5 also discuss policy. These discussions are either addressed to resolving implementation issues raised in the chapter or ensuring that potential benefits in the area can be realized by consumers and airlines. Finally, Chapter 6 summarizes and outlines how airlines and policymakers might utilize the insights generated by this research.

Despite the legal analysis offered in this thesis, it should not be considered legal advice. Readers are encouraged to consult an attorney for legal advice on these topics. Given the focus on the future, the thesis at times offers speculation and opinion. The opinions and predictions offered in this thesis are those of the author and do not necessarily reflect the position of MIT, the thesis supervisors, or any current or past employers of the author.

Chapter 2

Overview of Airline Revenue Management and Distribution

In 1992, American Airlines described their ticket selling processes using the analogy of a store. The "storefront" was their computerized reservations system, SABRE, and the decision of how much of each product to put on the shelves was made, in part, by their 'DINAMO' revenue management system (Smith et al., 1992). The analogy is helpful to understand the two major processes required for airline ticket selling: revenue management and distribution.

The revenue management process determines what products should be sold at a given time. The process is limited by the planning process,[1] but otherwise has total control over what the airline is selling, to who, and the price.

The distribution process communicates the prices and product availability to potential customers and provides a method to purchase items. Much as the store must have products delivered to the store, place them on shelves for customers to see, and let

[1] In the airline context, planning refers to both the purchase of aircraft and the planning of routes. Both define the limits of what a revenue management system can make available for sale. In the store analogy, planning might set the store size and presence of specialized equipment for products (e.g., a refrigerator).

customers purchase these products, airlines must accomplish the same distribution for airline tickets.

The store is also a useful analogy to understand the historical development of airline selling and what the future holds. The earliest airline "store" functioned more like a catalog. As Beatrice (2013) describes, travel agents would find flights in printed schedules from airlines that satisfied the needs of customers and then call to inquire whether the product they saw was available, confirm the cost, and purchase it. In the near future, the store may look more like Amazon where a consumer will be able to enter a general search and receive offers from numerous sellers for numerous products that satisfy their search query.

This chapter traces the history of the airline selling process in order to contextualize and understand the significance of recent developments in distribution and airline revenue management. The first section describes the history of distribution from the pre-computer era to IATA's New Distribution Capability. The second section covers the evolution of revenue management from its introduction to today's cutting-edge research. The final section establishes the terminology and framework used to discuss major areas of change in the remainder of the thesis.

2.1 History of Airline Distribution

In the early days of the airline industry, distribution was a cumbersome and labor-intensive process. American Airlines' "request and reply" system described in McKenney (1995) is illustrative of early distribution systems. Seat availability information for every American flight was recorded on physical index cards called 'flight cards' which were stored in booking offices around the country.[2] A reservation agent would determine which office stored the card for a particular flight and call that office to

[2]Offices would usually hold the flight cards for all flights departing from that city as well as nearby cities that didn't have their own offices.

determine flight availability. An agent at the booking office would locate the physical card and relay availability information to reservation agents. The booking office agent would update the card when bookings were made, changed, or canceled and return the card to its storage location. The process was inefficient - only one agent could handle a flight card at a time, the process took at least five manual operations to complete a reservation, and booking offices received 3.5-7 calls per passenger (Dornian, 1995).[3]

Airlines and others in the industry worked to make the process more efficient by improving the various stages of the booking process. At the inventory/seat availability stage, some airlines replaced the flight cards with display boards (see Figure 2-1) which allowed multiple agents to view availability simultaneously though bookings were still recorded on flight cards. At the flight search stage, the Official Airline Guide took the published schedules of various airlines and sorted them by route rather than by airline to simplify the flight identification process for reservation agents (Morris, 1988). This made the process easier for airlines and made it more likely agents were finding the best flight among the available options. These early innovations marginally improved the speed and cost of the booking process, but the process overall remained slow and manual.

1945-1976: Automation and Computerization of Distribution

Airline traffic grew significantly after the end of World War II in 1945 and the existing distribution processes could not sustain the massive growth. Assisted by the introduction of jet airplanes and a booming post-war economy, airline traffic grew over 10% per year between 1950 and 1970 (Oxley and Jain, 2015). What was true for the industry, was also true for individual airlines. For example, Trans-Canada Air Lines ("TCA", a predecessor to modern-day Air Canada) increased its daily passenger capacity by 90% between 1951 and 1956 and was boarding a quarter-million passengers per month by 1957 (Dornian, 1995). It became increasingly difficult for airlines like

[3] In Dornian (1995), these offices are referred to as "space control centers" rather than booking offices.

Figure 2-1: Pan Am Reservation Office, 1956 (Pan American Airways, 1956)

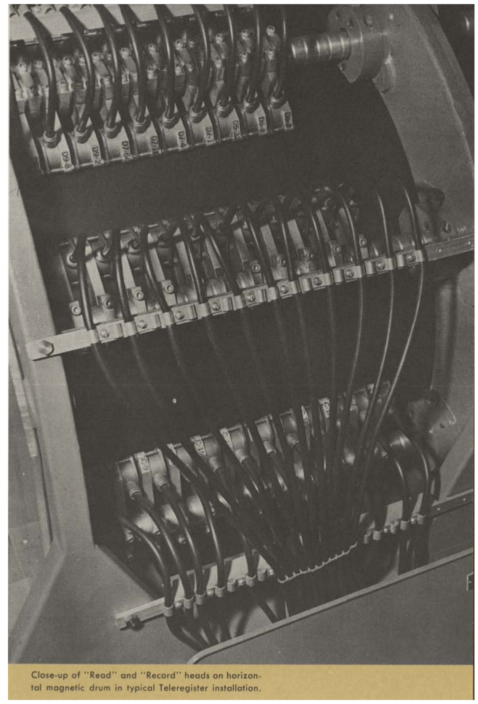

Figure 2-2: Magnetronic Reservisor (Teleregister Corporation, 1956)

TCA to handle these volumes of bookings with the existing labor-intensive methods. The industry required distribution innovation and turned to budding computer technology for that innovation.

The first major innovation in distribution came in February 1946 when the Teleregister Corporation installed an automated reservation system called a Reservisor at American Airlines' Boston reservation office. The Reservisor replaced the physical flight cards and allowed the office to serve 200 more passengers per day with 20 fewer agents.

A second, improved Reservisor[4] was introduced at American in 1952 and is "considered the world's first fully automatic reservation device" and more broadly the "first commercial system to combine electronic processing with electronic communication" (Dornian, 1995). The system was popular and Teleregister soon installed systems for United Airlines, National Airlines, and Braniff International Airways (Teleregister

[4]The second version was called the Magnetronic Reservisor.

Corporation, 1956).

These early systems were only able to automate the maintenance of seat availability information. Communications between customers, travel agents, and reservation agents remained unchanged. As airline managers examined their systems, they realized "that a computerized reservation system was the best solution" (Dornian, 1995).

IBM and American Airlines joined forces in 1953 to develop such a system - one that could automate some of the communication and also "keep a record of the passenger's name, the passenger's itinerary, and [...] his phone number" (Mapstone, 1980). Other airlines, like TCA, continued to work on their own systems often cooperating with universities for testing.

TCA turned on their system, called ReserVec, on October 16, 1961. After a year of testing, the system "commenced full-scale operation on January 24, 1963" (Dornian, 1995) becoming the first Computerized Reservation System ("CRS"). ReserVec was processing 80,000 to 100,000 transactions per day and allowed TCA to reduce its reservation control center staff from 230 to 90 (Dornian, 1995).

ReserVec was joined by the IBM/American system, called SABRE, two years later. SABRE was a sea-change in distribution technology (so much so though it is now misremembered as the "first airline computerized reservation system" (Kärcher, 1996)). SABRE's design anticipated the future - "they had analyzed the airlines' needs, and imagined what should happen even without the technology to do it" (Mapstone, 1980). It was much larger than ReserVec - supporting three times as many terminals and nearly twice as much external drum memory (Dornian, 1995). In addition to the automated seat inventory control processes of ReserVec, the SABRE system created passenger records, managed passenger waitlists, maintained flight forecasts, furnished flight manifests and passenger name lists, processed schedule changes, and automatically generated lists of passengers affected by schedule changes with their contact information (Plugge and Perry, 1961). Sabre "truly[...] revolutionized the airline system" and IBM quickly sold similar systems to Delta and Pan American

(Mapstone, 1980).

Recognizing the potential of SABRE, IBM developed and released a generalized program based on SABRE called the Programmed Airline Reservations System (PARS) that ran on newer computer equipment while American took over the control and development of Sabre. The PARS system and CRSs based on PARS quickly spread throughout the industry: Eastern Airlines adopted PARS in 1964, it was introduced at TWA in 1976, and United introduced Apollo based on PARS in 1971 (Kärcher, 1996).

1976-1993: Agency Connections and the introduction of Global Distribution Systems

The new computerized reservations systems significantly improved inventory control and the airlines' internal processes but did little to improve the work of travel agents. Travel agents still had to call reservation offices to determine flight availability and to make bookings. Passengers continued to have to trust that travel agents had found the most convenient flight at the best price through a manual search of printed schedules and fares.

In the 1970s, recognizing the continued inefficiency for travel agents, airlines began to allow travel agents to access the computerized reservation systems directly (Beatrice, 2013; Kärcher, 1996; Sabre Corporation, 2017). In early 1976, American installed the first automated reservation terminals in travel agent offices. By the end of the year, they had installed Sabre terminals at 130 travel agencies (Sabre Corporation, 2017). When a travel agent was connected to a particular airline's CRS - like American's Sabre terminal - the travel agent would, by default, see a display biased towards the CRS provider (Bingemer, 2018). Since the airlines were able to collect fees and saw a higher share of bookings from agencies using their CRS, "every carrier strived for a proprietary CRS" (Bingemer, 2018) and CRSs proliferated throughout the industry.

Three Generations of Transportation Industry EDI

Decade	Generation	Description
90's	3	International: UN-JEDI, EDIFACT
80's	2	Inter-Industry: CCITT-X.12
70's	1	Industry-Based: IATA-AIRIMP, CARGOIMP

Figure 2-3: Generations of Transportation Industry EDI (Niketic and Mules, 1993)

Over the next three decades, the airline computerized reservation systems slowly transformed into the Global Distribution Systems of today. The foundation for the transition was laid by the rise of intermediaries and standardization in communication methods. Intermediaries, like SITA, which provided "the world's largest international data network" (Kärcher, 1996) were necessary to transform the individual CRS networks of each airline into distribution networks with global reach. The Airline Tariff Publishing Company ("ATPCO") was reorganized as a separate organization in 1974, began publishing non-US airline fares in 1979, and began offering electronic subscriptions to fare information in 1982 (ATPCO, n.d.). Niketic and Mules (1993) trace the first three generations of communication standardization using "Electronic Data Interface" (EDI) which provided "a common [data language] to send structured data from one business system to another." The earliest standards focused on facilitating interline travel, but over time more standards were developed using EDI for other stages in the distribution process (see Figure 2-3). With standardized communication schema, functionality was no longer "restricted to airlines participating in a particular CRS" (Niketic and Mules, 1993). By 1990, the UN had approved the EDIFACT standard which is still utilized in airline distribution today (United Nations Economic Commission for Europe, n.d.). Able to connect to global networks, access consolidated industry data, and communicate using defined standards, GDSs became technically possible.

In the late 1980s and early 1990s, airlines began to combine and consolidate their

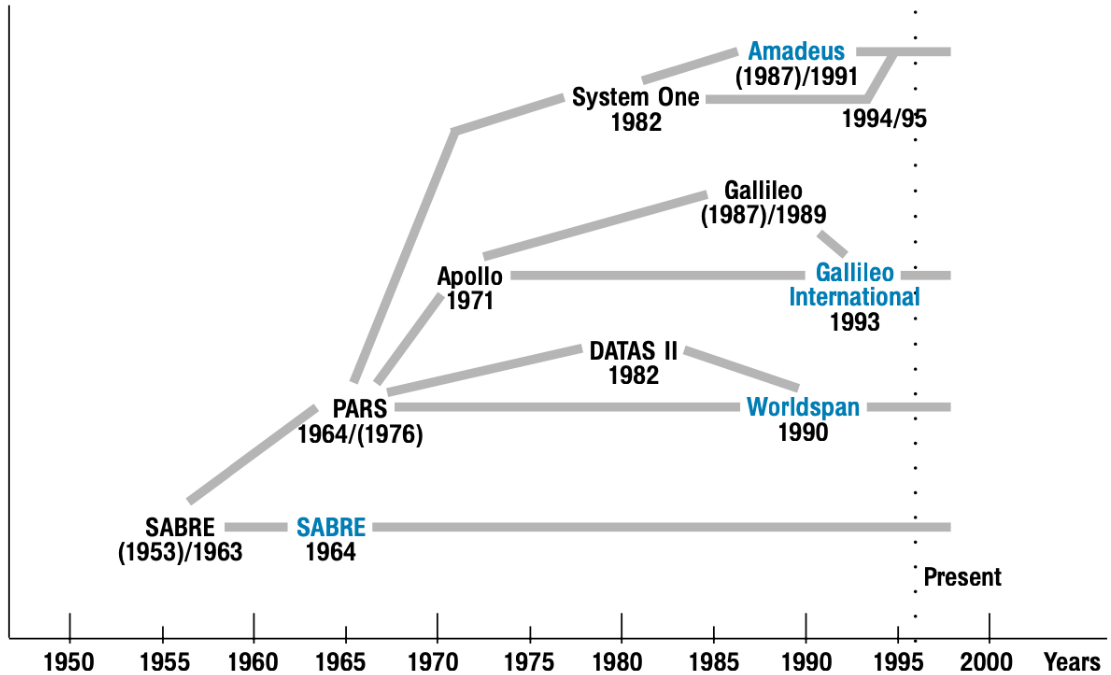

Figure 2-4: Evolutionary Development of CRS/GDS Platforms (Kärcher, 1996)

individual CRSs into today's GDSs. Worldspan was created in 1990 by the merger of Northwest, TWA, and Delta's CRSs. Amadeus was created in 1991 by the combination of Air France, Iberia, Lufthansa, and SAS. Kärcher (1996) shows this development and consolidation of the GDSs in Figure 2-4. By 1997, the Global Distribution Systems had fully taken hold with 115,000 travel agencies around the world connected to a GDS (Morrell, 1998).

1993-2012: The Internet and rise of Direct Channel Distribution

Around the same time as the creation of the GDSs, the internet was invented and began to be slowly adopted by consumers. Sabre had experimented with a direct consumer connection to the CRS with easySabre in the 80s (Sabre Corporation, 2017), but it failed to be widely adopted. The internet had the potential to be a widespread, self-service direct channel for consumers to book airline tickets (Bingemer, 2018). In December 1995, Alaska Airlines became the first carrier in the United States "to

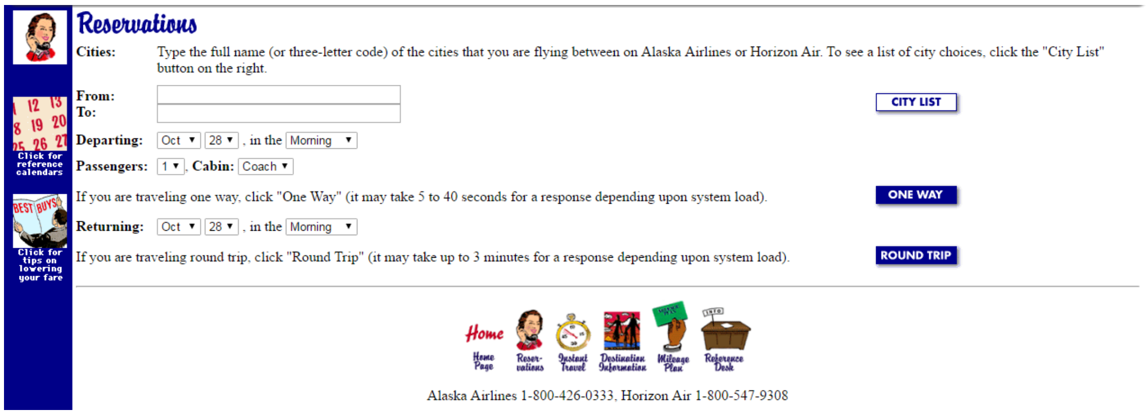

Figure 2-5: First US Website for Booking Flights, Alaska Airlines (Lindsey, 2016)

offer customers the option of using the Internet to book themselves for travel and to purchase tickets" (Lindsey, 2016). The GDSs also got into the website business: Sabre launched Travelocity in 1996 (Sabre Corporation, 2017) and Amadeus bought Vacations.com in 2000 (Cogswell, 2000).

As consumers began adopting the internet as a new way to purchase airline tickets, the cost to airlines of distributing and selling seats through traditional channels was rising. For example, selling costs exceeded 16% of operating costs for British Airways from 1994-1996 (Morrell, 1998). While legacy carriers like British Airways were trying to deal with these high costs, new low-cost carriers (LCC) like Ryanair, Easyjet, and Southwest adopted internet-focused distribution approaches (often eschewing the GDSs entirely) (Bingemer, 2018). These airlines were able to realize significant cost savings and more importantly saw significant growth, undermining the idea that GDSs were necessary for airline success.

The airline industry faced two significant shocks in the 2000s: at the beginning of the decade the 9/11 terror attacks shut down some parts of the industry for days and decreased demand in the following years, at the end of the decade the 2008 financial crisis and global recession led to significant declines in demand. The US airline industry shrank[5] in 2001-2002 and 2008-2009. The shocks were significant enough

[5]As measured in RPKs or revenue passenger kilometers - the total number of kilometers traveled by passengers.

that the global industry shrank in 2001 and 2008 (Belobaba, Odoni, et al., 2015). Though there had always been a distinction between direct channel distribution, where all steps of distribution are under the control of the airline, and indirect channel distribution, where third parties control a portion of the distribution process, this distinction became more pronounced during the 2000s as airline managers, facing intense cost and demand pressures, deliberately tried to cultivate direct bookings and decrease indirect bookings.

The primary reason for the heightened relevance of direct channel distribution was the cost of indirect distribution (e.g., Frontier said in 2012 that an indirect booking cost the airline 15 times more than a booking made on their website (Associated Press, 2012)), but airlines also saw direct channels as a way to access increasingly important customer data and to de-commodify the purchase process by providing rich content highlighting flight features and ancillary options (Ziegler et al., 2017). While ancillary charges, like bag fees, had existed for low-cost airlines since practically deregulation,[6] these fees were a minor portion of overall industry revenues until 2008 when American was the first legacy carrier to introduce a baggage fee. Airline believed they were missing out on potential revenue when ancillaries could not be sold through indirect channels during initial flight purchase.

In addition to websites, airlines also tried to improve distribution through direct connections - connecting agencies directly to the airline's servers and bypassing GDSs (Bingemer, 2018). This reduced GDS costs and allowed the sale of ancillaries by travel agents. By 2012, airlines had increased direct channel sales from 20% of bookings before the introduction of airline websites (Ziegler et al., 2017) to 45% of bookings for legacy carriers and 84% of bookings for LCCs (Harteveldt, 2012). The cost and revenue pressures in the industry and evolving distribution methods led to conflict between traditional distribution players[7] and the emergence of new players like Farel-

[6] People Express advertised a $3 charge for checked bags in 1982 (Shifrin, 1982).

[7] Expedia, Sabre, and Orbitz stopped displaying or suppressed the display of American Airlines fares after the airline introduced Direct Connect. American sued the companies and won in an out-of-court settlement (Bingemer, 2018).

ogix, Concur, and Routehappy. Airline distribution was ready for change.

2012-Present: New Distribution Capabilities

The airline industry has been trying to create an XML-based communication standard for more than twenty years. The first effort began in April 1999, when airlines, hotels, and rental car companies came together to form the Open Travel Alliance to develop such a standard (OpenTravel Alliance, 1999). Though the group had the support of many individual companies and trade groups, their progress was slow. Meanwhile, Farelogix had been developing an XML standard to facilitate direct connections between airlines and travel agencies (McDonald, 2013). Frustrated by a decade of slow progress by the Open Travel Alliance, a group of airlines formed a new organization called the Open AXIS Group with the same goal (Open AXIS Group, 2010). The Open AXIS Group licensed the Farelogix XML standard and began to publish XML schema for distribution.

The timing for XML was right and less than two years later, IATA (a global trade group representing 290 airlines) passed Resolution 787 creating a Passenger Distribution Management Group "to oversee the development of new passenger distribution processes and standards" (IATA, n.d.). In 2013, the group selected the Open AXIS XML schema (over the Open Travel Alliance schema) as the backbone of its standard (Rice, 2013). IATA called this standard 'New Distribution Capability.' The effort received regulatory approval from the United States in 2014[8] (U.S. Department of Transportation, 2014) and although the European Commission inquired about the resolution,[9] it did not take action to stymie the project (Kohnstamm, 2013).

IATA released the first NDC schema in 2015 (IATA, 2019). As IATA worked to continually revise and improve the standard and encourage the adoption of NDC,

[8]The US review was done under antitrust authority but required some privacy-related changes to the resolution.

[9]The EC review was undertaken by Working Group 29 - privacy officials inquiring about privacy concerns.

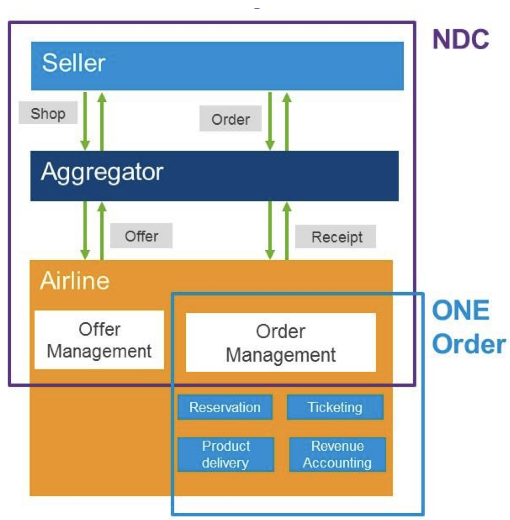

Figure 2-6: NDC and ONE Order (IATA, 2016)

they also expanded their focus to modernizing airline retailing. In addition to NDC, the core component of this modernization is the ONE Order initiative begun in 2016. The goal of ONE Order is to utilize NDC to combine various electronic booking records into a single order record. The relationship between NDC and ONE Order is illustrated in Figure 2-6. ONE Order and NDC represent a significant change in distribution technology. Airlines have had increasing flexibility to collect information from passengers and display purchase options to customers through their websites. NDC will provide this same flexibility in the indirect channel. The current standard, EDIFACT, can only request availability about a particular flight and thus requires some other system to determine which flights meet a passenger's needs. A single NDC shopping request can be more general (e.g., just a date, origin, and destination) and sent to multiple airlines. Rather than respond with just availability airlines can create multiple offers that satisfy the requirements in the request and share them with the requester.

The industry has steadily adopted these standards. IATA keeps a registry to recognize companies that have implemented part or all of the NDC technical standard. In the year following the first release, 41 total companies - and none of the GDSs - were certified (Triometric, 2017). By the end of 2020, 185 companies had been certified including Sabre, Amadeus, and Travelport, and other key industry players like ATPCO/SITA and Pros, Inc (IATA, 2021). Seventeen airlines have also achieved "NDC@Scale" status, indicating the technical capability to process high volumes of NDC transactions and a commitment to process 20% of transactions using NDC. A similar registry for ONE Order currently recognizes 27 ONE Order capable companies.

Despite the 2020 COVID Pandemic, steady adoption has continued. In December 2020, Sabre and Lufthansa announced a new distribution agreement including a diversified NDC program (Sabre Corporation, 2020), Google and Vistara Airlines joined forces to use NDC to allow ticket purchases directly in Google search (Ghosh, 2020), and United launched an NDC platform with Cheapoair (CheapOair, 2020). Though complete adoption within a single airline or across the industry remains in the future, that day now appears inevitable.

2.2 Evolution of Revenue Management

Though algorithms were being developed to aid airlines in managing inventory as early as 1958,[10] the story of modern revenue management begins with the Airline Deregulation Act of 1978. The act called for “a gradual transition from regulation to competition” in the industry, “eliminat[ed] most entry controls”, and eliminated “domestic rate regulation” (Dempsey, 2003). Liberalization spread from the United States to most of the industrialized world and airlines turned their focus to “cost efficiency, operating profitability, and competitive behavior” (Belobaba, Odoni, et al., 2015). Now that airlines had the power to determine the prices of their tickets, they needed methods to do so.

Before deregulation, airlines could only vary the prices for seats on a flight when they

[10] Weatherford (2016) reviews the revenue management forecasting literature from 1958 through 2016 and identifies 5 articles released in 1978 or earlier

were in different classes of service (e.g., first and coach). After deregulation, capacity expanded, low fares emerged, and airlines began to practice differential pricing and demand segmentation (Belobaba, 1987). Demand segmentation and differential pricing occurred through the introduction of restricted fare classes. A fare class is a set of restrictions or amenities that accompany a flight ticket. The airline can create different "products" with a single seat on an aircraft. Airlines price these products based on their perceived value to consumers or cost to the airline (e.g., refundability is costly to airlines and valuable to certain passengers and is usually only available in higher-cost fare classes). Customers sort themselves into fare classes by selecting a fare from the class whose attributes best align with their preferences. A primary goal of these restrictions is to allocate seats to demand in a manner that maximizes revenue.

With the ability to sell each seat in any fare class, revenue management systems were created to determine how to allocate the physical seats (i.e., inventory) to the different fare classes. The first RM systems collected historical booking data and provided it to analysts who had to use their own judgments about how to use the data to decide how much of each product to provide for sale. The second wave of RM systems improved upon this method by using the historical data to create a "booking curve" or prediction of when passengers would book in particular fare classes. The systems monitored bookings to determine when they deviated from this prediction but left inventory control decisions to the analyst (Belobaba, Odoni, et al., 2015). Belobaba (1987) introduced the concept of Expected Marginal Seat Revenue which "became the foundation of most airline RM systems" (Yeoman and McMahon-Beattie, 2017). EMSR complemented the existing demand forecasts by providing a method to optimize seat inventory controls and became an essential component of third-generation RM systems (see Figure 2-7). American Airlines was among the first to implement a third-generation RM system that included statistical forecasting and mathematical optimization models in 1988. The system, called DINAMO, resulted in $500 million in annual revenue contribution as a result of improved inventory control

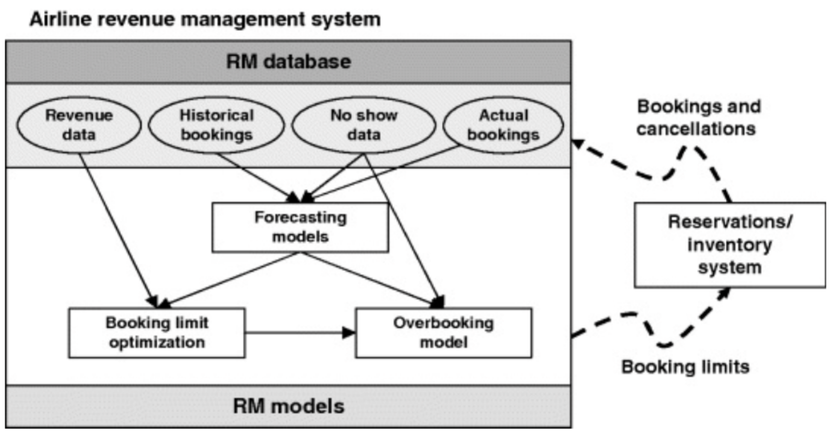

Figure 2-7: Third Generation RM Systems (Belobaba, Odoni, et al., 2015)

and fewer unsold seats (Smith et al., 1992).

With more control over which routes to fly, airlines largely consolidated to hub-and-spoke networks (Rodrigue, 2020). Hubs allowed airlines to offer significantly more itinerary options to passengers but created a similar problem to the expansion of fare classes - each physical seat had the potential not just to be sold in different fare classes, but also had the potential to be sold as part of different itineraries. For example, the airline had to decide whether a seat on a PHX-DFW flight was more valuable as part of a PHX-DFW-BOS itinerary or PHX-DFW-DCA itinerary. Fourth-generation RM systems solved this problem by introducing network-based, rather than leg-based RM. Various methods have been utilized to introduce what has been called "OD or Origin-Destination Control." Virtual Nesting and bid price control are two common implementations of network-based revenue management (see Talluri and van Ryzin (2004) for further discussion of solutions to network revenue management).

Just as the rise of low-cost carriers impacted distribution, it also impacted revenue management. This impact was twofold. First, low-cost carriers tended to use 'simplified' or 'unrestricted' fare structures. For example, minimum and Saturday-night stay requirements were eliminated. Travelers who previously would not have purchased in a fare class because of these restrictions could now purchase from lower fare classes with available seats. Many airlines that had been utilizing restricted fare structures began eliminating some restrictions to stay competitive. The existing RM systems were designed based on the restricted fare structure and utilizing them on an unrestricted or semi-restricted structure had the potential to lead to substantial revenue losses (Belobaba, Odoni, et al., 2015). Hybrid forecasting (Reyes, 2006), Q-forecasting (Belobaba and Hopperstad, 2004), and fare adjustment (Fiig et al., 2009) have allowed airlines to continue to use their RM systems with less restricted fare structures and fare structures remain largely semi-restricted today. Second, many low-cost carriers began 'unbundling' their fares and charging for services that had formerly been included in the fare (e.g., on-board food service, checked bags, etc.). The major airlines also replicated this change and fees for ancillary services are now a major source of revenue for most airlines.

The focus of revenue management research has been to respond to the developing competitive dynamics in the industry and to realize the potential of New Distribution Capability. Some notable works include: Wittman (2018) which proposes segmenting business and leisure traffic and dynamically offering discounts or increments to existing fares and ATPCOs efforts to develop Dynamic Pricing Engines to accomplish the same; attempts to jointly optimize for fare revenue and ancillary revenue with dynamic bundling as introduced in Bockelie (2019); research focused on the transition away from the traditional 26 fare classes including continuous pricing (Papen, 2020); competitor-aware RM systems which incorporate knowledge of competitor's prices and availability (Fiig, 2019); and dynamic offer generation which combines dynamic bundling with dynamic pricing to create individualized or point-in-time flight offers to consumers (Wang, 2020).

2.3 Analytical Framework of Thesis

The goal of this thesis is to explore the legal, regulatory, and commercial implications of recent developments in airline revenue management and distribution. As the above summary demonstrates, these developments are numerous. The thesis considers the implications for airlines, consumers, and regulators in three areas of important change: **fare distribution**, **collection and use of customer data**, and **bundling**.

These areas are explored because of their potential to significantly change the structure of the industry and because they have already generated research in the academic community. These are likely to be areas that draw the focus of regulators, consumers, and the airlines themselves and are worthy of deeper analysis. The analysis of each area began with a review of research in the area and the adoption of new technology or methods by airlines. Next, current and proposed changes were considered under the existing legal and regulatory landscape to determine what rules and laws might influence continued development in the area. Finally, the changes are considered in light of existing commercial practices and relationships in the industry.

The focus of chapter three is **fare distribution**. New Distribution Capability could eliminate the public filing of fares by individual airlines which will impact the entire distribution system and competition in the industry. Without publicly filed fares, airlines may have less insight into their competitor's pricing and consumers could end up with fewer insights into what options are available. Importantly, policymakers can play a significant role in determining what information will remain available to competitors and consumers.

The focus of chapter four is the **collection and use of customer data**. NDC allows, but does not require, airlines to collect significantly more information about passengers than they do today. This data can be used to improve forecasts, to segment passengers, or to personalize pricing. Much of the body of current research contemplates segmenting passengers (i.e., matching passengers to pre-defined segments and providing them offers based on that segment), and some research imagines personalized pricing (i.e., creating an offer specific to a passenger based on individual passengers and trip characteristics). This is also an area that has caused considerable consternation among policymakers and the public.[11] The storing, sharing, and use of this data will also continue to be a source of potential liability for airlines.

The focus of chapter five is **bundling**. The recombination of ancillaries and fares is more significant than their earlier separation. Consumers reacted negatively to ancillary charges - in particular, bag fees - and the DOT has created a regulatory structure that often assumes the separation of fares and ancillaries. Certain implementations of bundling could be seen as violations of competition law. Bundling may also extend and exacerbate some concerns of fare distribution and data collection, like how airlines will monitor competitor's offerings and how customer data is used to provide different customers different offers.

2.4 Summary

This chapter provides background on airline distribution and revenue management from the period following World War II to the present day. The remainder of the thesis considers more recent and expected new developments and how they will impact airlines, the public, and other interested stakeholders now and in the future. The review of history may be useful to those readers who are not well versed in distribution and revenue management and it is helpful to the remaining analysis in this thesis in three ways. First, airlines have faced similar legal challenges and political pressures throughout their history. While examining, for example, the antitrust issues of new fare distribution methods in Chapter 3, it is useful to understand past antitrust challenges the industry has faced. We can ask: Are the current challenges more like those faced by IBM when deploying the first computerized reservation systems (Mapstone, 1980) or more like those faced by ATPCO when it was sued by the Department of Justice in 1992 (*United States v. Airline Tariff Publishing Company, et. al,* 1992)? Second, we can identify the actual changes wrought by new developments and avoid

[11] Examples of the reaction from the public and lawmakers can be found in Section 4.1.

overselling recent changes. For example, recognizing that airlines have long had the ability to collect, through direct channels, the customer information that NDC will now allow them to collect, through indirect channels, helps to focus review of these changes. Discussion of how airlines will use their new abilities can be enriched by asking, what have and haven't they done with those abilities to the extent they already have them? Finally, the history demonstrates that the airline industry has both changed significantly and remained remarkably the same. Many modern innovations (e.g., Direct Connect) are reincarnations of past practices (e.g., initial agency connections to CRSs). Reviewing why the industry embraced or eliminated the past practice and considering structural changes of the industry in the interim provides a sound basis to infer what may happen with current developments.

Chapter 3

Impacts of Distribution on Data Availability and Information Flows

The development and changing nature of airline distribution have historically been drivers of changes in the structure of the entire industry. Today's largest distribution firms were created at times when the industry was undergoing change - like the creation of computerized reservation systems (e.g., Sabre) or the rise of Global Distribution Systems (e.g., Amadeus). New Distribution Capability has the potential to similarly change the distribution and airline industry. This chapter describes how NDC may impact the distribution industry and, in turn, how changes in the distribution industry will impact airlines. Section 3.1 opens with a discussion of the distribution industry and possible changes. Section 3.2 discusses how changes in distribution could impact what competitive information is available to airlines and alternatives to the current sources for this information. Section 3.3 concludes with a discussion of policy implications.

3.1 The Airline Distribution Industry

Assessing the impact of NDC on airline distribution depends substantially on an assessment of how the industry is going to implement NDC. A difference in expectations around adoption can lead to significantly different assessments of the impact of NDC on the industry. This is well-illustrated by Sabre's proposed acquisition of Farelogix in 2019.

Sabre is one of the major GDSs and provides numerous other airline IT solutions. Farelogix is a technology company providing several NDC-enabled distribution products to airlines. When reviewing the transaction, the U.S. District Court in Delaware felt obligated "to predict whether widespread adoption of NDC technology is going to lead to greater use of GDS bypass, essentially eliminating the role of Sabre's GDS, or whether it is more likely to foster the expansion of GDS passthrough, by which NDC allows for the creation, delivery, and servicing of richer airline content through GDSs, including Sabre." The court based its approval of the purchase on the *factual*[1] finding that NDC "will be used more for GDS passthrough than GDS bypass" (*United States v. Sabre Corp.* 2020). In a decision to block the same transaction, the UK's Competition and Markets Authority thought GDS bypass would be more significant - stating that the merger might "result in the GDSs charging higher prices than they otherwise would do to some airlines, due to a reduction in airlines' ability to redirect volumes away from the GDSs to Farelogix GDS bypass as an alternative channel" (*Anticipated acquisition by Sabre Corporation of Farelogix Inc. Final Report* 2020). The analyses diverged at the outset with different expectations regarding how NDC will impact GDS distribution and corresponding differences in opinion regarding the level of competition in airline distribution.

Understanding the implications of NDC adoption depends on understanding the range of potential implementations of NDC. These implementations may change the roles

[1] Factual in the legal sense meaning based on the evidence presented, the court decided the fact and used the fact in legal analysis.

and responsibilities of entities in the distribution process. Airlines will have significant control over which of these implementations occur (and multiple implementations are possible by different airlines), but certain implementations rely on other entities (like aggregators) expanding their technological capabilities. Global distribution systems, airlines, aggregators, and metasearch engines could all change their roles in distribution depending on how NDC is adopted.

3.1.1 Role of Global Distribution Systems in Future Distribution System

Though their high cost and lack of ancillary distribution capability inspired NDC, GDSs are likely to remain an important element in airline distribution. Airlines anticipated that bookings that relied on GDSs - travel agency and travel management company (TMC) bookings - would still represent 49% of overall bookings in 2021.[2] These bookings are also some of the most valuable. Bookings with TMCs and retail travel agents generate yields 16% and 4% higher, respectively, than bookings made directly on airline websites (Harteveldt, 2016). Given this importance, an NDC implementation will need to include or replace the important role of GDSs as facilitators of corporate and agency travel.

In their closing argument opposing the Farelogix purchase, the U.S. Department of Justice outlined three possible implementations of NDC (see Figure 3-1) and highlighted the role of GDSs in each implementation. The three implementations considered how three functions of GDSs might be accomplished after NDC adoption. The functions are offer creation,[3] aggregation,[4] and booking services.[5] The three implementations are **new communication standard only**, **pass through the GDSs**,

[2] Estimated in 2016 before the COVID-19 pandemic

[3] Offer creation is the combining of schedule, fare, and availability information to create a specific flight offer in response to a query.

[4] Aggregation is the combination of multiple offers from multiple airlines for sorting and selection by a customer.

[5] Booking service is making a reservation on a flight that has been offered for purchase.

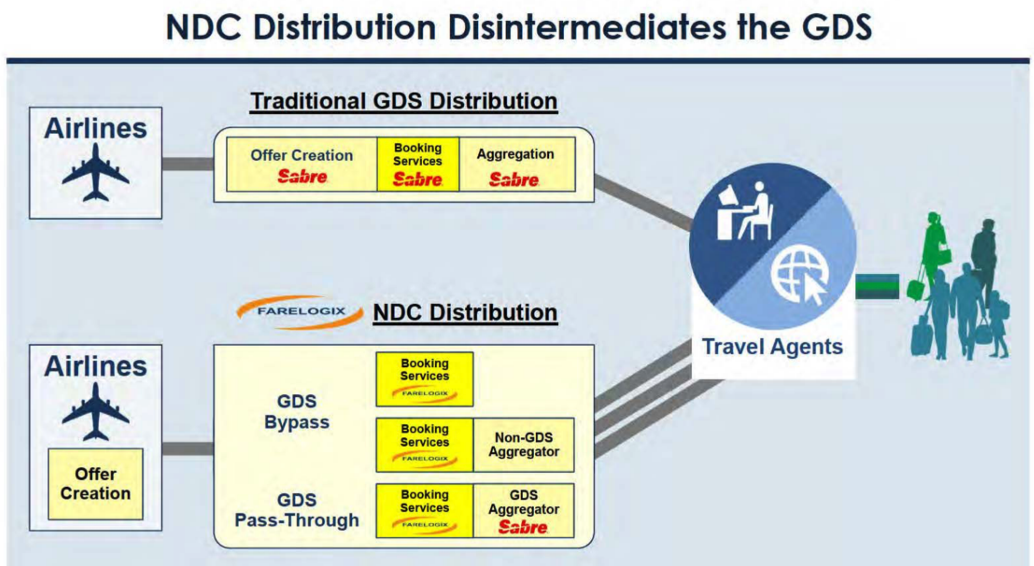

Figure 3-1: Traditional GDS Distribution v. NDC Distribution

and **bypass the GDSs**. These implementations and functions provide a helpful lens to consider the potential impact of NDC adoption on GDSs, aggregators, and airlines.

The first implementation is as a **new communication standard only**. In figure 3-1 this implementation mirrors the 'Traditional GDS Distribution'. NDC is a communication standard. The roles and responsibilities in the distribution system may stay the same as today with NDC only replacing EDIFACT as a standard for GDSs to request availability information from airlines. The offer creation, booking service, and aggregation functions remain with the GDS. It is unlikely that the entire industry would implement NDC in this way. Several airlines, like American and United, have already begun to invest in their offer creation capabilities with a desire to use them with corporate clients. Boutique airlines with limited ancillaries and few corporate bookings might implement NDC in this way.

The second implementation is to **bypass the GDSs**. As shown in figure 3-1, two implementations bypass GDSs with slight variations. In both cases, airlines have responsibility for offer creation. In the first implementation, booking services are provided by a third party (in the illustration, Farelogix) but there are no aggregation services. This might be the case for a franchised, branded travel agency. If the agency only sells tickets from one airline, they do not need to receive offers from multiple airlines. They can use NDC shopping requests to receive offers directly from the airline whose brand they share. In the second, booking services continue to be provided by a third party (again, Farelogix) and a separate third party provides aggregation services. In this scenario, each of the functions of the GDS (offer creation, booking services, and aggregation) have been separated and are performed by non-GDS entities. As of June 2021, this implementation is not widespread because of a lack of capability among aggregators, but it is a likely implementation in the future.

The third implementation is to **pass through the GDSs**. In this scenario, airlines create offers and the GDSs maintain their role as aggregators but a third party provides booking services. This scenario capitalizes on NDC's potential in offer creation while relying on the GDSs existing aggregation knowledge and relationships with agencies. This is the scenario which the U.S. court determined would be most prevalent.

As the three implementations illustrate, NDC could change little for a GDS or eliminate a GDS entirely from a distribution process. All three of these implementations may occur for some airlines, agencies, and GDSs. It is unlikely in the short term that the industry consolidates around any particular implementation.

3.1.2 Role of Aggregators, Metasearch Engines, and Online Travel Agencies in Future Distribution System

Though there is a range of functionalities and capabilities offered by aggregators, OTAs, and metasearch engines, as a whole, they accomplish the offer creation and aggregation functions of GDSs for individual consumers. Aggregators and metasearch engines could maintain this function in a **new communication standard only** implementation. They would replace the EDIFACT availability request with an NDC availability request during offer generation but would continue to direct customers to airline websites for the booking process. At least some aggregators and metasearch engines will implement NDC in this way. Implementing NDC as more than a communication standard can be a costly endeavor and aggregators don't always have independent methods of generating revenue - these aggregators may not be able to make the investment necessary to add booking service functionality to their platforms.

Many aggregators and metasearch engines are likely to expand their booking service functionality. Today's aggregators and metasearch engines are among the most likely candidates to create the 'non-GDS aggregator' services necessary in the **bypass the GDSs** implementation. Different aggregators will face different challenges in making the conversion, but given the range of players today there is the potential for a wide variety of aggregation services. Existing aggregators like Google Flights could expand their functionality to include corporate travel policy management services. Corporate travel technology providers, like Concur/SAP, could also expand into the booking process itself. There are already technology intermediaries creating tools to allow companies to quickly and easily add booking functionality. For example, Duffel offers a tool that allows for direct booking with 21 different airlines. The service does not require the user to contract directly with airlines and instead lets virtually anyone sign-up for the service and search and make bookings with its airline partners.

If existing firms could expand their functionality, they could create a competitive market for aggregation services that benefits consumers. Some aggregators might focus on corporate clients. Others might focus on privacy-conscious consumers or consumers redeeming credit card points. While there is variation between aggregators today, this variation could increase and provide more diversity of services better aligned with the variations in customer preferences.

There may be conflicts as the industry adopts new distribution practices that inhibit the ability of aggregators, OTAs, and metasearch engines from expanding their current role. In early 2021, JetBlue pulled all of its content from Fareportal and other OTAs. Fareportal subsequently sued JetBlue raising breach of contract and antitrust claims. The litigation illustrates both the power that airlines continue to have to control what content is available on third-party sites and the conflicts that may arise as incumbent firms shift their distribution methods and strategies. If the case, which remains in the early stages of litigation as of mid-2021, is ultimately decided on the antitrust claims it could either limit the power of airlines to control where their content is available or affirm their exclusive ability to determine their distribution methods.[6] If the latter occurs, it will be difficult for OTAs, aggregators, or metasearch engines to assume the role of 'non-GDS aggregators' without support from airlines.

Aggregators and metasearch engines have the potential to replace many GDS functions, but they will need to improve their functionality significantly to do so. They may face obstacles as the industry adopts new distribution practices and could require airline support for any change in their role. If they do replace GDSs, they may be able to provide consumers higher quality flight search functionality with greater variation in product offerings than the GDS oligopoly of today.

3.1.3 Role of Airlines in Future Distribution System

Airlines may also change their role in the distribution process upon the adoption of NDC. Airlines have significant flexibility to decide which, if any, of the GDS functions to control. As with other distribution entities, airlines could adopt NDC as a communication standard only and undertake distribution like today without any changes other than replacing EDIFACT messages with NDC messages. However, the inspiration for NDC was to give airlines more control over offer creation and it is likely that many airlines will at least be engaged in some offer creation.

Airlines could also control all offer creation across distribution channels. In this

[6] *Fareportal Holdings Inc. et al v. JetBlue Airways Corporation*, Docket No. 1:21-cv-00061 (E.D.N.Y. Jan 05, 2021), Court Docket

scenario, airlines might no longer need to publish fare and schedule information. Instead, any query, regardless of the source, would be sent to the airline to provide information on price, schedule, and availability. An aggregator's role would be to collect information from a consumer, create a query, and send the query to multiple airlines who each respond with offers. In the short term, this implementation might not be possible given the need for a fast response time and the large volume of queries it would generate. However, speed and volume processing challenges may be addressed through technological improvement in the medium term.

At the other extreme, airlines might not control any of the offer creation process. This implementation is somewhat unlikely given the trends towards airline control, but it could be part of a business model of fully outsourced distribution. The airline would run their passenger service system (i.e., reservation and inventory control system) and a revenue management system and all distribution functions would be undertaken by third parties. While it is unlikely that an existing airline would shift to this system, this distribution method might be useful for the integration of new technologies like urban air mobility into the airline distribution and booking process.[7]

Airlines could control the entire aggregation process. In addition to creating their own offers, airlines would aggregate offers of other airlines. This implementation is unlikely as it replicates the distribution landscape when airlines first developed CRSs and owned GDSs. Airlines have already once moved away from such a system. Regulators were concerned with the competitive implications of distributing the products of a competitor and the system was highly regulated as a result (14 C.F.R. §255 before the regulation was repealed). Between the high cost of creating and maintaining the systems and the lack of synergy with operating the airline, airlines preferred utilizing third parties for aggregation (at least to some extent).

Airlines could exit the aggregation function entirely and perform only booking services. If aggregation services improve significantly, airlines may find little reason to

[7]This is, in fact, similar to the operation of Uber and Lyft today. Where Uber and Lyft control pricing and distribution, drivers control their individual operation.

provide aggregation for their even own offers. An industry aggregator will normally have more advantageous economies of scale than an individual airline. Aggregators could create functionality that can't be matched by airlines. Even today, few airlines show all possible offers to consumers booking with miles/points. The use of miles on partner carriers in particular often requires calling a reservation office. An aggregator could focus on mileage/point redemption and provide broad results that include credit card point redemption and partner redemption that would be difficult for an individual airline to match.

Airlines may also change their responsibilities in the booking function. Removing themselves entirely from the booking process might occur in the fully outsourced distribution model, but otherwise, it makes little sense for an airline to provide offers to consumers but not the ability to book them. Total control of the booking function is also unlikely. Widespread distribution of fares has been beneficial to airlines. 43% of leisure passengers and 51% of business passengers already think they spend too much time researching and booking flights (Harteveldt, 2016). Requiring potential customers to visit an airline site for booking could be a significant disadvantage if other airlines allow booking directly through aggregators.

This section outlined possible implementations of NDC and the various roles and responsibilities that GDSs, aggregators, and airlines might assume after the adoption of NDC. The distribution of responsibility will depend on the value of these services to each airline. Some airlines will value the revenue-generating potential of dynamic offer generation and move to control the offer generation process. Others may have simple ancillary products and fare pricing and leave all of these GDSs functions with a GDS or other third-party. At the industry level, airlines will likely assume some offer creation responsibilities and aggregators and metasearch engines may expand into the aggregation function. GDSs probably will continue to offer competing aggregation services and possibly continue to offer some booking services. None of the implementations discussed are mutually exclusive at the industry level and over time it is likely that some airlines, aggregators, and GDSs could implement NDC in each of the ways outlined.

3.2 Information Flow and Availability

As offer creation, aggregation, and booking service responsibilities shift, so will the flow of information between entities in the distribution system. If aggregators like the mileage/point redemption-focused example come to exist, airlines will have started to include redemption information in their offers. Today, this information might be published as an award chart but otherwise is not shared in the distribution system. Though all the implementations will change information flows to some degree, total airline control over the offer creation process has the potential to significantly change information availability in the industry.

3.2.1 The End of Public Fare Filing

Fare filing through the Airline Tariff Publishing Company (ATPCO) and schedule publishing through OAG have long been essential elements in the offer creation process by GDSs and aggregators. These entities use public fare and schedule information from airlines to determine which itineraries might satisfy a particular consumer's flight request. They then query airlines for availability on these itineraries. As airlines take responsibility for offer creation, aggregators and GDSs might shift to query building. Rather than identify particular itineraries, a more general query would be sent to airlines and they would identify available itineraries that satisfy the query and provide the schedule and fare information. If an airline controls the offer creation for all distribution of its tickets, offer creation and distribution will no longer require the public filing of fares and schedules that it does today.

Total control over offer creation may seem attractive to airlines when implementing NDC. Airlines will always have an information advantage over third parties with respect to their own products. The rich information airlines have on their schedules, airports, aircraft, and operational plans can be utilized as a part of the flight search function (for example allowing customers to search for a certain type of business class seat or a plane equipped with satellite Wi-Fi). NDC will allow airlines to communicate this information *after* an itinerary has been identified by a GDS or aggregator, but there may be revenue advantages to providing it at the search stage. To capitalize on that potential advantage, airlines would either need to distribute this information in the same way they do fares and schedules so that GDSs or aggregators can incorporate them into their offers or control the offer creation process themselves.

NDC will also allow airlines to include ancillary services in offers (see chapter 5 for further discussion on ancillaries and bundling). Airlines that adopt dynamic bundling or dynamic offer generation might take full responsibility for offer creation. Once airlines are creating dynamic offers, the fare identification process in offer creation is no longer relevant. Instead, the offer creation process consists of itinerary identification and the dynamic offer. In this case, whether airlines or third parties control the itinerary identification process may depend on the dynamic offer algorithms. It may be more computationally advantageous to create dynamic offers for a given set of itineraries (leaving itinerary identification to third parties) or a simultaneous itinerary identification and offer creation might be preferred.

3.2.2 The Potential of NDC to Create Alternatives to Public Filing that are Less Restrictive of Trade

Though presented as a possibility in the prior section, current antitrust law in the United States could force the elimination of public fare and schedule filing under certain circumstances. When commercial actions have both a pro-competitive and anti-competitive result, courts will create "a hypothesized alternative and ask whether the alternative action is less harmful" in order to determine whether the commercial action is itself a violation of antitrust law (Hemphill, 2016). Publicly sharing fare and schedule information benefits competition and consumers today because it facilitates widespread distribution and is utilized to provide comparison shopping to consumers, but public fare filing and schedule publishing can have anti-competitive harms.

In 1992, the Department of Justice sued eight airlines and ATPCO for violations of antitrust law. The DOJ alleged that the airlines utilized first and last ticket dates, fare codes, and footnote designators within the ATPCO fare dissemination system to coordinate and negotiate fare increases, changes in fare restrictions, and elimination of discounts (*United States v. Airline Tariff Publishing Company, et. al,* 1992). In their settlement with the government, the airlines and ATPCO mostly eliminated first and last ticket dates, fare codes, and footnote designators. In the competitive analysis, the government differentiated between conduct that had some pro-competitive justification (like last ticket dates used to warn passengers when prices may increase) and conduct that only facilitated coordination and prohibited the latter.

If airlines are responsible for most offer creation, the pro-competitive benefits of schedule and fare sharing decline relative to the anti-competitive harms. Airlines can only match fares and schedules when they have this information from their competitors. Providing this information without a pro-competitive justification is likely illegal due to the potential use of the information for price or schedule matching. Schedule sharing still retains some value (like coordinating gate use and runway capacity at airports), but providing the information only to certain parties rather than publicly is a less restrictive alternative that achieves the same benefit. Codeshare or joint venture arrangements, which provide pro-competitive value by offering consumers itineraries that might not otherwise be available, may require sharing of fare information. This too can be accomplished with a much narrower information-sharing arrangement than publicly filing fares. Given the intricacies of the airline industry, public fare filing and schedule publishing may have other benefits. Still, it is important that airlines and the industry are conscious of when NDC makes information sharing optional rather than necessary because it may inadvertently cause the end of that information sharing.

3.2.3 Possible Sources of Fare and Schedule Information

The loss of competitive information described in the prior section could be a significant blow to airlines that have come to rely on such information to inform their strategic decisions. Any concerns regarding the adoption of NDC and its eventual impact on information availability in the industry may be ameliorated if the information is available or could be available from other sources.

A potential source of this information is indirectly from the airlines. Just as a shopkeeper might occasionally browse a competing shop to determine its prices and product offerings, an airline might occasionally look to see what competing airlines are selling. Manually 'looking' is probably impractical but airlines or data providers could scrape airline websites for this information. Unfortunately, airlines may have raised their own barriers to website scraping through website terms of use and associated litigation. Most airline websites limit their access and use. Delta Air Lines limits their website access and use to "personal use for non-commercial purposes, or ... use in the scope of your employment . . . in purchasing services or products from Delta" (Delta Air Lines, n.d.). Using a web crawler or scraping the site would not comply with these terms.

Airlines have expended resources and energy to enforce these terms. In 2017, Southwest Airlines sued a company that had been scraping its website to alert Southwest customers if their flight price had declined so that they could use the airlines' generous refundability policies and receive a refund (*Southwest Airlines Co. v. Roundpipe LLC et al* 2018). Removing the terms or failing to enforce them against competing airlines to allow for mutual web scraping would be legally equivalent to providing the information directly to other airlines. Website scraping is unlikely to be a viable method to obtain this information.

The government already collects significant information on airline fares and traffic information. Recently proposed changes to the Department of Transportation's O&D

Survey and Form 41 will make the data more accurate (by increasing the O&D survey sample size to 40%) and make the data more recent (by increasing Form 41 reporting from quarterly to monthly).[8] Retrospective fare and schedule data do not raise the same anti-competitive concerns as prospective data because matching old schedules and fares does not decrease current competition. If public fare and schedule filing were eliminated, the government could further increase and improve these data collection efforts.

3.3 Policy Implications

This chapter outlined possible changes in the roles and responsibilities of airlines, aggregators, metasearch engines, and GDSs in the distribution process. Several potential arrangements are discussed and while some seem likely based on today's context, it is difficult to predict which will be most advantageous to consumers and airlines in the long run. Still, the discussion identified an opportunity and a potential concern in airline distribution arising from the adoption of NDC.

The opportunity is to cultivate a competitive aggregator industry. Airlines are highly likely to provide some offer creation services which will create a new market for aggregation services. There is significant potential for aggregators to provide a greater variety of search functionality to consumers than is available today. Better aggregation and search functionality might increase passenger volumes, but at the very least will reduce the transaction costs and frustration of passengers who already believe they have to visit too many websites to book flights. A barrier to this increased competition is the lack of funding mechanisms for these entities. Airlines could pay GDS-like fees, but given airlines' current frustration with these fees this could recreate an existing issue. However, if aggregators can create technology that far exceeds what an airline can develop themselves such a fee might be appropriate. The government

[8] See DOT Docket No. DOT-OST-2018-0132

could also create a funding mechanism. One option is to use existing flight taxes and fees to fund the "shared infrastructure" of a virtual ticket marketplace. Another option is to give aggregators a statutory or regulatory ownership interest in the data they collect from passengers during the distribution process. Aggregators could then monetize the data to fund their operations.

The concern is the potential of NDC adoption to eliminate publicly filed fares and schedules. To address the possibility that this information becomes unavailable, the government could increase its data collection efforts. Such an improvement could increase data access for researchers, small airlines, and airports. It could increase competition by making data available that, though publicly filed, is often only accessible to the public through paid services. Replacing future information with historical data reduces the potential for price coordination but gives airlines the information they need to make important strategic decisions.

While greater government data collection may solve the access to information issue, airlines should still be cognizant of how NDC adoption changes information-sharing requirements. Should the government determine that information sharing is anti-competitive, it can be difficult to share that information even if the anti-competitive concerns subside. It may be beneficial to airlines to ensure that NDC adoption does not eliminate the need to publicly file fares and schedules or that the implementation continues to include publicly filed fares and schedules.

Chapter 4

Collection, Storage, and Use of Personal Information by Airlines

4.1 Introduction

The prospect of airlines collecting and utilizing increasingly detailed passenger data has animated significant discussion around the adoption of New Distribution Capability (NDC) and modern developments in revenue management. When IATA Resolution 787 - the resolution creating the NDC working group and development process - was considered by the U.S. Department of Transportation, the approval explicitly excluded "any agreement among IATA member airlines to require the disclosure by any passenger of personal information of any kind" (U.S. Department of Transportation, 2014). This was in response to many comments from individuals and organizations espousing views like: "I believe this resolution eliminates comparison shopping and purchase by anyone on a non-discriminatory basis, I am concerned that planned airline 'profiling' could disadvantage the consumer resulting in differential pricing" (Peters, 2013). Even after approval of the resolution, lawmakers continued to voice concerns. In 2018, then-Senate Minority Leader Chuck Schumer sent a letter to the Federal Trade Commission requesting an investigation into the use of personalized pricing by airlines (Schultz, 2018). These concerns are likely amplified by beliefs that airlines *already* personalize and dynamically adjust prices based on, for example, browser history (Hunter, 2020), type of browser (Polat, 2016), or repeated searches (Wey, n.d.). There is some truth in these beliefs: Orbitz has admitted to steering Mac users to pricier hotels (Mattioli, 2012) and Delta Air Lines has displayed higher prices to customers logged into their frequent flyer accounts (Collin, 2012).[1] Though there are some customer-based variations used widely in the industry (e.g., point-of-sale price variation), the majority of price variation is time- or demand-based.

Despite the DOT order, there does not appear to be any legal impediment to an individual airline implementing NDC without an option for anonymous shopping.[2] The approval of the show cause order only precludes "an agreement among IATA member airlines to require disclosure of . . . personal information." NDC gives airlines the ability to collect more detailed passenger information, but NDC is a communication standard and only provides a format to request and receive customer data. Individual airlines will determine which of the potential data types they will accept or require in shopping requests and other NDC messages. An airline could require a significant amount of customer information before providing any flight or fare information. At the same time, an airline could use NDC and request and accept the exact same information as today.

The likely implementation is somewhere between those extremes. Airlines may require some information that is not required today, like the desired number of checked bags, without demanding personal information from customers. Given the potential benefits of generating personalized offers and providing personalized services, airlines are likely to at least *allow* more information to be communicated. Whether the in-

[1] Delta attributed this to a system error rather than a deliberate pricing strategy.

[2] The DOT certainly has the authority to undertake a rulemaking that obligates airlines to provide anonymous shopping. Since the department has already revealed their preference for anonymous shopping, it remains likely that they would undertake a rulemaking if airlines adopt NDC without providing the ability to shop anonymously. Still, airlines could implement NDC without providing anonymous shopping in a way that is beneficial to consumers. If they do so, the department may not see a need for rulemaking.

formation is given voluntarily when permitted or required, it will raise many of the same data privacy and protection issues. As the purpose of NDC is to develop a more robust communication standard, it seems unlikely that it would be implemented without at least some airlines utilizing it to request and require more information from passengers.

This chapter explores the implications of increased data collection and use. Section 4.2 explores data collection with a focus on the storage and collection of data in light of recent data privacy and protection laws. Section 4.3 considers the use of data for customized pricing. Section 4.4 discusses policy and Section 4.5 summarizes.

4.2 Data Collection and Storage

Data collection and storage have been a persistent liability and legal concern for airlines who face numerous challenges regarding data. First, airlines must decide what information to collect and can face public scrutiny regarding those decisions. For example, airlines have faced consumer backlash regarding the collection of biometric data - even when required by governments (Hongo, 2019). Second, airlines must ensure collected data is properly used and securely stored. Cathay Pacific (Bloomberg, 2018) and Sabre (Ting, 2017) have recently suffered data breaches and in July 2019, the UK's Information Commissioner fined British Airways £183m, the largest privacy fine ever, for a data breach (UK Information Commissioner, 2019). Finally, airlines must decide how to share information with other parties (e.g., partner airlines and technology providers) and manage the data security risks that accompany that sharing. Delta Air Lines recently faced a class-action lawsuit after hackers accessed data the airline had shared with a third-party chat provider on their website (Zara, 2018).

As airlines deal with new types and greater volumes of customer information, they are also faced with new data privacy and data protection laws. In Europe, the General Data Protection Regulation ("GDPR") was passed by the European Parliament in

2016 and took effect in May 2018. In the United States, there is no national data privacy or data protection law, but the state of California passed the California Consumer Privacy Act ("CCPA") in 2018 and it became effective in 2020.[3] Both laws apply to the data of citizens or residents of the respective jurisdictions. Few, if any, airlines serve only California and/or European Union residents so these laws usually apply to only a subset of a carrier's passengers. Airlines could conceivably develop parallel systems which are GDPR/CCPA -compliant or non-compliant, but it is unlikely that the benefits are worth the additional cost and complexity of managing parallel booking systems and customer databases. It is more likely that carriers that have any obligations under these laws will ensure their entire system is compliant.

As of May 2019, 40% of the world's airlines served either California or the EU.[4] Airlines that operate to these jurisdictions are practically guaranteed to have some passengers whose data must be handled according to these laws. Some airlines, like China Southern, operate a small share of their total seats (1%), in these jurisdictions, but must follow the laws whenever EU- or California-based passenger data is collected. Similarly, some carriers, like GOL, don't operate to either jurisdiction but since they sell codeshare tickets of partners that operate to the jurisdictions they're also likely to collect some customer data that is subject to the laws. While only 40% of airlines operate to California or the EU, these airlines operate 77% of global flights and 80% of global seats (see Figure 4-1). A significant majority of seats and selling transactions are potentially subject to one or both of these privacy laws and the majority of customer data collection and storage efforts are likely to be compliant with one or both of the laws.

The remainder of this section outlines the changes to data collection that NDC could introduce to the distribution process and then explores what issues these changes might raise under the General Data Protection Regulation and the California Con-

[3]Virginia was the second state to adopt a comprehensive data privacy law in March 2021 and other states could easily follow suit.

[4]EU is used as a shorthand for countries subject to the GDPR. This includes all EU members plus Iceland and Norway.

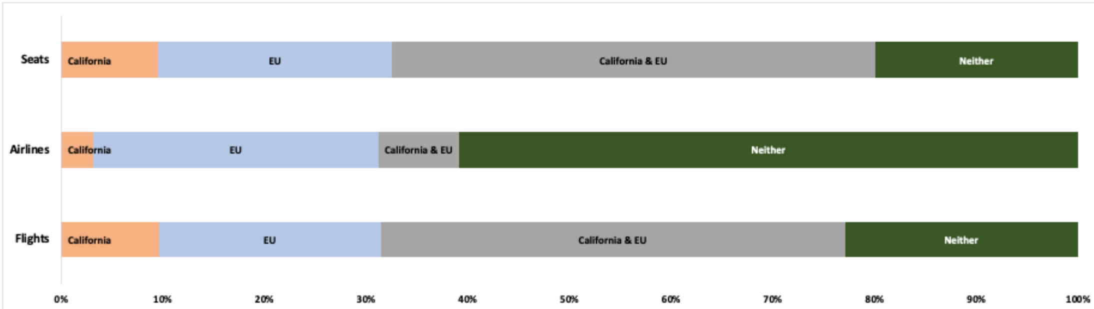

Figure 4-1: May 2019 Share of Worldwide Airlines, Seats, and Flights Potentially Subject to GDPR or CCPA

sumer Privacy Act.

4.2.1 NDC-enabled Changes in Data Collection

With NDC, the flight search or "shopping" phase of the booking process is likely to become a more significant point of customer data collection. Today, airlines mostly collect identifiable information from passengers as part of the purchase and booking process after a flight has been selected. The flight selection process, on the other hand, does not include the collection of customer data. Prospective passengers usually search for flights providing information on the origin, destination, dates, desired cabin, and the number of passengers (see Figure 4-2). The entity performing the search utilizes the input along with airline-published schedules and fares to determine which itineraries best satisfy the customer's inquiry. Once itineraries are identified, EDIFACT transmissions are used to query the airline for the availability of the particular itinerary and fare. These availability queries are the only information that is transmitted during the search process. The queries contain itinerary information only and contain no customer data. They are so general and non-customer-specific that search engines like Google flights have used cached queries (i.e., recent results from similar searches by other customers) to provide customers more extensive, albeit less current, search results (de Marcken, 2003).

NDC adoption will allow detailed customer information to be communicated along-

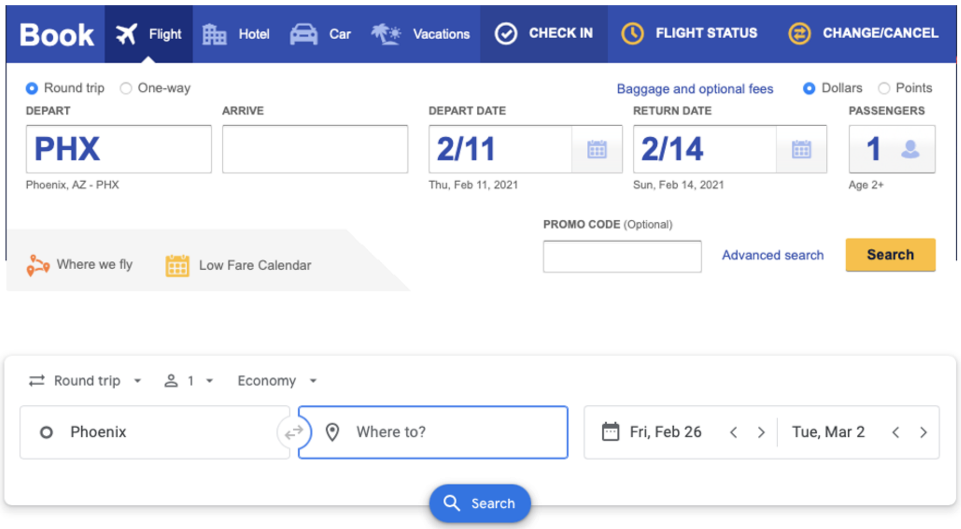

Figure 4-2: Southwest Airlines (Top) and Google Flights (Bottom) Search Boxes

side itinerary information during the "shopping" phase. The latest NDC schema includes more than 50 message types and a 100-page code set directory. Among these is the “AirShopping” request which allows customers to communicate, among other information, a trip purpose and a budget amount with a flight request. The NDC standard, by design, is extensive and airlines will determine what information to accept and require when they implement the standard. While it is unclear whether airlines will solicit more information from passengers at the shopping stage, they will certainly have the ability to do so.

Airlines have some limited experience with customer data during the shopping phase. They occasionally receive or have access to passenger information during the shopping phase (e.g., when a customer is logged into their frequent flyer profile and searching on an airline’s website) and will occasionally use that information to determine search results (e.g., a customer eligible for a corporate discount logged into their associated frequent flyer account). If airlines were to require customer information in NDC shopping requests, it would be a significant change from a data privacy and protection perspective. Notably, airlines would be collecting (and likely storing) the data of non-customers (those that search but do not purchase tickets), and indirect channel distribution would necessarily require the transmission of customer data at the shopping stage in addition to the booking stage. These changes have the potential to raise new issues for the airline industry under the GDPR and CCPA.

4.2.2 General Data Privacy Regulation

Since the GDPR became effective, airlines and other businesses have invested significant resources in ensuring compliance with the law. Two potential changes may raise issues that implicate the GDPR. The first change is that airlines may collect and process the data of non-customers. The specificity of this data will depend on what airlines decide to collect in a shopping request, but unlike the current distribution system airlines could receive personal data from every prospective customer that performs a search that the airline responds to. Under the GDPR, the processing of data must have a legal justification (as described in the law). In many cases, the justification is the consent of the individual. Lufthansa uses consent to justify processing data in order to send "specific information and offers" and "personalise the use of the website" (Lufthansa, n.d.). Consent is likely to be used as a justification for processing data to customize pricing, but this requires airlines to track and maintain records of customer consent. Airlines will need to develop systems to manage consent for both regular customers who may have accounts with the airline and large numbers of infrequent customers (who may not have accounts) as well as those who search for flights but never become customers.

The second change is that the indirect channel may transmit customer data at the shopping stage. For travel agents, this will simply add to the existing data transmission stage in the booking process. For aggregators and other types of search engines, this could introduce customer data transmission for the first time. Google flights, for example, currently provides a search function and then transfer customers to an airline's website for booking. Google does not transfer any personal data of the customer. However, if personal data is required by an airline in their NDC shopping request, Google would need to transmit that personal data to airlines to provide any search results at all. Data transfers are restricted to countries outside the EU unless the European Commission has determined that the laws of the country the data will be transferred to ensure adequate protection of the data. Absent such a determination, data can be transferred so long as the organizations transferring data have agreed to provide adequate safeguards which ensure a GDPR-level of data protection for the transferred data. Consumer-facing indirect distributors of airline tickets may be required to police the data protection and data security efforts of airlines.

4.2.3 California Consumer Privacy Act

The two changes which implicate the GDPR also implicate the CCPA. In particular, the transmission of data between travel agents and airlines may cause issues under the CCPA. The CCPA distinguishes between a business that "collects consumers' personal information, or on the behalf of which such information is collected and that . . . determines the purposes and means of the processing of consumers' personal information" and a third party that is neither a "business that collects personal information" nor "a person to whom the business discloses a consumer's personal information for a business purpose." The act also defines a service provider as an entity that "processes information on behalf of a business and to which the business discloses a consumer's personal information for a business purpose."

NDC has the potential to provide travel agents with more information about their clients that they may not have now. If an agent books meals, checked baggage, and purchases Wi-Fi for a client, they have information that formerly was only available to the airline. A travel agent may want to use such information to improve the marketing of their own services or to maximize the commissions that they receive from an airline. Under CCPA, the airline will qualify as a business (just as they would if they were collecting the information directly) since the travel agent is collecting the information "on behalf" of the airline. The airline may also be a service provider since the travel agent “disclose[d] a consumer’s personal information” to the airline to perform an operation on that information (i.e., process). This leads to a possibly bizarre result - if a consumer requested that the travel agent delete the consumer’s personal information, the agent would have to “direct” the airline “to delete the consumer’s personal information from their records.”

This may be precisely the purpose of the CCPA - to allow a consumer to cause their information to be deleted at the same place it was collected, but airlines might perceive this as their information and that travel agencies collect the information on their behalf in the first instance. Since CCPA is construed such that it “afford[s] the greatest protection for the right of privacy of consumers,” an airline might be obligated to delete such information. As airlines allow other entities to collect information on their behalf (as is necessary for those other entities to sell the airlines’ services), they may be able to contractually establish themselves as the only entity with the power to determine the purpose and means of processing. At a minimum, this would ensure that these other entities are not considered controllers or businesses under the two laws. It also likely prevents an airline from being considered a "processor" or "service provider" with respect to the other entities.

Federal Preemption of State Privacy Laws in the United States

In the United States, regulation of airlines is primarily the purview of the federal government. The Airline Deregulation Act (‘ADA’) prohibits states from "enact[ing] or enforc[ing] a law, regulation, or other provision having the force and effect of law related to a price, route, or service of an air carrier" (49 U.S.C §41713). The California Consumer Privacy Act, a state law, is potentially preempted and inapplicable to airlines. Preemption could exempt airlines from these laws and future laws by other states.

In 2013, now-Vice President Kamala Harris sued Delta Air Lines for failing to provide a privacy policy in their mobile app in violation of California’s Online Privacy

Protection Act of 2003. A 2014 trial court decision and a 2016 appeals court decision in California state court determined that the law was expressly preempted by the ADA and dismissed the case against Delta. More recently, Delta Air Lines defeated breach of contract and unjust enrichment claims by a passenger arising from a data breach. A federal district court and the 9th Circuit court of appeals determined these claims were also preempted by the ADA. Both cases suggest that privacy-related laws sufficiently implicate airline "services" to be preempted by the Airline Deregulation Act.

On the other hand, in a 2018 lawsuit by a passenger against Volaris for recording customer calls without notice to the customer, a federal court in California determined that the California law banning recording without consent was not preempted and applied to airlines. A few years earlier, blind passengers sued United Airlines for failing to provide accessible check-in kiosks and the 9th Circuit Court of Appeals found that California's anti-discrimination laws were also not preempted. These disparate results regarding preemption of state law are the result of ambiguity in what constitutes a "service" and judicial determinations of when a state law impacts an airline's provision of services.

The question of preemption is further complicated by changes in the industry. Airlines have increasingly used customer data in ways that are less connected to the provision of flights - like credit card and hotel marketing. Not only have airlines moved into non-flight services, but non-airlines have begun to move into the provision of flights. Though all Amazon Air flights are currently operated by other carriers, Amazon could conceivably operate flights themselves in the future. The operation of flights by a company whose primary business is not air transportation could absolve the business of legal duties via preemption. Until a court addresses the specific question of CCPA preemption, airlines will have to determine for themselves whether or not they believe the law is applicable and whether or not to follow it.

Several airlines have taken actions that suggest they believe the CCPA is applicable or at least they've decided the risk of penalty exceeds the benefits of remaining non-compliant and testing the question of preemption. Frontier Airlines "has adopted [a] California Privacy Policy to comply with the California Consumer Privacy Act of 2018" and publishes the policy on their website (*Privacy Policy for California Residents* n.d.). Integris, a data privacy company that is now part of OneTrust, reported assisting a major U.S. airline in reviewing its data practices in terms of CCPA compliance (Waddell, 2020).

At the industry level, apart from the airlines, the CCPA would almost certainly be applicable. Travel agents, OTAs, technology providers, and other entities engaged in the distribution process but who do not operate flights do not benefit from ADA preemption. These companies must collect, store, transmit, and use data in compliance with the CCPA.

4.3 Utilizing Customer Data

Airlines have long practiced differential pricing or "price discrimination" where different customers pay different prices for the same product. With better customer data, airlines will have the ability to engage in increasingly customized pricing. This ability exists on a spectrum. At one end of this spectrum is **fixed pricing** in which every passenger pays the same price. At the other end of the spectrum is **personalized pricing** where every passenger pays a unique price based on characteristics specific to that individual, for example, their employer. In between, is **segmented pricing** where customers are sorted into segments and each segment pays a different price. Segmenting can be accomplished via self-sorting as airlines have done for decades with restricted fare structures or airlines can sort customers on their own using customer or itinerary characteristics. Segmenting can be done with limited or no customer-specific data (as it is often done today) or it can be done with the same detailed customer data that would be necessary for personalized pricing.

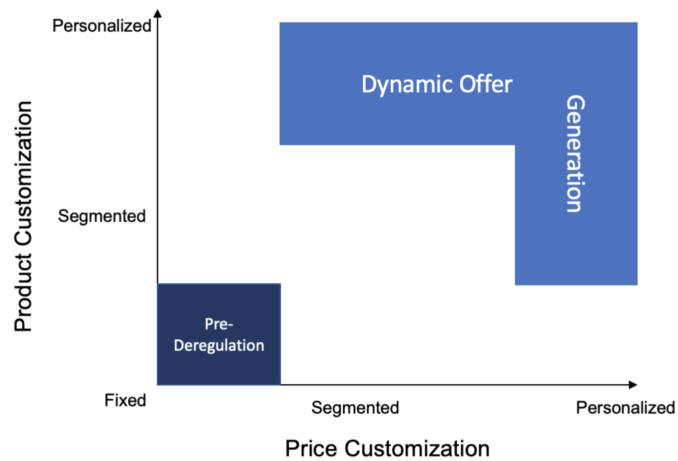

Figure 4-3: Product and Price Customization Matrix - Dynamic Offer Generation and Pre-Deregulation

In addition to varying price, airlines can also vary product offerings. The spectrum is the same. Together, these form a customization matrix (see Figure 4-3 with dynamic offer generation and pre-deregulation systems as examples on the matrix). Improved data collection facilitated by NDC will allow airlines to move towards customization. Airlines could also move towards customization by improving their analysis and processing of existing data. These two methods of increasing customization are often conflated and it is helpful to remember that customization could increase without the adoption of NDC. The remainder of this section considers the benefits of customization (whether they come from improved data or improved models) and issues that may arise as airlines adopt more customized offerings. The focus of this section is exclusively on price. Product customization is addressed in Chapter 5.

4.3.1 Benefits of Customization

The extent to which airlines will utilize customer data for customization will depend on the revenue gains that they expect to receive from segmentation and personalization, the legal and regulatory barriers to data use, and consumer reactions. The existing discourse that airlines will collect significant customer data assumes that segmentation and, in particular, personalization represent a significant revenue generation opportunity for airlines. Recent research on its potential benefits is more mixed suggesting that personalization might occur slowly or even not at all.

Wang (2020) proposed a formulation for dynamic offer generation ('DOG') and tested it in the Passenger Origin-Destination Simulator ('PODS') to investigate its potential revenue benefits. Wang did not propose a customer segmentation method but instead noted that "a separate customer segmentation model would have to be trained." Since the testing occurred in a simulated environment, Wang was able to perform sensitivity analyses to determine how segmentation accuracy impacted the performance of DOG adoption. In a "realistic market environment," DOG increased revenues up to 1.7% when airlines could segment business and leisure passengers with 100% accuracy. At 50% accuracy, the airline still increased revenue by 1.2%. The majority of the revenue gain did not require particularly high accuracy.

However, the implementation in Wang bound DOG prices to existing fares and the realistic environment utilized the smallest bounding range. The tests with a larger bounding range showed a stronger connection between accuracy and revenue gains and required at least 60% accuracy to achieve any revenue gain at all – 50% accuracy led to a decline in revenue of 0.6% and 100% accuracy increased revenues by 5.1%. The results in Wang suggest that high accuracy is necessary when a DOG implementation is given significant leeway to create or modify prices, but that accuracy is less important when the algorithms are only permitted to make smaller changes. Airlines could potentially move towards letting such algorithms set prices in the future and these tests in Wang (2020) suggest that highly accurate algorithms could lead to significant revenue gains. However, because the revenue benefit is closely tied to accuracy, it seems unlikely that airlines will embrace them in the short term.

Considering the larger shifts in airline retailing, McKinsey & Company (2019) estimated $93 B in annual value captured by airlines by 2030 with the adoption of new retailing technologies and strategies. Several of the identified sources of value require some form of customer segmentation. “New revenue management solutions built on booking request context, microsegments, and demand drivers” and “Total revenue management optimization . . . across a dynamic offer” are expected to create $11.1 B in annual value. “Stimulat[ing] new demand through new content [and] more relevant offers” is estimated to create $2.3 B in annual value. $13.4 B is not insignificant, but it represents only 15% of the total value of new retailing opportunities. However, the implementation outlined by McKinsey imagines different technological shifts unlocking multiple sources of value creation. Even though the drivers which require customer segmentation may be a small portion of the value, once the technological shift is made (i.e., “Large airlines emerge into travel platforms”) the customer segmentation becomes a marginal cost resulting in significant annual value.

Utilizing customer data for customer segmentation and personalized offers is only one possible use of customer data. Improved customer information and information on search volumes and conversion rates could also be used to improve other elements of revenue management systems like demand forecasting. Papen (2020) notes that forecast errors of 25% in each fare class are not uncommon in reality and result “in an expected revenue decrease of 1-2%”. Not only can customization be increased without additional data collection, but increased data collection may occur without any increase in customization.

Beyond revenue benefits to airlines, customization has the potential to improve the customer experience. From a customer service perspective, airlines could use customer data to customize the shopping process or in service delivery. Elderly customers might receive offers customized to prioritize hubs where flight connections require less walking or business travelers might receive customized offers that prioritize aircraft with faster internet connections. In the long run, increased data collection may allow airlines to better understand customer preference and modify their product offering (e.g., aircraft layouts, flight schedules, meal offerings) to better serve customers.

4.3.2 Customization Issues

Customization has the potential to increase airline revenues and improve offerings to customers. Enhancing customization may also cause issues for airlines. This section explores some of those issues. The first issue is the question of when customization (and in particular personalization) might constitute illegal discrimination. The second issue is how customers will react to these changes.

When Customization Could be Illegal Discrimination

In a 2018 note to the Organization for Economic Co-operation and Development, the United States stated that personalized pricing "could violate antidiscrimination law if pricing were based on certain protected consumer characteristics" (United States, 2018). Airlines that fly to the United States are forbidden from engaging in discrimination by federal law. 49 U.S.C. §40127 states that "[a]n air carrier or foreign air carrier may not subject a person in air transportation to discrimination on the basis of race, color, national origin, religion, sex, or ancestry." Pricing or dynamic offer algorithms which utilize these protected characteristics could violate this law. Race, color, and ancestry are unlikely to be collected and used by airlines and the current NDC schema does not include any codes relevant to these characteristics.

Religion and national origin information can both be indirectly collected. For example, Kosher or Halal meal selections suggest the religious characteristics of a passenger. Citizenship data as revealed through passport information suggests national origin. In both cases, the information collected is merely suggestive of the characteristic. A non-Muslim could prefer a halal meal and a French passport holder could have no other relation to the country than current residence and citizenship. Gender is directly collected. Gender, meal choice, and passport/citizenship information are currently collected during the booking or flight phase of a trip. Of these, meal choice is the most likely to be conveyed via NDC during the shopping phase. For passengers with strict dietary guidelines, the ability to receive offers for only flights with their desired meal may be a significant benefit and improvement to today's process. As airlines build systems that accommodate responses to such shopping offers, they should be cognizant of the possible legal ramifications of using that data in the pricing decision. If airlines use so-called black-box algorithms and machine learning, they should avoid or think critically about feeding algorithms data that either directly or indirectly implicates one of these protected characteristics. Unlike a simple regression model where the influence of each input variable on the output is known by the developer, many machine learning algorithms (e.g., neural networks) are more opaque. An airline that simply used all data it has on passengers and past purchase behavior to estimate future passenger's willingness-to-pay and inform pricing could unknowingly be relying on a protected characteristic to determine prices.

Customizing price based on these characteristics, whether deliberately or inadvertently, would almost certainly violate anti-discrimination law. Customized product offerings (as in dynamic offer generation) could also violate anti-discrimination law, but the risk is not as straightforward. In the example above, showing a customer who requires Halal meals only flights that offer Halal meals is a response to a customer request and not discrimination. The line between customization and discrimination for product variation has not been well explicated by courts. For example, if an air carrier were to offer bundles with additional leg room to male customers (who are, on average, taller), this might be considered a valid response to customer preference or intentional discrimination. Discrimination is more likely to be found if customers can only access certain bundles - simply prioritizing which bundles to display likely does not raise concerns.

The courts have, however, eliminated the ability of private parties to enforce anti-discrimination provisions. Since the government is the only entity able to enforce the provision, the Department of Transportation may provide guidance to airlines regarding anti-discrimination in customized product offerings. Such guidance is unlikely for price customization where the connection to customer preference does not exist and the discrimination is more clear. Anti-discrimination liability risks, therefore, are more significant for price customization than product customization.

The penalty for violating 49 U.S.C. §40127 is a civil fine of up to $25,000 per violation. Each flight involving a violation constitutes a separate violation (49 USC §46301). These fines could quickly become significant. For example, Southwest Airlines operated on average 3,747 per day in 2019. If their revenue management system had been illegally using a protected characteristic to make pricing decisions, the airline might have faced a fine of $93.6 M per day. This is significantly more than the airline's $62 M in average daily revenue. Given that there are relatively few protected characteristics, there remain numerous characteristics with which airlines can develop segmentation models or personalized pricing that don't risk violating federal anti-discrimination laws.

Carriers could also be constrained by existing laws in individual U.S. states. For example, passengers of United Airlines recently sued the carrier for "violat[ing] California's Unruh Civil Rights Act" by "charging older customers more than younger customers . . . based solely on the customers' age." The lawsuit challenged a United promotion that provided discounted fares to MileagePlus members who were 18-22 years old. The state law at issue in the United case entitles all persons in California "no matter what their sex, race, color, religion, ancestry, national origin, disability, medical condition, genetic information, marital status, sexual orientation, citizenship, primary language, or immigration status . . . to the full and equal accommodations, advantages, facilities, privileges, or services in all business establishments." (Calif. Civil Code. Division 1, Pt. 2, Sect. 51(b)). The enumerated list in the California statute is the most extensive of any state. Though the act does not actually list age, it has been interpreted by California courts as being an illustrative, rather than restrictive list and prohibiting discrimination based on "personal characteristics of an individual" (Harris v. Capital Growth Investors). This interpretation makes the law expansive and if individualized pricing were to run afoul of any existing state law, it would be in California.

While the California law has recently been enforced against businesses pricing services based on age (e.g., Tinder was recently found to have violated the act by offering cheaper subscriptions to younger users in Candelore v. Tinder), airlines may not be subject to the law. As with the California Consumer Privacy Act, state anti-discrimination laws could be preempted by the ADA. The previously mentioned lawsuit by blind passengers against United demonstrates that airlines can be subject to anti-discrimination laws. However, unlike accessible check-in kiosks, applying the law to age-based discounts directly implicates prices. The United case was dropped before the company was able to respond, so whether or not United violated the act and whether application of the act would have been preempted was never answered by the courts. Nevertheless, airlines have a strong case that anti-discrimination laws at the state level would be preempted. Any legal action under such law would cause airlines to modify their prices or services (either because of a legal order to do so or to avoid financial penalty) - the precise outcome which is prohibited by the ADA. Still, federal preemption can always change, and airlines will have to be cognizant of when they are using characteristics that are protected by state law.

Customer Reaction to Data Collection and Customized Offers

Airline customers are generally accepting of the dynamic pricing already practiced in the airline industry. In a survey of German consumers, 50% of those that had flown in the prior year accepted the practice. However, there was significant variation in acceptance depending on the type of dynamic pricing practiced. Providing discounts to customers who buy several products was considered a "very good" or "good" practice by 66% of airline customers. Setting price based on a "customer profile (purchase history, search behavior, etc.)" was considered "good" or "very good" by only 14% of airline customers and was considered "bad" or "very bad" by 42% of airline customers and 47% of non-customers (Kramer et al., 2018). Personalized pricing, in particular, may engender a significant negative reaction from consumers.

An important aspect of consumer opposition (and legal challenges) to price segmentation and personalization is consumer knowledge of a discount offered to a particular segment. Consumers are unlikely to oppose segmented or personalized pricing if they don't know of its existence or extent.

In the United age discrimination case, passengers explicitly pointed to United's act of "providing customers 18 to 22 years old a 10% discount." When United began the promotion, it was described on their website ("up to 10% off flights") and in news articles as a 10% discount (e.g., a USA Today article titled "United Airlines gives young adults a 10% discount on flights"). Sometime between January 11, 2020 and February 29, 2020, United changed the language on their website from calling the promotion a 10% discount to more ambiguously referring to it as a "flight discount" and "access to special fares." The discount was only available to customers logged into their frequent flyer accounts and the age qualification was verified against the birth date in the account.

A non-qualifying customer could not view or know the discount offered to qualifying customers unless they accessed the discount through a qualifying customer's login/app. The structure of the promotion approximates the lack of knowledge customers will have of segmented and personalized pricing proposed utilizing NDC capabilities. Those not offered or not qualifying for a segment discount are unlikely to know the level of discount they are missing and, for all but the savviest travelers, unlikely to know that they are missing out on a discount at all. Considering that many passengers already believe that airlines are engaging in price discrimination, any additional or enhanced discrimination could be overlooked if it is not obvious.

In addition to the lack of knowledge of specific discounts, consumers may also be unaware of any shift by airlines towards personalized or segmented pricing. Though personalized pricing relies on NDC, NDC does not require personalized or segmented pricing. Airlines could use current pricing methods while fully adopting NDC. Customers may notice when a flight search requests more information than they're accustomed to providing, but the change is not necessarily an indication of a shift in pricing methodologies.

Like today, a majority of consumers may be unaware of the intricacies of personalized airline pricing. However, for savvy consumers, there are likely to be services that ameliorate any pricing power airlines gain from segmented and personalized pricing. Consumers may find methods to circumvent personalized pricing just as they've found ways to circumvent point-of-sale fare variations. Algorithms have already been proposed that would "protect consumer interests against personalized pricing schemes" (Dong et al., 2020).

If consumers are unaware of data collection changes and customization, they are unlikely to impact the implementation of these practices. Consumers could also frustrate these practices if they are aware of them and find ways to circumvent them. If consumers react negatively to data collection and customized offers, they may inspire regulators or lawmakers to restrict these practices. Many consumers already believe pricing is customized in various ways and consumers have already challenged customization practices. Challenges will likely continue. Given the regularity with which consumers object to airline practices, if airlines adopt personalized pricing, they are likely to at some point be challenged on the practice even if the challenge is not inspired by any specific change.

4.4 Policy Implications

Big data and data privacy are important topics for all businesses and NDC provides an acute, near-term illustration of the issue for the airline industry. Airlines and regulators developing policy for the industry should focus on facilitating data collection that can improve the customer experience and allow for improved demand and capacity allocation while avoiding over-regulating airlines based on data concerns in other industries (like the tech industry).

One major policy issue in data collection and use is the applicability of state privacy laws in the United States. Airlines have a strong argument under federal preemption doctrine that they are exempt from these laws. The current legal and regulatory landscape might result in some airlines choosing to follow state laws and some not. It might also result in more privacy rights for customers utilizing non-airline intermediaries and indirect channels since these channels have no preemption exemption to compliance with these laws. Such a variable privacy landscape will be unnecessarily difficult for consumers to navigate (particularly when consumers are used to dealing with privacy standards that are consistent across an industry like HIPPA in the healthcare industry).

The technical systems necessary to comply with these laws can be costly and some airlines are unlikely to comply with these regulations unless required to. Regulators may consider eliminating ambiguity in the applicability of state privacy laws. This could be done either by creating an airline industry data privacy regulation or creating guidance stating that state laws apply. Airlines may choose to advocate for the former path. While it might seem unusual for an industry to ask to be regulated, a uniform national standard might be preferable to complying with multiple state laws. It could also avoid inadvertently "breaking" airline preemption doctrine which has provided a useful aid to airlines in avoiding liability based on other areas of law. An industry-specific regulation could also address ambiguities on data ownership that arise under these laws.

A second major policy issue is discrimination and the use of prohibited characteristics in personalization. While dynamic offer generation has shown only a limited potential to improve revenues, there may be a point where highly personalized offers can generate significant revenue for airlines. For now, the most valuable information to collect might not be used to improve revenue. NDC could be used by airlines to provide discounted offers to customers whose previous flights were delayed or to offer wheelchair-bound customers connections in the most accessible hubs, these are improvements that can be made through better information sharing between airlines and passengers and broad regulations meant to protect customer privacy could inadvertently inhibit this type of beneficial data collection.

For their part, airlines could make an effort to affirmatively demonstrate that they are not using customer information in a way that violates anti-discrimination laws. The airline pricing process is opaque to most passengers and once information is collected, some customers may get the impression that the data provided is being used for personalization of pricing or offers. For example, if a customer has to start providing information about wheelchair use in the flight search phase and notices increasing prices, they could attribute it to the new information revealed. To prevent these misconceptions, airlines could clearly state how such information is used (e.g., "Wheelchair use information is utilized to prioritize itineraries connecting in airports with limited walking required between gates"). This level of clarity can reduce the risk of future litigation and might keep regulators from limiting beneficial data collection.

Providing an anonymous shopping option (even if it is not presently legally required) is likely also an advisable decision for airlines. Regulators have already expressed a desire for anonymous shopping. The fact that the DOT's show cause order does not legally compel airlines to provide anonymous shopping does not mean that the department won't find other legal authority to create such a requirement. This option will also encourage airlines to collect information from passengers that can be put to beneficial use for consumers. If airlines have to convince customers to provide information, they'll be inclined to demonstrate to passengers that disclosure will benefit them.

Such disclosure can be mutually beneficial for airlines and the public. For example, if an airline requests meal information in flight queries, they may be able to observe that many passengers searching for an itinerary they offer request a meal option that they do not offer. The airline may then choose to offer the specialized meal to better serve the market. This information disclosure helps the airline because their product is more competitive in the market. This information disclosure also helps consumers since, for this subset of passengers, there are now more options that meet their preferences.

A final major policy issue is data storage. Airlines and industry players have already experienced several data breaches and data security issues. If airlines collect and store more private information, their attractiveness as targets for hackers increases, and the harm of a security breach also increases. This increased risk cannot be ignored. On this issue, regulators and airlines are likely aligned. Airlines have significant incentives to keep their data secure, and there is no indication that they are under-investing in these efforts. Regulators and policymakers should determine if there are additional ways to assist in data security efforts (i.e., facilitating greater sharing of information between competitors).

4.5 Summary

This chapter explored the collection, storage, and use of personal information by airlines. New Distribution Capability will create the ability for airlines and customers to exchange more and different information than they do today at different stages in the ticket purchase process. Most significantly, NDC will permit the collection of customer data during the flight-search portion of a transaction. In turn, the collection of passenger information at the flight-search stage enables greater customization and perhaps even personalized pricing based on this information. Presently, significant revenue benefits of personalized pricing have not been shown, but this area of research is new and different formulations of personalized pricing could demonstrate revenue gains. Customer data could also be valuable to airlines in other ways like improving forecasting.

Data collection and personalized pricing made possible by NDC has already generated opposition to NDC and may put airline privacy practices under a microscope whether or not they adopt the personalized pricing or other behaviors feared by consumers.

As airlines collect and store more customer information, they will face compliance requirements from new data privacy laws in the EU and the United States. While some of these laws may not apply to airlines, the best commercial decision for airlines may be to comply with the requirements of all of these laws.

Airlines, regulators, and others in the industry can focus on ensuring beneficial data collection while ensuring consumer's information remains private and secure. Regulators have the opportunity to resolve ambiguity in privacy law applicability by creating an industry-specific data privacy regulation. Airlines have the opportunity to address consumer and policymaker concerns by adopting anonymous shopping and affirmatively demonstrating information is not used in a discriminatory manner.

Chapter 5

The Airline Product: Flight and Ancillary Bundling

5.1 Introduction

Over the last two decades, airlines have introduced optional ancillary services for a fee and steadily increased the amount of revenue generated by these services. Some of these services were once included in the price of the flight. Many airlines have "unbundled" their product to some degree and now charge separately for the flight and the ancillary service.

Ancillaries are a significant source of revenue - accounting for 12.1% of the total revenue airlines collected in 2019 (IdeaWorksCompany, 2020). Ancillary fees can benefit airlines as more than just a source of revenue. Given that many GDSs and metasearch engines display flight options based on the fare alone, airlines offering low fares (separate from ancillary fees) benefit from being at or near the top of search results.

Some passengers have benefited from lower fares made possible by the introduction of ancillary fees - these customers often take advantage of the low fare and eschew the optional ancillary services. For other consumers, airline fees, particularly those for checked baggage, have not been popular. As early as 2010, Congress held hearings on airline fees and Robert Rivkin[1] testified that the Department of Transportation was working to "ensure that airline passengers have accurate and complete information about the full cost of the air transportation they are purchasing, including the ancillary airlines (sic) fees they must pay" (Rivkin, 2010). The unpopularity amongst consumers has resulted in significant government action in the US and numerous regulations have been adopted since unbundling began. For example, the DOT adopted rules regarding the notice required for baggage and other fees (14 C.F.R. §399.85), price advertising (14 C.F.R. §399.84), and consolidated baggage fees across codeshare or interline itineraries (14 C.F.R. §399.87).

As airlines unbundled services, their revenue management systems have continued to operate with the goal of maximizing ticket revenue. Recently, revenue management researchers have begun to shift their focus from ticket revenue maximization to total revenue maximization. This shift recognizes that a passenger who pays a low fare but buys multiple ancillary services can generate more revenue for the airline than a passenger who pays a higher fare but doesn't buy any additional services. This has inspired an interest in bundling through dynamic offers. New Distribution Capability provides airlines the technical capacity to create and distribute offers for dynamically created and priced bundles of flights and ancillary services in response to customer requests.[2]

This chapter considers how bundling and dynamic offers fit into the robust regulatory structure designed for unbundled airline fees. The first section explores the display of bundled offers in light of existing fare display rules. The second section discusses how the application of IRS rules to the combination of taxable fares and largely non-

[1] Mr. Rivkin, the current General Counsel of United Airlines, was at the time the General Counsel for the Department of Transportation

[2] Bockelie (2019) and Wang (2020) offer some early formulations of optimization methods for airlines to generate dynamic offers.

taxable ancillary services. The third section evaluates the potential antitrust risks of bundling. The final section explores policies that would address concerns identified in the rest of the chapter. Some of the issues discussed are not unique to NDC adoption and would be relevant whether or not NDC is adopted by the industry (in particular tax issues). However, NDC adoption has the potential to bring additional scrutiny to bundling practices and these issues.

Discussions regarding ancillaries and bundles in the airline industry can be complicated by a lack of precise definitions. To provide clarity, this thesis uses the following terms in the discussions in this chapter. A **fare** is the price of an airline flight. A **fare attribute** is a restriction or a policy applicable to a fare or set of fares. An **ancillary** is an optional service that can be purchased with a fare. The same service can be a **fare attribute** in some circumstances and an **ancillary** in others. For example, every passenger on American Airlines is permitted one carry-on bag. Since the service is not optional, it is a **fare attribute**. On Frontier, a carry-on must be purchased separately and is an **ancillary**. An **ancillary bundle** is a combination of multiple ancillary products offered for a single price. A **bundled offer** is a fare and ancillary or fare and ancillary bundle offered for a single price. Finally, a **product** is what is purchased or made available for purchase by an airline. The product is the total set of services purchased by a passenger regardless of whether the services are offered as fare attributes, ancillary bundles, or bundled offers.

Airlines may use the term bundle differently and may sell identical products in different ways. For example, Frontier Airlines offers a "bundle" called "The Perks" which includes a personal item, a carry-on, a checked bag, seat selection, and priority boarding (as well 100% of mileage which is included on all flights regardless of fare/bundle). "The Perks" is an **ancillary bundle**, the mileage is a **fare attribute** and the collection of services and the flight is the **product**. Air Canada offers three economy "fares" including a "flex fare" which includes a checked bag, seat selection, one flight change, and earns 100% of mileage as rewards (as well as a personal item and a carry-on which are included with all fares). All of these services are **fare at-**

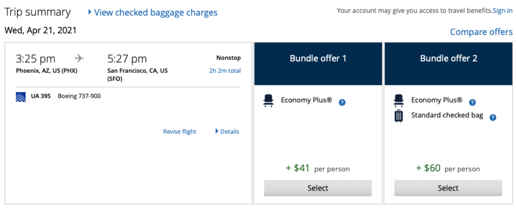

Figure 5-1: United.com screen displayed after flight selection

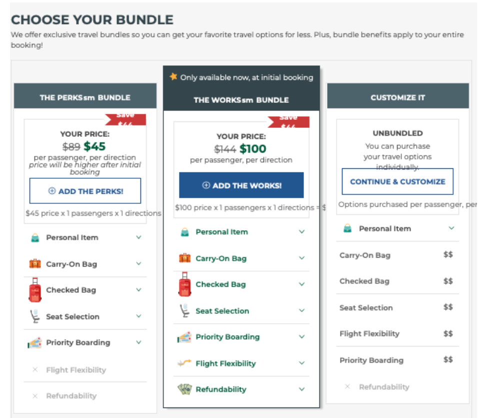

Figure 5-2: FlyFrontier.com bundle screen displayed after flight selection

tributes. Though Frontier sells this product as a fare and ancillary bundle and Air Canada sells this product as a fare with particular fare attributes, they are essentially identical products. As the remainder of this chapter shows, both the services contained in a product and its presentation as fare, fare attribute, and ancillaries are important.

5.2 Regulations Impacting the Display of Bundled Offers

If airlines add bundled offers to their available products, they will have to decide how to display these offers to prospective passengers. Airlines that provide some form of ancillary bundle today often show the bundle after the flight selection process. For example, after a passenger selects a flight, United Airlines displays two ancillary bundles (see Figure 5-1). Frontier Airlines provides a similar display with two branded ancillary bundles to customers after flight selection and customer information entry (see Figure 5-2).

The Department of Transportation regulates websites and display of flight information for carriers selling tickets to passengers in the United States in 14 C.F.R. §256. The regulation has two operative subsections: §256.4 prohibits undisclosed display bias and requires Electronic Airline Information Systems to "display information in an objective manner based on search criteria selected by the user"; §256.5 sets minimum disclosure requirements if a carrier biases a display based on the carrier.

The applicability of §256 depends in part on whether a given information system is an Electronic Airline Information System (EAIS). The regulation defines an EAIS as "a system that combines air carrier or foreign air carrier schedule, fare or availability information for transmission or display." Given this definition, the display method adopted by United and Frontier today probably avoids the regulation because ancillary bundles are not schedule, fare, or availability information. However, if airlines were to "dynamically create and price bundles of itineraries and ancillary services" (Belobaba, Brunger, et al., 2017), the resulting offers would likely need to be displayed in accordance with this regulation.

Unbiased display of bundled offers has the potential to raise some interesting issues. For example, the regulation requires that an EAIS "order the information provided so that the flight options that best satisfy the parameters of the user-selected search criteria are displayed conspicuously and no less prominently... than any other flight option." While many of today's search parameters, like departure time, lend themselves to objective ranking, some ancillary services that may be components of bundled offers do not.

The problem could be particularly pronounced for metasearch engines and OTAs. For example, imagine a metasearch engine received a booking request for a flight from Cleveland to Las Vegas, non-stop, with a carry-on, internet access, and club access (see Figure 5-3). In February 2021, no carrier could offer a customer internet access, club access, and a non-stop itinerary on this route. The search provider could provide notice that no flights matched the customer's search. If some search engines show results that substantially or partially match a request, a website that provides a "no match" notice could be seen as less functional by consumers, so there may be

Customer Search	CLE-LAS	Non-Stop	Carry-On	Internet Access	Club Access
Frontier	CLE-LAS	Non-Stop	Carry-On		
Spirit	CLE-LAS	Non-Stop	Carry-On	Internet Access	
American Airlines Delta Air Lines	CLE-LAS	1-Stop	Carry-On	Internet Access	Club Access at Connecting Airport
United	CLE-LAS	1-Stop	Carry-On	Internet Access	Club Access at Origin, Destination, and Connecting Airport

Figure 5-3: Hypothetical Customer Search and Airline Results based on today's routes and amenity availability

a competitive incentive to provide results.

Search engines that provide results would have to decide how to prioritize the display of flights that each conform to some portion of the user's search. At an airline level, Figure 5-3 shows how today's schedule and amenity offerings of airlines could meet the consumer's request. Some display preferences are clear - Spirit should be preferred to Frontier in the display since it satisfies the same search parameters as Frontier but can also provide internet access. Other preferences are less clear - should United receive priority display over American and Delta since club access is available at the origin, connecting, and destination airports rather than just the connecting airport?

Airline websites could face separate issues particularly during the adoption of more complicated search parameters. Airline customers who might be interested in or consider bundled offers may instead search using only dates, origin, and destination information based on past practice. If a customer has not indicated an interest in bundles in their search, §256 would seem to require that an airline prioritize unbundled fares over bundled offers in this situation. For airlines with many flight options, this could make it difficult to display bundled offers such that customers will see them.

5.3 Tax Implications for Bundled Ancillaries

In the United States, the sale of transportation of persons by air incurs a 7.5% excise tax. (26 U.S.C. §4261(a)). Some ancillary services are subject to this tax, while others are not. Depending on the implementation of dynamic offers, the algorithm utilized by airlines might calculate a single bundle price without having calculated prices for the constituent components of the bundle. If a single price bundled offer includes taxable and non-taxable products, compliance with tax laws may be difficult.

In 2010, the IRS published Letter PLR-118216-09. The letter is a public response to an inquiry by an airline regarding which of several airline services the IRS considers taxable and non-taxable under §4261.[3]. The letter describes the IRS's assessment of whether 39 different airline services are subject to excise taxes. Six of these services are ancillary services that an airline may want to include in bundled offers (see Table 5.1).

Service Name in Letter	Description of Service	Taxable?
Service E	In-Flight Meals and Alcohol	No
Service F	Headset Sale	No
Service G	Baggage Fees	No
Service J	Lounge Day Pass	No
Service M	Unaccompanied Minor	Yes
Service P	Bonus Miles on Purchased Flight	Yes

Table 5.1: Ancillary Services in IRS Letter PLR-118216-09

The fare for a flight is currently taxable. If airlines combine taxable and non-taxable services in a single bundled offer price, the appropriate tax on the offer is unclear based on existing guidance. The IRS might consider a single-price bundled offer to be a simple fare and the bundle's services fully taxable much like fare attributes are today. If not, there are at least three methods that airlines might utilize to distinguish the taxable and non-taxable portions of the offer price each with different tax burdens.

[3]The agency will often publish response letters to inquiries by taxpayers to give similarly situated taxpayers notice of the agency's interpretation of tax laws.

To illustrate, consider an airline that sells three products: a flight, a checked bag, and a bundle that includes both a flight and a checked bag. This airline prices the flight at $100, checked bags at $25, and the bundle at $120.

The first method is to use the a la carte flight price (i.e., $100) to derive the effective price of the ancillary in the bundle (i.e., *Bundle Price - a la carte flight price = ancillary price*). The effective checked bag price is $20. Since the flight is taxable and the checked back is not, the tax is $7.50. The second method is to use the a la carte ancillary price to derive the effective price of the flight in the bundle. The effective flight price is $95 and the tax is $7.13. The third method is to equally allocate the bundle discount to each component in the bundle. The bundle offers a 4% discount, so the effective price of the checked bag is $24 and the effective price of the flight is $96 resulting in a tax of $7.20.

The potential tax savings of utilizing the second method is small (5%) and even smaller when considering the total cost (<1%), but airlines and customers would still prefer the second method. The government, on the other hand, generates the most revenue from the first method. Each of these methods could be justified under existing law.

These tax implications are important for an airline's overall pricing strategy. As currently implemented by United and Frontier, customers receive a discount on ancillaries, but no tax benefit. Restructuring the discount as a fare discount rather than an ancillary discount could increase an airline's revenue without increasing the price paid by passengers. Figure 5-4 shows a United flight from PHX to SFO and two bundled offers. The first bundle offers an economy plus seat (normally $35 or $45) and a checked bag (normally $35) for $60. This represents a $10 or $20 savings depending on the seat selected. If this savings were taken off the fare rather than the ancillary services (and the fare increased by the tax savings), United would increase their revenue collected by 0.7% or 1.4%.[4] The revenue improvement is relatively large given

[4]This assumes that any change in ancillary prices does not impact demand for ancillaries.

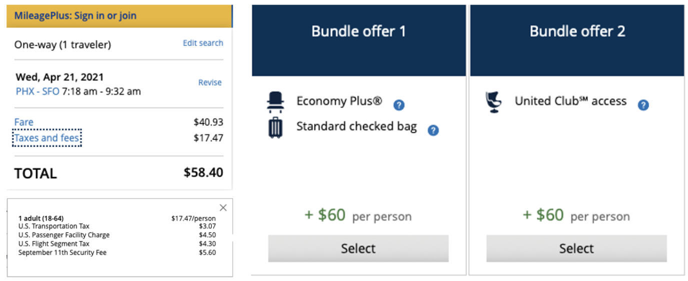

Figure 5-4: United.com flight and bundle offers. Accessed March 7, 2021.

the discount is almost 20% of the original revenue. As the ratio of airline revenue to discount increases, the revenue improvement will decline. Still, the structure of offer prices and the resulting taxes can play a meaningful role in the revenue impact of bundled offers.

5.4 Bundling as Illegal Tying

The makeup of bundles and when certain bundles can be offered could be constrained by US antitrust law. Two laws form the backbone of US antitrust law: the Sherman Act forbids arrangements "in restraint of trade or commerce" and the Clayton Act forbids arrangements whose effect "may be to substantially lessen competition or tend to create a monopoly in any line of commerce." Tying is one of several business arrangements that have been found by courts in the United States to violate these laws. Tying is "an arrangement by a party to sell one product but only on the condition that the buyer also purchases a different (or tied) product" (Black, 1958).

If tying does restrict how airlines can create and sell bundles, it does so only in a few, specific situations. Not all combinations of flights and ancillaries implicate tying. Tying requires combining multiple products in a single bundle for sale. Two items are considered separate products when there is sufficient consumer demand for each product that it is efficient for a firm to offer each product on its own. Baggage fees, for example, do not implicate tying because there is no market for a checked bag except for as an add-on to a flight purchase (and there are no firms engaged in the independent business of checking bags).[5]

Three ancillaries could be considered distinct products under tying law: club access, security priority at the airport, and on-board food and drink. Each of these services faces competition from non-airline firms. Airports and private firms offer airport clubs like American Express's Centurion Lounges. Clear is a non-airline firm that offers priority security screening at airports using biometric data. Airports offer numerous food options which provide an alternative to buying food on board. If airlines were to display a set of offers that bundled any of these services without also providing a flight-only bundle, they could violate tying laws.

To illustrate how this behavior is anti-competitive, consider security priority at Salt Lake City International Airport. Delta flies more than 50% of passengers that arrive or depart at the airport (Bureau of Transportation Statistics, 2021). If Delta were to only display bundled offers that included security prioritization, customers who might otherwise purchase security prioritization services from Clear might forgo Clear and use the included prioritization service. Though Delta is unlikely to include security prioritization in every bundle (there would be no prioritization between passengers at that point), including security prioritization in every first-class bundle or bundle offering to business passengers could still "restrain trade" and "lessen competition" for security prioritization services at the airport.

Though bundled offers that include club access, security priority, or onboard meals represent the most significant antitrust risk, bundling could also be an issue at an airport where an airline has market power. Dozens of airports in the United States are served by only one carrier. Some of these, like Orlando Sanford International Airport, are secondary airports in metropolitan areas with service to nearby airports by other carriers. For the remaining airports, even those served infrequently, the

[5] A checked bag is the simultaneous transportation of a person and their luggage. It is distinct from transportation of luggage alone which is potentially offered by shipping companies,

carrier serving the airport often has a monopoly on air service.[6]

Carriers that operate to these airports risk significant antitrust scrutiny if they don't offer an unbundled fare for itineraries that include these airports. Without an unbundled fare, the airline may be forcing customers to purchase ancillary services that they might not otherwise purchase which could violate antitrust laws.

5.5 Policy Implications

Bundled offers have the potential to better align customer desires and airline offers. As airlines and researchers continue developing methods for generating dynamic offers and implementing ancillary bundles and bundled offers, awareness of the issues discussed in this chapter may help to ensure smooth development and implementation. Airlines may benefit from focusing on search functionality and ensuring their product offerings do not violate antitrust laws. The US government can facilitate the adoption of dynamic offers and bundled offers by reforming a tax system that has not kept up with industry practices.

§256's display requirements may be satisfied by adopting new types of search functionality. Rather than letting passengers select "Wi-Fi access" with a radio button or some other binary option, searches could instead provide multiple options like "requires Wi-Fi access", "prefers Wi-Fi access", "No preference", and "No Wi-Fi access." For airline websites, a "no preference" selection would allow the airline to decide how to prioritize fares and bundled offers. For metasearch engines and OTAs, the multiple options would provide more information on which to decide which flights "best satisfy" a customer's request.

Airlines will likely also benefit from ensuring that unbundled fares are offered for all

[6] Some of these airports are somewhat close to other airports with commercial service, e.g., Punta Gorda Airport is less than 40 miles from Southwest Florida International Airport. Others are relatively remote, e.g., Yuma International Airport is roughly 180 miles from the closest airport with commercial service.

searches or at least offered in the situations described in this chapter. Single carrier airports and bundled offers that include club access, security prioritization, or in-flight meals present little opportunity for revenue generation[7] but significant antitrust risk. If these situations do occur, they may arise inadvertently due to the implementation of a bundled offer generation system. If an airline uses an inventory system like today and the unbundled fares are managed similar to today's lowest fare class, the airline's inventory system might not offer unbundled fares on high-demand flights. As carriers implement new systems, they should carefully consider when their system might not offer an unbundled fare and review these situations for antitrust concerns.

NDC adoption and bundled offers highlight the need for reform in the transportation excise tax system. To date, the IRS has been relatively lenient, and airlines are allowed to structure their product offerings and pay taxes accordingly. Offering services as an attribute of a particular fare will result in those services incurring excise taxes. Offering those same services as ancillaries may make them non-taxable. The tax system has not aligned with industry practice for many years. It makes little sense for the government to collect tax depending on how airlines construct their product offerings. Ultra-low-cost carriers have capitalized on this poorly designed system. Today, Spirit Airlines charges a \$6.99 to \$22.99 "Passenger Usage Charge" for "bookings created online or via reservation centers" and a \$7 per segment "Regulatory Compliance Charge" to "recover costs incurred due to regulatory changes." On almost any other airline, these charges would be part of the fare. It makes little sense for these charges to be tax-free while a similar charge included in the fare would incur tax.

As the largest airlines begin to adopt bundled offers, they may convert taxable revenue to non-taxable revenue. Given their collective size, this shift could impact tax receipts such that the action inspires government action. If not, airlines might advocate for a

[7] In February 2019, according to U.S. DOT data, less than 3% of airline flights were to airports served by a single carrier. Since many of these airports are served by regional jets, the share of seats is even smaller. No airline provides specific revenue information for club access, security prioritization, and in-flight meals. American Airlines earned \$45.8B in operating revenue in 2019 including \$7.4B in revenue from ancillaries. Of the ancillary revenue, \$5.4 B came from the loyalty program and \$1.3 B came from bag fees. 7% of ancillary revenue and 1% of total revenue comes from other sources.

more straightforward tax system that doesn't create incentives to structure offerings to avoid taxes. Some airlines, like Spirit, pay less than their fair share of taxes because of the tax-advantaged structure of the product offering. A strong and healthy aviation and airport system requires adequate funding, and that funding should be collected fairly from flyers and airlines.

Chapter 6

Conclusion

The airline industry is in the midst of potentially extreme change. New Distribution Capability (NDC) could disrupt the Global Distribution System landscape that has existed for forty-five years or eliminate the publishing of schedules, fares, and associated rules that has gone on for nearly a century. On the other hand, NDC could simply update communication technology and hardly change the industry at all. This range of possibilities has resulted in a lack of clarity on the future of NDC and this lack of clarity has resulted in discourse often addressed at extreme potential outcomes rather than the range of possibilities. This thesis explored the range of implementations while also providing an analysis of the implications of specific implementations to help airlines, academics, and policymakers understand the current dynamics of NDC implementation and plan for the near future. This chapter concludes with a review of the insights from each chapter and a discussion of how airlines and policymakers can effectively utilize these insights.

Review of Thesis Insights

In Chapter 2, we reviewed the historical context of new revenue management and distribution technologies. We traced the history of airline distribution from the slow, manual process of the 1950s through computerization and the rise of global distribution systems to the introduction of New Distribution Capability. We also reviewed the evolution of airline revenue management from simple flight forecasts through network-based OD controls, to today's cutting-edge research including developments predicated on NDC, like dynamic offer generation. This history revealed how many of the potential changes generated by the implementation of NDC (like customer data collection) are not the introduction of new practices, but rather the expansion of practices to new channels of distribution. It also identified possible implementations of NDC with striking similarities to past practices.

In Chapter 3, we analyzed the potential impacts of NDC on the distribution system itself and companies engaged in distribution. With a focus on indirect distribution, we considered three possible implementations of NDC: as a new communications standard, as a method to bypass the GDSs, and as a pass-through to GDSs. We considered how each implementation would change the roles and responsibilities of entities in the distribution industry. More specifically, we identified three GDS functions - booking services, aggregation, and offer creation - and discussed how airlines, GDSs, and other airline industry companies might perform these functions under various NDC implementation scenarios. We then explored whether fare filing and schedule publishing would be necessary in the future. We also considered how existing antitrust law might restrict information sharing if it becomes non-essential for distribution and how the airline industry might obtain industry data in this scenario.

In Chapter 4, we addressed NDC's ability to facilitate greater collection of personal data from consumers. Two major privacy laws - Europe's GDPR and California's Consumer Privacy Act - were described along with an analysis of how extensively they apply to airlines. Changes in data collection practices were then reviewed against the provisions of these laws. The potential uses of customer data were then explored including a review of research demonstrating revenue improvements for airlines with the use of more data. We also discussed how consumers might react to enhanced data collection and when data collection and use could cross the line to illegal discrimination.

Finally, in Chapter 5, we discussed airline bundles. We established a set of definitions to understand the various ways that fares and other services can be combined in the product sold to consumers. We considered how bundles, and especially dynamic bundled offers, could be displayed to consumers considering existing regulations about the display and ordering of flight search results. We addressed how excise taxes apply to dynamic bundles and the incentives created by the current tax system. We also considered scenarios in which bundling might create antitrust tying liability.

The contributions of this thesis are three-fold. First, the history and development of airline revenue management and distribution are comprehensively documented. This documentation provides a useful context from which to understand how NDC may change the airline industry and is among the most thorough available in current literature. Second, NDC implementations are analyzed through a policy and legal lens. While this analysis is not comprehensive given the extent and variety of potential NDC implementations, the thesis offers one of the first attempts to understand what legal or regulatory issues the airline industry may encounter as it continues to implement NDC. Finally, potential policies were explored that consider the current legal and regulatory landscape, the potential benefits of NDC to the industry, and the possible harms to consumers from NDC implementation.

Acting on these Insights

While some readers of this thesis may already be intimately involved in NDC implementation for a particular airline or engaged in the development of technology or revenue management methods enabled by NDC, others may be encountering these issues for the first time. For those readers, we close with some opportunities for potential action stemming from the insights generated by this research.

For airlines and companies serving airline clients, the thesis may aid in focusing development efforts and highlighting potential legal risks and liability. Global Distribution System providers, Online Travel Agencies, Metasearch engines, and Travel Management Companies must understand the possible implementation methods for NDC, how they could impact their business, and the business opportunities in the future. The implementations and business impact are discussed in Chapter 3. A few opportunities are worth highlighting. As airlines take responsibility for offer creation, they will need the technical systems to do so, and many may not be able to undertake this development in-house. Search aggregation may also become a more significant intermediary business in the airline industry. Companies beginning to address these business challenges now will be best suited to become important players in the industry as NDC continues to be implemented.

The legal risks and liability issues associated with NDC implementation should not be ignored. Data privacy laws are new, and most companies are only a few years into understanding how to comply with them. The changes in processes and data flows that may come from NDC may change compliance obligations. There is also the potential to inadvertently discriminate. In particular, airlines that may soon come to possess large amounts of customer data must be careful to ensure that the data isn't inadvertently used in discriminatory ways. This is especially true when using data with machine learning algorithms. While it may be attractive to collect data at the outset and determine later how to put that data to valuable use, this path could present serious legal and liability risks. Airline revenue management departments should be in close contact with their legal departments to jointly develop processes that comply with the law but still capture the significant potential revenue benefits of NDC.

Antitrust risks are also potentially significant. Bundling might be considered tying. While the breadth of market power differs for airlines, there are at least some routes and airports without any competition. Airlines, through unbundling, have established that some ancillaries are separate products and third parties have begun offering some services to compete with those provided by airlines (e.g., airport lounges and security priority). If a bundle contains an ancillary service that has non-airline competition in a place where the airline has market power, it could be viewed as the airline using its market power in providing air travel to sell the separate product which would otherwise face competition.

Fare filing and schedule publishing could come to be considered an anti-competitive practice. Filing fares and publishing schedules notifies a competitor of an airline's plan for production and pricing. Though a few aspects of filing fares were challenged on antitrust grounds and eliminated in 1992, the system has largely been permitted because it is necessary to distribute tickets with existing technology. If not for public filings, only airlines could sell their tickets. The pro-competitive benefit of comparison shopping justifies the anti-competitive competitor notification. Particular NDC implementations could provide the same pro-competitive benefit without the anti-competitive harm. If these implementations occur at any airline, it will be evidence that there is a viable alternative to public filing that is less restrictive of competition and could obligate airlines to implement NDC in that way or face antitrust liability. Other benefits of schedule publishing and fare filing, like interline sales, may also be accomplished with more limited information sharing than providing the information for anyone who wants to access it.

These antitrust risks might be avoided if airlines recognize them and make strategic choices to avoid them. Tying issues can be avoided if airlines ensure that a fare-only product is offered alongside any bundles. Airlines can adopt NDC in a way that public filings remain essential to distribution in some channels. The airline industry is a frequent target of antitrust litigation and NDC will likely lead to additional litigation. Considering potential antitrust issues during implementation will aid in ensuring airlines are adopting pro-competitive practices and avoiding antitrust liability.

For policymakers, the insights in this thesis can be utilized to address pre-existing issues that have the potential to be exacerbated by the introduction of NDC and to resolve implementation ambiguities and create smart, prospective policy. Two issues identified in this thesis are not new and not a result of NDC implementation. Rather, the display of dynamic offers and tax implications of bundled fares exist already but may be exacerbated by NDC.

Displaying information in an "objective manner based on search criteria" has been an appropriate policy when search parameters were themselves objective. The regulation now has the potential to be a barrier to providing robust search functionality to consumers. policymakers may need to take action to avoid this. The regulations may not need to be changed, but guidance could be provided that ameliorates concerns of airlines or other developers that they might violate the regulation. For example, a search result that gives the user power to rank, sort, and filter by a subjective characteristic, like ease of flight connection, might be discouraged by today's regulation. When the power to control the search result display shifts to consumers, policymakers should consider exempting the display from these requirements. Regulators might also consider providing guidance on how objective display requirements can be met with evolving search functionality.

The peculiar tax treatment of bundles and ancillary services depending on their classification as fare restrictions or optional ancillaries could also be addressed. The current system does not seem to advance any particular policy goal and instead incentivizes behavior that can be confusing to passengers and reduce tax receipts used to ensure a well-maintained aviation system. Even if there are good reasons to treat payments for transportation and other services differently, identical products should not face different tax burdens because one is sold as a set of fare attributes (as with fare families) and another is sold as an ancillary bundle. Guidance is also warranted for how to treat single-price bundled offers. Airlines and airline passengers should receive fair and consistent treatment by the tax code. Policymakers can avoid having airlines charge taxes in different ways by providing proactive guidance in the area.

Beyond addressing existing issues, policymakers may also resolve ambiguities and create prospective policy. As NDC is implemented, airlines will decide whether to allow the sale of their fares in certain distribution channels. From the airline perspective, it is important to provide companies as much flexibility as possible since they are best suited to ensure that their distribution methods serve the needs of their passengers and business structure. Consumers have become accustomed to comparison shopping for flight tickets. As NDC potentially gives airlines additional leeway to determine which distribution channels have the ability to display and sell their tickets, the distribution system could devolve into a collection of disconnected channels that reduce the ability to compare offers and prices from different airlines. If policymakers and regulators hope to preserve comparison shopping sites while allowing airlines to shape their own distribution policies, they may be able to create rules today that address both of these concerns. It may be more difficult in the future once relationships have already been terminated and investments made towards a particular NDC implementation. The specifics of these policies are beyond the scope of this thesis, but the government could undertake a rulemaking or request for information that gives interested parties the potential to inform and shape such a policy.

Those involved with NDC might feel like the last several years have been filled with discussion about the potential benefits and issues of NDC without a realization of those benefits or issues. It might seem to some that we are still in that discussion phase. If this phase is not already over, it will end shortly. Courts and governments have begun to assume the implementation of NDC will occur - whether in analyzing the merger of distribution companies or in private litigation between airlines and OTAs. In the United States, government action investigating or regulating NDC and developments in airline pricing and distribution methods is significantly more likely under the Biden administration than the Trump administration. Now is the time for airlines and policymakers to thoughtfully consider the future of the industry with New Distribution Capability and new methods of revenue management.

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