Domestic Codesharing, Alliances and Airfares in the U.S. Airline Industry*

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Abstract

This paper examines the impact of domestic codesharing alliances on airfares. Our analysis yields two novel and somewhat surprising findings that have yet to be documented in the literature. First, unlike international codesharing, we find that the overwhelming majority of domestic codeshare itineraries involve a single operating carrier, a phenomenon that we refer to as "virtual" codesharing. Second, we find that these virtual codesharing itineraries are priced lower than itineraries operated and marketed by a single carrier in the same market. We suggest that carriers may be using virtual codesharing—in large part—as a "generic" product to compete for the most price sensitive passengers.

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*The views expressed in this paper are those of the authors and do not necessarily reflect those of LECG, LLC. All errors are ours alone.

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1 Introduction

The impact of cooperative marketing agreements—in particular alliances and codesharing—has been a dominant theme of international aviation over the past decade (Brueckner 2003, Brueckner 2001, Brueckner and Whalen 2000, Park and Zhang 2000). Recently, the same trend has also taken hold in the U.S. domestic airline industry. Over the past few years, for example, virtually all of the largest U.S. hub and spoke carriers have entered into broad domestic codesharing partnerships, including the United/US Airways alliance that began in January 2003, and even more recently, the three-way alliance between Northwest, Continental and Delta initiated in June 2003.[1] In light of this recent trend towards increased codesharing (the number of domestic codeshare passengers grew over thirteen-fold between 1998 and 2003 to roughly 2 million domestic passengers) and the fact that carriers comprising the three largest U.S. alliances (Continental/Northwest/Delta, United/US Airways and American/Alaska) account for nearly two-thirds of all domestic origin and destination ("O&D") passenger traffic, there are legitimate policy concerns regarding the impact of these cooperative marketing agreements on fares and service levels (Transportation Research Board 1999).[2]

Simply stated, codesharing is an agreement between two carriers whereby one carrier (the operating carrier) allows another carrier (its codeshare partner) to market and sell seats on some of the operating carrier's flights. For example, the codeshare agreement between United and US Airways allows United to market and sell seats on thousands of flights operated by US Airways, and vice-versa. In international markets, the popularity of cooperative marketing agreements arises from the fact that they enable airlines to extend the scope of their networks by offering relatively seamless travel to destinations they otherwise would be unable to serve, either due to cost or regulatory (i.e., route authority) factors. For example, while no carrier currently carries passengers between Providence, Rhode Island and Warsaw, Poland solely on its own network, numerous U.S. carriers and their international alliance partners such as Delta/Air France, American/British Airways, United/Lufthansa and Northwest/KLM are able to offer passengers convenient, well-integrated, connecting service in this market. Consequently, numerous government and academic studies have concluded that cooperation among international carriers has resulted in lower fares and higher traffic in literally thousands of international aviation markets (Brueckner 2003, U.S. Department of Transportation 2000, Park and Zhang 2000, Brueckner and Whalen 2000).

While the effects of codesharing and alliances have been well-studied in the context of international air travel (i.e. Brueckner 2003, Oum, Park, and Zhang 1996, Brueckner and Whalen 2000),

[1] It is important to note that codesharing between mainline and regional carriers (i.e., American/American Eagle, Northwest/Mesaba, Delta/Comair, etc.) has been an integral part of the U.S. airline industry for several decades.

[2] See also, "Competition in the Airline Industry", Testimony of Joel Klein, Assistant Attorney General, Before the Committee on Commerce, Science and Transportation, United States Senate, March 12, 1999.

codesharing and alliances among domestic carriers is a relatively new phenomenon, and therefore, has received only limited attention. Using data from 1994-1996, Bamberger, Carlton, and Neumann (2004) found that average fares fell by 7.5% in markets where codesharing was introduced by Continental/America West (relative to non-codeshare markets) and by 3.9% in markets where codesharing was introduced by Northwest/Alaska. Whalen (1999), however, predicted that there could be substantial losses in consumer welfare from the Northwest/Continental, American/US Air and United/Delta alliances, because the increase in online fares (mainly in hub-to-hub markets) more than offsets the impact of lower fares for the relatively small number of passengers who had previously purchased interline tickets on the alliance partners.[3] Using a discrete choice model based on flight characteristics, Armantier and Richard (2003) also attempt to measure the change in consumer welfare associated with the Continental/Northwest alliance. Finally, Clougherty (2000) studies the welfare benefits of domestic alliances taking into account of their international effects.

This paper assesses the impact of domestic codesharing and alliances on airfares in the U.S. airline industry. Following Brueckner and Whalen (2000) and Brueckner (2003), we estimate cross section and market fixed-effects fare equations using a broad set of city-pair markets. Although our methodological framework is quite similar to that found in the international codesharing literature (Brueckner 2003, Brueckner and Whalen 2000), we find that domestic and international codesharing practices differ significantly. In particular, while international codesharing typically combines the networks of two different operating carriers in order to create a convenient connecting itinerary—a practice we refer to as "traditional codesharing"—the overwhelming majority (i.e., 85%) of domestic codesharing itineraries involve a single operating carrier, a practice we refer to as "virtual codesharing." For example, a typical traditional codesharing itinerary might involve a connection between a Northwest flight and a Continental flight, where the entire ticket is marketed by Northwest while a virtual codeshare itinerary could consist of a connection between two United Airlines flights, where the entire ticket is marketed and sold by US Airways. Our analysis demonstrates that the distinction between traditional and virtual codesharing is critical to understanding the effects of domestic codesharing because the economic incentives—as well as the implications on airfares—behind these practices may differ substantially from those documented in international codesharing literature. Our paper also differs from the existing domestic codesharing literature (i.e. Bamberger, Carlton, and Neumann 2004) in that we focus on the price effects of virtual–rather than traditional–codesharing practices.

Although our paper is the first of its kind to distinguish between traditional and virtual codesharing, the notion of virtual codesharing has not escaped the scrutiny of policy makers. For example, in

[3]It should be noted that neither the American/US Air nor the United/Delta codesharing alliances ever materialized.

its 1999 study of competition issues in the U.S. airline industry, the Transportation Research Board questioned the potential benefits of such arrangements:

> Less plausible, however, are the consumer benefits from codesharing that major carriers have claimed for single-connect or nonstop markets in which one or both of the partners already operates through-service. The concern is that such arrangements will reduce competition in these markets, because it is likely that the partners have—or had—competing flights in the market, or that they had the potential to become rivals in the market... These arrangements also might aim at increasing market shares by diverting traffic from competitors through the preferential listing of online itineraries in CRSs. (Transportation Research Board 1999, pp. 141-142)

In light of concerns such as those cited above and to demonstrate why it is important to distinguish between traditional and virtual codesharing, we first estimate our models without pooling different types of codesharing and then re-estimate the same models disaggregating generic codesharing into its traditional and virtual subcategories.

Consistent with the existing literature, we find that codesharing itineraries are priced lower than their respective benchmarks. As expected, traditional codeshare itineraries are roughly 11.6% less expensive than non-allied interline itineraries, but 6.4% more expensive than "pure online" itineraries (i.e., those operated and marketed by a single carrier) in the same markets. Somewhat surprisingly however, we find that virtual codeshare itineraries are 5-6% less expensive than "pure online" itineraries. This latter finding is particularly interesting since the common explanations of codesharing incentives (i.e., network expansion, reduction of the double marginalization externality etc.) do not predict that codesharing should lower fares below those offered by a single carrier. In light of this surprising and somewhat counterintuitive empirical finding, we conclude that another factor is at work. In particular, we argue that for at least some travelers, virtual codeshare itineraries are perceived as imperfect substitutes to otherwise identical, non-codeshare itineraries operated by the same carrier since virtual tickets are typically not bundled with all of the same attributes—many of which are highly valued by some travelers—as non-codeshare tickets. For example, most airlines do not permit passengers holding virtual codeshare tickets to upgrade to first class and/or may offer fewer frequent flyer miles on virtual tickets. Thus, while the "pure online" itineraries offered by a carrier can be thought of as that carriers' "brand name" product (i.e., one that is bundled with all of the benefits of the fully branded product), its codeshare itineraries can be thought of as its less desirable "generic" product which is used to attract more price-sensitive travelers. Thus, we conclude that domestic virtual codesharing represents—in large part—another means of product differentiation beyond those which are typically associated with the industry such as advance purchase restrictions.

The remainder of this paper is organized as follows. Section 2 presents some notation and definitions used throughout the paper. Section 3 discusses the economic incentives behind domestic codesharing and explores how the various incentives might be expected to impact airfares. Section 4 presents our data and empirical model. Estimation results are summarized in Section 5. Section 6 provides brief concluding remarks.

2 Definitions and Notation

2.1 Preliminary Definitions

In order to understand the effects of domestic codesharing, it is important to distinguish between three related, but different concepts in airline marketing: codesharing, interlining and alliances.

A flight itinerary or ticket consists of one or more flight coupons, each coupon typically representing travel on a particular flight segment between two airports.[4] While every flight segment has, by definition, a single operating carrier (the airline whose aircraft is used to operate the flight) it can have one or more marketing carriers (airlines that have the ability to list the flight as part of their flight schedule, set its fares, and in turn, market seats on the flight to travelers).

Definition 1 *A flight is said to be* **codeshared** *when the operating and marketing carrier for that flight differs.*

For example, Alaska Airlines operates non-stop flights between Seattle and Chicago O'Hare. However, the Seattle–Chicago flights operated by Alaska are listed in computer reservation systems ("CRSs") and flight schedules of both Alaska Airlines and American Airlines. Thus, because seats on a flight between Seattle and Chicago operated by Alaska Airlines can be marketed and sold by American Airlines, the flight is said to be codeshared.

From an institutional standpoint, all domestic codesharing agreements use what is known in the industry as the *free-sale* model. Under a free-sale agreement, the operating carrier maintains and controls the seat inventory, but allows its codeshare partner(s) to market and sell seats on designated codeshare flights under their own marketing "code."[5] Hence, both the operating and codeshare carriers sell seats out of the same general inventory, and the operating carrier receives all of the ticket revenue, regardless of which carrier actually sells the seat.[6] In return for selling a seat

[4]The one exception is on so called "direct" flights, which involve an en route stop without a change of flight number.

[5]A carrier's marketing code is its two letter designator in computer reservation systems. For example, AA for American, WN for Southwest, and UA for United.

[6]In practice, there may be technological differences between the seat inventories available to the operating and codeshare carriers. For example, while the operating carrier will have "real time" access to its seat inventory, the codeshare partner's inventory may be delayed if the particular agreement calls for its inventory to be updated only periodically throughout the day.

on a codeshare flight, the operating carrier usually pays the marketing carrier a nominal commission to cover costs (for example, the "cost" to the marketing carrier of issuing its frequent flyer miles). Since virtually all of the revenue from a codeshare flight accrues to the operating carrier, codeshare agreements are carefully negotiated so that they are "balanced" in the sense that partners exchange their operating/marketing roles across different routes so as to roughly equalize the benefits from the agreement.[7] Finally, federal regulations require the codeshare carrier to indicate that the flight is actually being operated by a partner airline. In flight guides or computer reservation listings, this is commonly done by placing a symbol (i.e, *, †) next to the flight number.

A related but different concept in airline marketing is whether or not an itinerary is *online* or *interline*.

Definition 2 *An itinerary is said to be* **online** *when the operating carrier for each flight coupon of the itinerary remains the same. In contrast, an itinerary is said to be* **interline** *when there are two or more operating carriers.*

For example, a ticket which is operated by Delta Air Lines for both of its segments is said to be online, while a ticket where the first segment is operated by Delta and the second segment is operated by American would be considered interline. It is important to emphasize that a ticket's status as online versus interline depends only on that ticket's operating carrier(s). Thus, while a ticket may consist of flights with multiple marketing carriers as a result of a codesharing agreement, it can still be online. Likewise, an interline ticket can have the same marketing carrier throughout as a result of a codeshare agreement. Finally, note that all single coupon itineraries are online by definition, since it is impossible for the operating carrier to change.

Carriers can form cooperative marketing "alliances" that may cover a wide array of joint activities, up to—but not necessarily including—codesharing. Generally speaking, a typical domestic alliance may include costs reduction initiatives (i.e., sharing or consolidating airport facilities such as gates, lounges, etc.), schedule and gate coordination to provide more convenient connections between flights of alliance partners, and frequent flyer program and/or airport lounge reciprocity.[8] Unlike many international alliances, no domestic alliance currently has antitrust immunity that would allow them to jointly determine pricing on domestic codeshare flights. Since alliance partners strive to

[7] A less common type of institutional agreement is the so-called "block-space" agreement. Under this form of codeshare arrangement, the operating carrier sells a block of its seats on a given flight to another carrier (the codeshare partner) which then assumes the sole responsibility for marketing and selling the inventory of seats it has purchased, which it does under its own marketing code. Since the codeshare carrier purchases the inventory from the operating carrier, it keeps all of the revenue associated with the codeshare seats it sells.

[8] While most alliances currently do not allow passengers to pool miles from different programs together for award redemption, they do allow passengers to choose which of the alliance partners' miles they will earn on any given alliance flight, regardless of either the operating or marketing carrier. Thus, a Continental OnePass member can earn OnePass miles on flights operated and marketed by either Delta or Northwest.

provide passengers with an experience comparable (both in terms of convenience and other non-flight benefits) to that of a single carrier, alliance partners also benefit from expanded network scope. It is important to note, however, that alliances can differ significantly in their degree of integration. Thus, for the purposes of our analysis, we use the following definition:

Definition 3 *Carriers are* **alliance partners** *if passengers on one of the alliance carriers can earn "elite-qualifying" frequent flyer miles on flights marketed or operated by the other alliance partner(s) and vice-versa.*

Elite-qualifying miles are those frequent flyer miles that passengers accrue towards a carrier's "status" tiers in their respective frequent flyer programs, such as American's AAdvantage Gold/Platinum/ Executive Platinum status or United's Premier/Premier Exec/Premier 1K status. Frequent fliers who achieve elite status on an airline are entitled to additional benefits such as automatic bonus miles for every flight, complimentary upgrades, preferred seat assignments and priority boarding. During the period of our analysis, the alliances we consider are: Northwest/Continental/Delta, United/US Airways, Northwest/Alaska, Continental/Alaska, American/Alaska, American/Hawaiian, Northwest/Hawaiian, and Continental/Hawaiian.[9]

Table 1 summarizes the current domestic alliances and codesharing agreements in the U.S. As of the third quarter of 2003, the three-way alliance between Continental, Delta and Northwest was the largest domestic alliance, accounting for slightly more than 30% of domestic O&D passengers. The next largest alliance was United/US Airways, accounting for 17.6% of domestic O&D passengers.[10]

INSERT TABLE 1 HERE

2.2 A Taxonomy of Cooperation/Integration

In order to better understand how the concepts of codesharing, interlining and alliances are related to one another, Figure 1 depicts the six types of itineraries that we will focus on for the remainder of our analysis. In the examples below, we use the convention operating carrier code/marketing carrier code, and denote a codeshare carrier with an asterisk. Moreover, we denote a connection between two flights with the symbol "→". For example, AA/AA → AA/AA denotes a connecting itinerary between two flights in which both the operating and marketing carrier is American Airlines.

[9]Note that for the purposes of our analysis, United/Delta does not qualify as an alliance even though their joint marketing agreement was still in effect during the period of our data, since Delta SkyMiles members did not earn elite qualifying miles on United flights and vice-versa.

[10]Note that many airlines do not form exclusive partnerships. For example, both Alaska Airlines and Hawaiian Airlines have bilateral alliances with three different partners. This should come as no surprise, however, since both of these carriers' networks are fairly concentrated geographically.

Likewise, NW/CO* → CO/CO denotes a connecting itinerary where the first segment is operated by Northwest, but is marketed by Continental as a codeshare flight, and the second segment is both operated and marketed by Continental. For clarity of explanation (and to match our empirical analysis that follows), we assume that all itineraries are comprised of either one or two coupons per directional leg.[11]

INSERT FIGURE 1 HERE

We start by describing two benchmark cases for our analysis.

#1: Pure Online: We say that an itinerary is "pure online" if it is both online *and* has no codeshare segments. *Examples:* A two segment ticket with both segments operated and marketed by Continental Airlines (CO/CO → CO/CO) or a single coupon ticket operated and marketed by Southwest Airlines (WN/WN).

#2 Non-Allied Interline: A non-allied interline itinerary is a connecting ticket between two carriers that are not part of an alliance. *Examples:* connecting itineraries between Delta and American (DL/DL → AA/AA) or Alaska and United (AS/AS → UA/UA).[12]

Categories #1 and #2 are the two extreme cases on the spectrum of integration/cooperation. While case #1 represents a fully integrated (and presumably most desirable from the point of view of the traveler) itinerary, case #2 is the least integrated, potentially most inconvenient and the most costly type of itinerary to provide. Next, we consider two commonly studied types of cooperative itineraries.

#3: Allied Interline: We say that an itinerary is "allied interline" if it consists of an interline transfer between two carriers that are alliance partners. *Example:* A two segment ticket between United and US Airways, with each segment marketed by the operating carrier (US/US → UA/UA). Other examples would include NW/NW → DL/DL and AS/AS → AA/AA.

#4: Traditional Codeshare: We define an itinerary as a "traditional codeshare" itinerary when it: (a) has two segments, (b) is interline, and (c) has one codeshare segment. *Examples:* A connecting itinerary between Continental and Northwest, marketed solely by Northwest (CO/NW* → NW/NW) or a connecting itinerary between United and US Airways, marketed solely by United (UA/UA → US/UA*).

[11]Importantly, neither the distribution of itineraries, nor our empirical results, change if we include three-coupon itineraries.

[12]While it is possible that one or both of the segments in a non-allied interline ticket could also be codeshare (i.e, NW/CO* → UA/US*) we abstract from this possibility as they are exceedingly rare. We have also dropped such itineraries from our data set, of which there were 8.

It is important to note that traditional codesharing involves two distinct operating carriers. Finally, we consider two additional types of codesharing, which we refer to as the *virtual* codesharing cases.

#5: Semi Virtual Codeshare: A "semi virtual codeshare" itinerary is defined as a two coupon itinerary that: (a) has the same operating carrier throughout, and (b) has one codeshare segment. *Examples*: A connecting itinerary operated solely by Northwest, but marketed partly by Continental and partly by Northwest (NW/NW → NW/CO*).

#6: Fully Virtual Codeshare: Finally, a "fully virtual codeshare" itinerary is defined as an itinerary that: (a) has the same marketing carrier throughout, (b) is online, and (c) is codeshared on all of its segments. Thus, a fully virtual codeshare itinerary has the potential to create an entirely new online competitor. *Examples:* A connecting itinerary operated entirely by United, but marketed solely by US Airways (UA/US* → UA/US*) or a non-stop itinerary operated by Alaska, but marketed by American (AS/AA*).

The key distinction between traditional (case #4) and virtual (cases #5 and #6) codesharing is that in the virtual cases, the operating carrier remains the same across all coupons of the ticket. We refer to codeshare itineraries of these types as "virtual" rather than "traditional" since pure online service is already being offered by one (and perhaps both) of the carriers in the market. Thus, codesharing of this type creates an additional "virtual" competitor in the market. Put differently, what makes virtual codesharing arrangements unique is that the operating carrier will always offer (and in 70% of the cases in our data, the marketing carrier as well) their own pure online service in the same market. Indeed, in some markets, seats on the same flights may be marketed as pure online (case #1, i.e., NW/NW → NW/NW), semi virtual codeshare (case #5, i.e., NW/NW → NW/CO*) and fully virtual codeshare (case #6, i.e., NW/CO* → NW/CO*), potentially all at different prices.

At this point, it is worth pausing to understand how cases #1–6 fit into the existing literature on codesharing. Thus far, most of the existing literature on codesharing—both international and domestic—has only considered connecting itineraries involving two distinct operating carriers (i.e Brueckner 2003, Brueckner and Whalen 2000, Bamberger, Carlton, and Neumann 2004). Thus, for all intensive purposes, the term "codesharing" used in the previous literature refers to our traditional codeshare case, #4. Moreover, since prior to the proliferation of international alliances, the majority of international itineraries involved non-allied interline connections, the benchmark of comparison in the international literature (Brueckner 2003, Park and Zhang 2000, Brueckner and Whalen 2000) has been equivalent to our case #2.

Furthermore, unlike the previous literature, we include non-stop itineraries as part of our analysis because nearly 20% of codesharing passengers in our data travel non-stop. By definition, the single coupon codeshare itineraries are included as part of our fully virtual codeshare case, #6. Thus, while the literature has focussed primarily on comparing type #4 itineraries (traditional codeshare) to type #2 itineraries (non-allied interline), we believe that some of the most interesting economic and policy questions surrounding cooperative marketing agreements in the domestic airline industry arise from the differences among the codesharing variations (cases #4–6). And since non-allied interline itineraries (case #2) are exceedingly rare in the U.S. domestic market, our benchmarks are the set of pure online itineraries (case #1).

3 Economic Incentives For Domestic Codesharing

In this section, we discuss alternative hypotheses about carriers' incentives to codeshare and explore their potential pricing implications.

The Impact of Double-Marginalization In the context of international aviation, interline itineraries are known to be more expensive than otherwise comparable online itineraries because of the double marginalization problem. Double marginalization occurs because each carrier of an interline itinerary tries to maximize the profit from its own segment independently from the other carrier. Consequently, interlining carriers typically charge segment fares higher than a single decision maker controlling prices over the joint itinerary would. Thus, in international aviation, it is well understood that a codeshare itinerary should result in a lower fare than an otherwise comparable interline itinerary, since cooperative pricing enables carriers to internalize part of the double marginalization externality associated with joint pricing on interline tickets (Brueckner 2003, Brueckner and Whalen 2000).[13] If the same logic applies to domestic itineraries, we would expect—in general—that both traditional (#4) and fully virtual (#6) codeshare itineraries will also be priced less expensively than non-allied interline itineraries (case #2). However, the double marginalization hypothesis does not predict codeshare fares to be below those of pure online itineraries (case #1). Rather, it predicts that codeshare fares will tend to fall between case #1 and case #2 (non-allied interline).

[13] As noted by Brueckner (2003), depending on the specific details of the revenue pro-rate agreement between codeshare partners (i.e., the formula used by carriers to divide ticket revenue) and absent antitrust immunity, it is unlikely that traditional codesharing could allow carriers to fully internalize the double marginalization externality. This same argument applies to the traditional codeshare itineraries in our domestic sample, and is consistent with our empirical results.

Crowding Out Since codeshare flights appear multiple times in CRSs, they can potentially crowd out itineraries of other carriers on the computer screen of travel agents or travelers trying to book tickets (Bamberger, Carlton, and Neumann 2004, Transportation Research Board 1999). This has led to a concern that codeshare partners may generate an unfair advantage relative to non-codesharing carriers, potentially resulting in less competition and higher fares. Likewise, if alliance partners chose to compete less vigorously than they otherwise would on overlapping markets but for the cooperative agreement, fares offered by codeshare partners in these markets could increase (Whalen 1999, Transportation Research Board 1999).

Network and Frequency Expansion Under traditional codesharing, the networks of two partner carriers are linked together to provide highly coordinated service, often where one (and sometimes both) of the partner carriers do not offer online service of their own. Since the operating carrier receives all of the revenue from the segment(s) it operates (under free-sale agreements) and since passengers using traditional codeshare tickets by definition travel on both partner carriers, carriers' incentives to engage in traditional codesharing are fairly straightforward.[14]

Virtual codesharing, on the other hand, entails a single operating carrier that allows its codeshare partner to market and sell tickets using its own marketing code. For example, for the virtual itinerary UA/US* → UA/US*, US Airways markets the ticket, but the passenger flies entirely on flights operated by United. At first glance, the incentives to engage in virtual codesharing are not at all obvious. In the above itinerary, for example, US Airways receives none of the ticket revenue despite the fact that it sold the ticket, and United could simply sell the same ticket as UA/UA → UA/UA. Unlike traditional codesharing, therefore, virtual codesharing incentives are more subtle.

In order to understand virtual codesharing incentives, it is important to emphasize that while the virtual marketing partner does not realize any ticket revenue (other than a nominal commission) for the virtual codesharing tickets it sells, it does benefit from expanded network scope and schedule frequency. For example, while US Airways does not operate non-stop service between Boston and San Francisco, it can sell non-stop service in this market to its Boston based customers (where it has a substantial base of frequent flyers) via its codeshare partnership with United. US Airways customers purchasing the nonstop UA/US* virtual ticket from Boston to San Francisco still receive elite-qualifying frequent flyer mileage and other benefits, such as access to United's lounges. Thus, virtual codesharing enables US Airways to compete more effectively for local customers in Boston,

[14]For example, on the traditional codeshare ticket NW/NW → CO/NW*, Northwest receives the revenue from the first segment and Continental receives the revenue from the second segment. Despite the fact that Northwest markets the entire ticket, both carriers benefit from the codeshare agreement since the passenger may not have flown on either carrier but for the ability of a single marketing carrier to set the price of the ticket, especially in markets where there is competition from other carriers offering pure online service.

many of whom will value the larger virtual network. And despite the fact that US Airways does not receive any revenue on the virtual tickets it sells, codeshare agreements between major carriers are carefully negotiated so that they are "balanced" in the sense that the sets of markets where partners offer virtual codesharing on each others networks are more or less equivalent. Thus, while US Airways benefits from expanded network scope from Boston to parts of country where it does not offer service (or does so with less convenient schedules and routings) such as San Francisco or Los Angeles, United benefits from US Airways' network coverage from Boston to destinations in the eastern part of the country such as US Airways' shuttle routes to New York's LaGuardia airport and Washington's National airport.

Likewise, in many markets (indeed, 70% in our data set), the virtual carrier also offers its own pure online service. Consequently, virtual codesharing enables both alliance partners to augment their schedule frequency, which is also valued by most passengers. For example, while Alaska Airlines and American Airlines both offer non-stop flights between Seattle and Chicago, virtual codesharing on each others' flights enables both carriers to increase their non-stop flight frequency in the market, which in turn should allow the carriers to collectively capture a greater share of the Boston–Chicago traffic, where they compete with other carriers offering non-stop such as United and Southwest.

Service Quality and Product Differentiation Thus, while the basic incentive for offering virtual codesharing (expanded network scope and frequency) appears to be consistent with traditional codesharing, the fare implications have the potential to be quite different. This is because there are small—but often significant—differences in the benefits offered to elite frequent flyers purchasing virtual codeshare tickets. For example, while American's elite frequent flyers are able to upgrade to first-class on flights operated and marketed by American, they are not eligible for upgrades either when purchasing virtual tickets operated by Alaska (i.e, AS/AA* $\rightarrow$ AS/AA*) or virtual tickets operated by American but marketed by Alaska (ie., AA/AS* $\rightarrow$ AA/AS*).[15] Consequently, a virtual ticket operated by American but sold by Alaska (i.e, AA/AS* $\rightarrow$ AA/AS*) is likely to be perceived by some passengers—in particular, American's elite frequent flyers—as an imperfect substitute. We would expect therefore, that in markets where American offers both pure online service *and* virtual service, its virtual service will be sold at a discount to its pure online service.

Thus, it is possible that beyond expanding frequency and network scope, virtual codesharing can be used as a customer-segmentation device by airlines. It is well know that airlines have long used various ticket restrictions (i.e, Saturday night stay requirements, refundability, change fees,

[15] Likewise, while Northwest's elite frequent flyers are eligible to receive free upgrades on flights operated by Northwest, they do not qualify for upgrades on virtual tickets operated by Delta (i.e, DL/NW* $\rightarrow$ DL/NW*).

etc.) to differentiate between business and leisure passengers. Virtual codesharing may provide yet another mechanism by which carriers can further differentiate between passengers that value all of the product characteristics that are "bundled" with the pure online product (i.e., upgradeability) and those passengers who may not (non-elite passengers seeking the lowest possible fare). In some sense, the pure online service represents a carrier's "brand-name" premium product, whereas the virtual codeshare service represents its "generic" product. In the absence of the virtual codeshare product, a carrier may not want to offer prices sufficiently low to attract extremely low willingness-to-pay customers, since some its higher willingness-to-pay customers (i.e., elite passengers hoping to upgrade) would also buy these tickets. However, by offering the virtual codeshare product, a carrier is able to serve these low willingness-to-pay consumers while its elite passengers will continue to choose the relatively more expensive—but upgradeable—pure online product.

To summarize, there appear to be at least four possible incentives for carriers to engage in codesharing: (1) to internalize the externality associated with double marginalization, (2) to increase the number of listings in the CRS (i.e., "crowding out"), (3) to expand network scope and schedule frequency, and (4) product differentiation. While the network scope, frequency and crowding out hypotheses imply that codesharing should result in higher fares, the reduction of double marginalization and product differentiation hypotheses imply that codeshare fares should be lower than otherwise similar, non-codeshare fares. We now turn our attention to studying how these competing incentives interact in the data.

4 The Data & Model

Data for our analysis was drawn from the U.S. Department of Transportation's (DOT) domestic origin and destination Databank 1B, a 10% sample of passengers traveling on U.S. certified carriers. The period of time covered in our study is the third quarter of 2003. Each observation in the raw DOT data consists of a unique airline itinerary, including the starting and ending airports of each flight coupon, the operating and marketing carrier for each flight coupon, the price paid, class of service, and (among other things) the number of passengers traveling on that particular itinerary. The raw DOT data set for the third quarter of 2003 consists of roughly 2.4 million observations representing over 55 million directional trips. In order to focus our analysis on common types of trips, we place the following restrictions on raw data. First, we restrict our analysis to passengers purchasing round-trip, coach class (both restricted and unrestricted) tickets in which the passenger started and ended at the same airport (i.e., we exclude "open jaw" tickets). Second, we limited our analysis to tickets with either one or two coupons per directional trip leg. Third, we excluded tickets with reported one-way fares less than $25 or greater than $1,500, since these might represent incorrectly coded non-revenue tickets (i.e., employee travel or frequent flyer tickets) or first/business class tickets. Fourth, we excluded itineraries where the marketing carrier of either segment was a non-U.S. carrier. Finally, we limited our analysis to directional city-pair markets generating, on average, at least one passenger per day.

Since the purpose of our analysis is to study the fare implications of codesharing between large carriers, care must be taken to ensure that itineraries involving the regional "codesharing" partners of the larger hub-and-spoke carriers are appropriately accounted for. Since the marketing carrier code for a flight segment operated by a regional affiliate (i.e., American Eagle ("MQ")) will be that of its mainline partner (i.e., American ("AA")), we recoded the operating carrier code for each coupon operated by a codesharing regional carrier with the code of its mainline partner. Although this is a rather tedious endeavor, failing to do so would substantially over-count the number of codeshare itineraries, since a flight segment is defined as being codeshared when its operating and marketing codes differ.

Our unit of observation is a directional, carrier-specific itinerary.[16] Since we are ultimately interested in studying the effect of codeshare agreements on fares in city-pair markets, we group itineraries with originating and terminating airports in the same metropolitan area.[17] Likewise, since there are often numerous records for itineraries with different prices that are otherwise identical, we collapsed the data by itinerary, retaining the passenger weighted average fare and total number of passengers for that itinerary. Our final data set includes 73,379 observations, representing slightly over 37.5 million passengers travelling on over 14,470 different city-pair markets.

4.1 Codesharing in Practice

This section presents some stylized facts regarding the various cooperative practices—as outlined in Section 2.2—seen in our data. Of the 73,379 itineraries in our sample, slightly more than 13% (accounting for 0.5 million passengers) involve at least one codeshare segment. Table 2 summarizes our data according to the six types of itinerary groupings described in section 2.2.

INSERT TABLE 2 HERE

[16] That is, we consider passengers traveling between Boston and San Francisco to be in different markets than those traveling between San Francisco and Boston.

[17] For the purposes of our analysis, we group airports in the following metropolitan area: Washington, D.C. (BWI, DCA, IAD), San Francisco Bay Area (SFO, SJC, OAK), Los Angeles (LAX, BUR, LGB, SNA, ONT), Houston (IAH, HOU), Dallas (DAL, DFW), Chicago (ORD, MDW), New York City (LGA, JFK, EWR, HPN) and Miami (MIA, FLL).

As expected, the overwhelming majority of passengers (over 98%) in our sample travel on pure online (case #1) itineraries. In contrast, and also as expected, only a small fraction of passengers (.15%) use non-allied interline itineraries. The fact that allied interline (case #3) itineraries are the least frequent type in our sample reflects the fact that codesharing among alliance partners has become the preferred type of cooperative marketing arrangement.

A key observation from Table 2 is that among codesharing itineraries, virtual codesharing (cases #5 and #6) is five times more common than the traditional codesharing (case #4). While virtual codesharing is also seen in some international markets (for example, Northwest and KLM sell seats on each other's flights between Boston and Amsterdam), the proclivity of such codesharing (either in domestic or international markets) has not yet been documented in the literature. Among the two types of virtual codesharing, fully virtual is more prevalent (in terms of passengers) than semi virtual.

4.2 The Models

Our empirical goal is to analyze fare differentials among the different categories of cooperative itineraries relative to the predominant type of domestic itinerary, i.e., pure online. We denote itineraries with index i where an itinerary is defined as a unique combination of market and operating/marketing carriers (for example, CO/CO $\rightarrow$ NW/NW between Memphis and El Paso). We denote the market of an itinerary i with index j_i or j for brevity.

Our dependent variable is the natural log of the passenger-weighted average fare on a given itinerary, denoted $\ln(fare)_i$. We regress these average fares on itinerary characteristics, including the codeshare and alliance status, while controlling for market fixed effects. For comparative purposes, we also present results from a pooled cross-section regression in which we also include a vector of market characteristics (our baseline model). All regression estimations are analytically weighted according to the number of passengers traveling on each itinerary.

Baseline Model In our baseline model, we regress $\ln(fare)_i$ on a vector of itinerary characteristics X_i, a market characteristic vector Z_j, and a vector of dummy variables W_i that represent the codesharing and alliance status of each itinerary.

$$\ln(fare)_i = \alpha + X_i'\beta + Z_j'\gamma + W_i'\delta + \epsilon_i \qquad (1)$$

The key parameters of interest are the vector δ, indicating how codeshare fares rank relative to other types of otherwise similar itineraries. We also show how traditional codeshare fares differ from virtual codeshare fares using these parameter estimates.

Market-Fixed Effects Model Since unobserved market heterogeneity may influence the estimates in the baseline model, our primary interest is a model with market fixed-effects. Using ϕ_j to control for market heterogeneity, we regress $\ln(fare)_i$ on the itinerary characteristics X_i and codeshare status dummies W_i.

$$\ln(fare)_i = \tilde{\alpha} + X_i'\tilde{\beta} + W_i'\tilde{\delta} + \phi_j + \tilde{\epsilon}_i \tag{2}$$

The advantage of the fixed-effects model is that $\tilde{\delta}$ estimates represent purely "within" market variations, independent of market heterogeneity. Controlling for market heterogeneity is important for two reasons. First, codesharing decisions may raise some market selection issues (Brueckner 2003). For example, if alliances choose to codeshare in markets where they face relatively greater competition, the codeshare variables are likely to pick up this market selection bias. Second, the presence of codeshare itineraries may influence the prices of other itineraries in the same markets, contributing further to market heterogeneity. Since we would like to separate those factors from our estimates as much as possible, our analysis focuses on the fixed-effect estimates.[18]

4.3 Independent Variables

Descriptions of our independent variables are detailed below and summarized in Table 4. Itinerary-specific variables are indexed by i and market-specific variables are indexed by j. We start by describing the itinerary specific variables included in the market fixed-effects regression.

Itinerary Specific Variables: Even within the same market, itineraries can differ in their routing choice and carrier. For example, for the same origin and destination, some itineraries represent non-stop service while others are connecting. Thus, we include a dummy variable $D(nonstop)$ that takes the value 1 if itinerary i consists of a single coupon (i.e., non-stop or direct itineraries) and takes the value 0 otherwise. We also include $distdif_{ij}$, which is computed as itinerary i's actual distance divided by the non-stop distance of market j. While longer itineraries are more expensive to operate (all things equal), travelers are likely to prefer shorter itineraries. Consequently, the sign on $distdif_{ij}$ is ambiguous *a priori*.

$orgshare_{ij}$ measures carrier i's share of O&D passengers at the origin of market j. We also include two dummy variables to identify itineraries operated by low cost carriers. $D(LCConline)_i$

[18] Since codesharing takes place in only 36.46% of all the markets in our sample, the fare differential calculated in the fixed-effects model between the codeshare and non-codeshare itineraries are essentially based on that sub-sample of markets. Consequently, to compare how codeshare fares compare relative to itineraries outside the sub-sample, we also need to use the baseline model.

is a dummy variable that takes the value 1 if itinerary i is a pure online LCC itinerary, 0 otherwise. Similarly, $D(LCCinterline)_i$ is a dummy variable that takes the value 1 if itinerary i in an interline itinerary involving a low cost carrier, 0 otherwise.[19]

Carrier Specific Effects: Following Brueckner and Whalen (2000) and Brueckner (2003), we measure airline specific cost effects by creating carrier variables generated by interacting airline dummies with the distance flown.[20] While we control for these carrier specific effects in both models, we suppress the estimates in our tables for brevity.

Cooperation Variables: Our main empirical goal is to determine the effect of various cooperative arrangements on domestic airfares. These cooperative variables, represented by the vector W_i in our model, measure the codesharing and alliance status of each itinerary.

The existing literature on cooperative airline agreements (both international and domestic) typically distinguishes between codeshare/non-codeshare itineraries, alliance/non-alliance itineraries, and online/interline itineraries. Thus, our first set of regressions follow this tradition by including three dummy variables representing an itinerary's codeshare, alliance and online status. $D(online)_i$ is a dummy variable that takes the value 1 if itinerary i is online, and takes the value 1 if the itinerary includes an interline connection (i.e., change in operating carrier). $D(codeshare)_i$ is a dummy variable that takes the value 1 if, for any coupon on itinerary i, the operating and marketing carrier differ, 0 otherwise. Finally, $ally_i$ is a dummy variable that takes the value 1 if itinerary i involves two allied carriers (based on our set of alliances from Table 1), 0 otherwise.

In our second set of regressions, we fully disaggregate our sample into each of our six, mutually exclusive cases, using pure online itineraries (case #1) as the base case. Thus, coefficients on the dummies representing all other cases measure the fare differentials from the base case.

INSERT TABLE 3 HERE

Table 3 summarizes how our six degrees of integration and cooperation outlined in Section 2.2 are related to the traditional treatment of *online*, *codeshare* and *ally*. The reader should be

[19]The low cost carriers we include in these variables as well as *lccshare* are: Southwest, JetBlue, Frontier, AirTran, ATA, America West, Spirit and Sun Country. Moreover, when constructing our share variables such as *orgshare*, we included first and business class passengers as well as those purchasing one-way tickets and tickets with more than two coupons per directional leg.

[20]For example, if the two operating carriers on an itinerary are Northwest and Continental, Northwest's variable equals the natural log of the distance flown on the Northwest operated segment and Continental's variable is equal to the natural log of the distance flown on the Continental operated segment, and the carrier variables for all other carriers would equal zero.

aware that in our data, codesharing need not imply online, and vice-versa. Likewise, while *codeshare* implies *ally*, the reverse relationship does not necessarily hold. Finally, there is one additional combination not covered by the six cases enumerated above: $online_i$=0, $ally_i$=0, $codeshare_i$=1, for example, the itinerary NW/CO* → UA/US*. In our data set, there were eight such observations, which were dropped.

Market Specific Variables: In the baseline model, we include market specific variables to control for market heterogeneity. $dist_j$ is the natural logarithm of the non-stop distance for market j. $pop\ org_j$ and $pop\ dest_j$ are the populations at the origin and destination cities of market j, respectively, in natural logarithm. Large cities often generate proportionally more business travelers and thus may tend to have higher average fares. Likewise, since markets with a high proportion of vacation travelers tend to have lower average fares, we follow Morrison (2001) by including $sunbelt\ dest_j$, a dummy variable that takes the value 1 if the destination of market j is in one of the following states or territories: California, Nevada, Arizona, New Mexico, Texas, Louisiana, Mississippi, Alabama, Florida, Hawaii, Puerto Rico, and the U.S. Virgin Islands.

We also include three variables that measure the overall competitiveness of markets. First, we include $mkthhi_j$, the Herfindahl index for market j based on O&D passengers. We also include $lccshare_j$, the collective share of low-cost carriers in market j. Finally, we include $\#\ itineraries_j$, the number of different pure online itineraries in the markets j.

Variable definitions are summarized in Table 4. Summary statistics (both raw and passenger-weighted) for our independent variables are presented in Table 5.

INSERT TABLE 4 HERE

INSERT TABLE 5 HERE

5 Estimation Results

Estimation results from our fixed-effects model are summarized in Table 6 and results from our baseline model in summarized Table 7. In both tables, Column (1) and (2) differ in their treatment of the cooperation/integration variables. We focus our analysis on the fixed-effect results in Table 6 because they better control for the effects of market heterogeneity.

INSERT TABLE 6 HERE

INSERT TABLE 7 HERE

5.1 Fixed Effects Results

Column (1) in Table 6 replicates the conventional treatment of codesharing and alliances on domestic itineraries by including three dummy variables *D(allied)*, *D(online)*, and *D(codeshare)*. Our *D(codeshare)* variable aggregates the traditional case (#4) and virtual codesharing cases (#5 and #6) into one group. The results show that codeshare itineraries—defined generically—are 3.2% less expensive than otherwise similar non-codeshare itineraries in the same market. Although the magnitude is relatively small and not statistically significant, the coefficient sign is consistent with the literature. Likewise, online itineraries are 14.1% less expensive than otherwise similar interline itineraries in the same markets, whereas alliance itineraries are 2.4% lower than otherwise similar itineraries.

The fairly large (i.e., 14.1%) gap between online and interline fares is consistent with the presence of double marginalization for interline itineraries, a result widely discussed in the literature. The relatively small price impacts of alliances and codesharing are, at first glance, somewhat surprising because these cooperative marketing agreements are intended to reduce fares by alleviating some of the double marginalization externality. However, we suspect that the aggregation of traditional and virtual codesharing may be masking a number of competing effects that are taking place at the same time.

To investigate further, column (2) in Table 6 disaggregates our sample by employing the six classifications outlined in Section 2.2. Using pure online itineraries (case #1) as our base case, column (2) includes five different dummy variables for the remaining cases. As expected, the most expensive itinerary type are non-allied interline (case #2), which are 18.0% more expensive than the pure online, a result of double-marginalization. Allied interline (case #3) and traditional codeshare itineraries (case #4) fall between pure online (case #1) and non-allied interline itineraries. In particular, allied interline itineraries are 11.6% more expensive than pure online itineraries, while traditional codeshare itineraries are 6.4% more expensive than otherwise similar pure online itineraries in the same market.

The results of the first three categories relative to the pure online case are consistent with the double marginalization story argued by Brueckner (2003). Alliance and traditional codeshare itineraries both lower fares relative to the non-allied interline level. As expected, codesharing is more effective at reducing the double marginalization externality than alliances absent codesharing, since the codeshare fare is set by a single carrier. Both cooperative arrangements however, still result in fares that are above pure online fares, the benchmark that perfect cooperation or integration would have achieved.

While traditional codesharing is more expensive than the pure online base case, both types of virtual codesharing are *less expensive* than pure online. While semi-virtual codesharing (case #5) is 4.6% less expensive than the pure online, fully virtual codesharing (case #6) is 5.6% less expensive.[21] This result, which has not yet been documented in the literature, is both novel and quite surprising.[22] Although the double marginalization hypothesis implies that codeshare fares could approach pure online fares, it does not predict codeshare fares to be lower than pure online fares. Thus, this outcome necessitates an alternative explanation.

Of the remaining hypotheses discussed earlier, we believe that the most compelling explanation as to why virtual codeshare fares are lower than pure online fares is product differentiation. Recall the example of the ticket AA/AS* → AA/AS* discussed in Section 3. For an American Airlines' "elite" frequent flyer, this is an imperfect substitute for American's pure online itinerary (i.e, AA/AA → AA/AA) since the virtual ticket does not allow the traveler to upgrade to first class, even though the flights on the two itineraries are the same. Since frequent flyers do not typically enjoy all of the same benefits when purchasing virtual tickets, we should expect virtual tickets—on average—to be priced lower, reflecting the vertically differentiated nature of these products.[23]

It is well known that airlines use a wide variety of ticket restrictions to segment passengers based on their willingness-to-pay. However, the widespread proliferation of low cost carriers in recent years has forced many carriers to relax certain restrictions, consequently, they have become somewhat less effective.[24] The effectiveness of differential pricing is limited by a carrier's ability to separate consumers by their different willingnesses-to-pay. Our results suggest that virtual codesharing may help carriers segment customers even further than they could otherwise do using only their pure online service. In particular, virtual codesharing appears to be a tool that carriers can use to further differentiate between customers seeking the "branded" product from those who are willing to purchase the non-branded virtual product in exchange for a lower fare.[25]

In contrast, both CRS crowding out as well as increased network and frequency expansion should—all other things equal—lead to a higher share of passengers at key airports for the al-

[21]We also estimated the same models with non-stop itineraries excluded from the data. Relative rankings and fare differentials remain the same.

[22]We have tested if the coefficients on cases 5 and 6 are significantly different. The result rejects the null hypothesis that these coefficients are the same at the 1% significance. We revisit the difference between these two cases later in our discussion.

[23]Likewise, the semi-virtual ticket, AA/AA → AA/AS* (i.e., case #5) is slightly more desirable than the fully virtual ticket AA/AS* → AA/AS* (i.e., case #6) to an American frequent flyer since the traveller would be able to enjoy its full elite privileges (i.e., upgrade) on the first segment of the trip marketed (and operated) by American. In both our fixed effects and baseline models, case #6 fares are lower (and statistically different) from case #5 fares. Thus, the results support our hypothesis on the difference between semi-virtual and fully virtual codesharing.

[24]For example, in markets where full-service hub and spoke carriers compete head-to-head with a low cost carrier, Saturday night stay requirements are often not required to qualify for the lowest fare.

[25]Moreover, we found that the average share of low cost carriers in markets where fully virtual codesharing was offered was roughly 24.4%, compared to 12.6% in markets where only traditional codesharing was offered. This tends to reinforce the notion that carriers use virtual codesharing as a means to segment extremely low willingness-to-pay passengers.

liance carriers, which in turn should lead to higher fares on flights to and from those airports (Evans and Kessides 1993, Lee and Luengo Prado 2005). This, however, is the opposite of what we find.

Turning our attention to the other independent variables in Table 6, most coefficients have the expected sign and are significant at the 1% level. The carrier's share of local passengers at the origin has a large positive effect on fares, a result commonly found in the literature (i.e. Evans and Kessides 1993). For example, a 1% increase in the carrier's market share at the origin raises fares by 0.304%. For a given a market, longer itineraries—relative to the non-stop distance—tend to have lower fares, reflecting travelers' preferences for shorter (and often more convenient) itineraries within the same market. However, non-stop itineraries are 12.8% less expensive than otherwise similar connecting itineraries, possibly a reflection of the lower operating costs, all things equal, associated with providing non-stop service. As expected, itineraries provided by low cost carriers are much less expensive than the otherwise similar itineraries. Also as expected, the impact of low cost carriers are stronger for online, rather than interline itineraries.[26]

Finally, we stress that our results control for carrier specific effects by including the interaction variables between carrier dummies and the distances they fly in each itinerary (these coefficients are have been suppressed in Tables 6 and 7). Thus, even if codesharing carriers consistently price differently than other carriers, those effects are already controlled for in our estimated coefficients.

5.2 Baseline Model Results

Table 7 presents the results of our baseline model where market heterogeneity is controlled for using a set of independent variables without market fixed effects. Most itinerary specific variables have the same signs as in Table 6. As expected, the coefficients' magnitudes are different, as they are influenced by unobserved market heterogeneity.

The signs and relative ranking of all the cooperation/integration categories remain the same as those in Table 6. However, the magnitudes of coefficients are often larger, due to unobserved market heterogeneity. For example, in column (1), the estimated coefficient for $D(online)_i$ shows a 21% gap between online and interline itineraries (compared to a 14% gap in the fixed effects model). Both alliances and codesharing appears to reduce fares. In column (2), non-allied interline itineraries (case #2) are 26% more expensive than pure online itineraries (case #1), and as before, the allied interline (#3) and traditional codeshare (#4) cases lie between these two benchmark cases.

The relative rankings of virtual codeshare cases remain the same. Semi-virtual and fully virtual

[26] We refrain from interpreting the coefficients on *D(LLC online)* and *D(LLC interline).* Since our regressions control for carrier specific effects by interacting carrier dummies and coupon distance (their coefficients are also suppressed in the table), these coefficients are the intercept differences at zero distance, which is devoid of meaningful interpretation.

codeshare itineraries are 5.4% and 10% less expensive, respectively, than pure online itineraries. And while the presence of market heterogeneity prevents us from interpreting these numbers solely as the impact of codesharing, it is nevertheless interesting to note that codeshare itineraries, when compared to pure online itineraries with similar characteristics across markets, have much lower fares than when we compare them solely within the same markets.

The coefficients on market specific variables are statistically significants at 1% and have the expected signs. More pure online itineraries in a market result in lower fares in that market due to added effective competition. Higher population, both at the origin and destination increase fares, as large metropolitan areas tend to generate proportionally more business travelers. In contrast, the higher the proportion of leisure travelers, as indicated by $D(sunbelt)_j$, the lower the fares. Higher market concentration, measured by the Herfindahl index of O&D passengers, increases fares, while—unsurprisingly—higher market shares by low-cost carriers results in lowers fares. Finally, longer markets have higher fares due to their higher costs, all other thing equal.

6 Conclusions

This paper investigates the price implications of alliances and codesharing in the U.S. domestic airline industry. While our results are fully consistent with the existing literature on international codesharing (Brueckner 2003, Brueckner and Whalen 2000), we find that internalization of the double marginalization externality plays only a limited role in shaping today's domestic airfares. This is because the overwhelming majority of passengers traveling in domestic markets already use online service.

We find that only 15% of codeshare tickets in our sample link the networks of two carriers together (a practice we refer to as "traditional" codesharing). Rather, roughly 85% of domestic codesharing is "virtual" in nature, whereby a carrier markets tickets entirely on flights operated by another carrier. From a policy standpoint, this distinction is very important since in these virtual codeshare markets, at least one (and often both) of the partner carriers already offers pure online service.

Surprisingly, our fixed-effects results find that virtual codesharing itineraries are 5-6% less expensive than single-carrier online service in the same markets. We believe that increased product differentiation may—in large part—be driving this somewhat surprising result. Under this hypothesis, a carrier uses virtual codesharing as a "generic" or qualitatively inferior product, to further segment its customers between those who are willing to purchase the "branded", premium product (i.e., pure online) and those passengers who are not.

Despite what is an admittedly focussed analysis of one particular aspect of domestic airline pricing, we believe that the findings documented in this paper are part of a growing and important trend for travelers. Indeed, the same trend of alliances that dominated international aviation throughout the 1990's and during the early part of this decade appear to be spilling over into the domestic arena.[27] Consequently, the number of passengers travelling on domestic codeshare itineraries—which had already reached roughly 2 million passengers in 2003—is likely to continue growing rapidly.[28]

[27]Indeed, in 2005, even Southwest Airlines an ATA—two low cost carriers—formed a domestic codeshare agreement.

[28]Finally, while the current number of passengers traveling on virtual codeshare tickets is small relative to all passengers, a recent related panel data analysis conducted by the authors (Ito and Lee 2005) suggests that the presence of virtual codeshare tickets also appears to have a negative, albeit small, effect on the prices of other carriers serving the market.

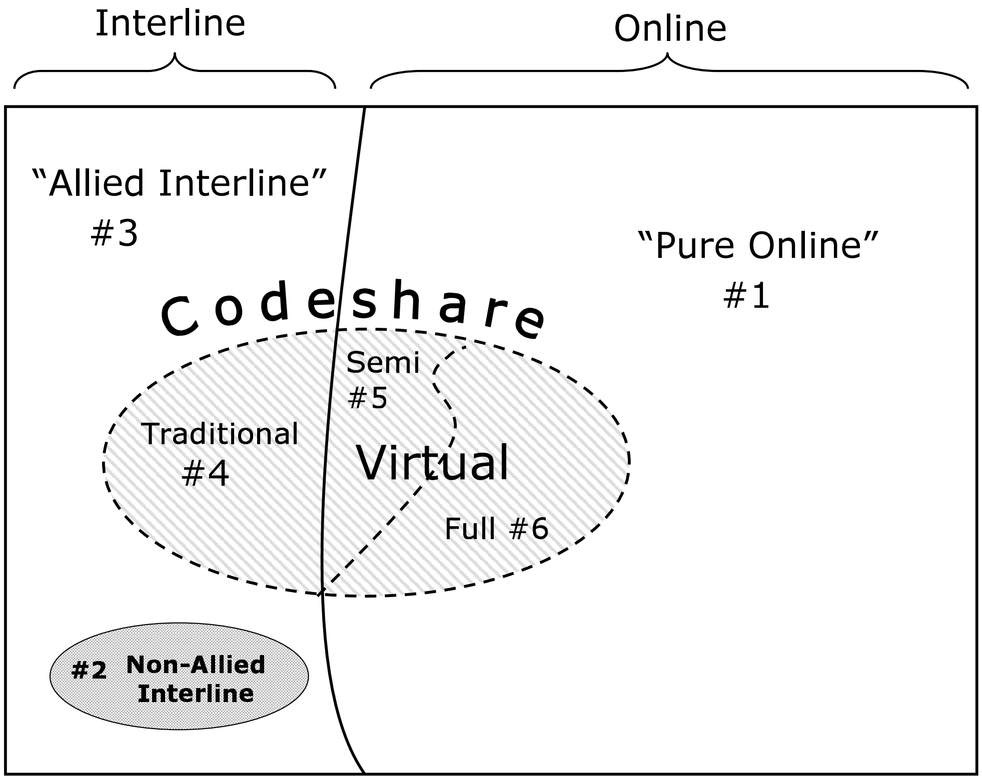

Figure 1: Taxonomy of Airline Cooperative Agreements

Table 1: Current Domestic Alliances/Codeshare Agreements

Carriers	Combined Domestic Share (%)	Notes
Continental/Delta/Northwest	30.4	Three-way codesharing began in June 2003. Excludes local hub markets.
United/US Airways	17.6	Commenced January 2003.
American/Alaska	16.2	Commenced 1999. Codeshare on select flights to/from Los Angeles/Portland/San Francisco/Seattle. Excludes reciprocal lounge access.
American/Hawaiian	13.9	Commenced March 1998. American codeshares on Hawaiian Airlines services within Hawaii. Hawaiian codeshares on American Eagle services at Los Angeles.
Northwest/Alaska	11.4	Commenced August 1999. Systemwide codeshare except select flights to/from Mexico and transcontinental flights. Excludes reciprocal lounge access.
Continental/Alaska	10.5	Commenced March 1999.
Northwest/Hawaiian	9.2	Commenced 1995. Codeshare on intra-Hawaii flights and Trans-Pacific flights. Excludes reciprocal lounge access.
Continental/Hawaiian	8.3	Commenced August 1999. Codeshare on inter-island flights. Excludes reciprocal lounge access.

Notes and Sources: Share is of domestic O&D passengers for the third quarter of 2003 based on U.S. DOT OD1A database. Effective dates from "Airline alliance survey 2003", *Airline Business*, July 2003. Airline lounge reciprocity information from carrier websites. United/Delta "alliance" is excluded from our analysis since passengers were not eligible for elite qualifying miles on partner flights.

TABLE 2: CLASSIFICATION OF COOPERATIVE AGREEMENTS IN DATASET

Case		Example	Observations		Passengers	
			Freq.	Percent	Freq.	Percent
#1	Pure Online	AA/AA → AA/AA	58,901	80.27	36,973,270	98.43
#2	Non-Allied Interline	AA/AA → CO/CO	3,369	4.59	54,530	.15
#3	Allied Interline	NW/NW → CO/CO	1,295	1.76	28,190	.08
#4	Traditional Codeshare	NW/NW → CO/NW*	1,865	2.54	77,850	.20
#5	Semi-Virtual Codeshare	DL/DL → DL/NW*	4,703	6.41	171,320	.46
#6	Fully Virtual Codeshare	UA/US* → UA/US*	3,246	4.42	258,860	.69
Total			73,379	100.00	37,564,020	100.00

Notes and Sources: Data is from the third quarter of 2003, U.S. DOT OD1A domestic database. Includes roundtrip, coach class tickets with less than three coupons per directional trip leg. Examples represent connecting itineraries between operating carrier/marketing carrier flight segments with codeshare segments denoted by *.

Table 3: Our Six Itinerary Classifications and Traditional Codesharing Treatments

Case	Classification	$online_i$=	$ally_i$=	$codeshare_i$=
#1	Pure Online	1	0	0
#2	Non-Allied Interline	0	0	0
#3	Allied Interline	0	1	0
#4	Traditional Codeshare	0	1	1
#5	Semi-Virtual Codeshare	1	1	1
#6	Fully Virtual Codeshare	1	1	1

Notes: Semi-Virtual Codeshare (#5) and Fully Virtual Codeshare (#6) are differentiated by the fact that all segments on a Fully Virtual Codeshare ticket are codeshared.

Table 4: Variable Descriptions

$ln(fare)_i$	natural log of average fare for itinerary j
$orgshare_i$	O&D passenger share of the carrier at the originating airport
$\#itineraries_j$	the number of pure online itineraries available at market i
$ln(pop\ origin)_j$	natural log of the population at the originating city
$ln(pop\ dest)_j$	natural log of the population at the destination city
$D(sunbelt)_j$	a dummy for the sunbelt destination
$mkthhi_j$	Herfindahl-Hirschman Index in the market
$lccshare_j$	collective share of O&D passengers held by LCCs in the market
$ln(dist)_j$	natural log of direct distance
$distdif_i$	an itinerary's travel distance divided by the direct distance
$D(nonstop)_i$	a dummy for nonstop itineraries
$D(LCConline)_i$	a dummy for LCC carriers' pure online itineraries
$D(LCCinterline)_i$	a dummy for LCC carriers' interline itineraries
$D(codeshare)_i$	a dummy for codesharing itineraries
$D(traditionalCS)_i$	a dummy for traditional codesharing itineraries (case # 4)
$D(virtualCS)_i$	a dummy for virtual codesharing itineraries (case # 5 and 6)
$D(allied)_i$	a dummy for itineraries between allied carriers
$D(online)_i$	a dummy for online itineraries
$D(case1)_i$	case # 1 : pure online
$D(case2)_i$	case # 2 : non-allied interline
$D(case3)_i$	case # 3 : allied interline
$D(case4)_i$	case # 4 : traditional codesharing
$D(case5)_i$	case # 5 : semi-virtual codesharing
$D(case6)_i$	case # 6 : fully virtual codesharing

Table 5: Summary Statistics

	Raw Data		Passenger-Weighted	
Variable	Mean	(Std.Dev)	Mean	(Std.Dev)
$ln(fare)_i$	5.174	(0.399)	4.988	(0.397)
$orgshare_i$	0.178	(0.183)	0.250	(0.197)
$\#itineraries_j$	7.243	(4.690)	10.610	(5.943)
$ln(pop\ origin)_j$	14.187	(1.226)	15.008	(1.193)
$ln(pop\ dest)_j$	14.075	(1.333)	14.756	(1.338)
$D(sunbelt)_j$	0.343	(0.475)	0.476	(0.499)
$mkthhi_j$	0.427	(0.193)	0.431	(0.199)
$lccshare_j$	0.160	(0.226)	0.335	(0.292)
$ln(dist)_i$	7.082	(0.585)	6.807	(0.722)
$distdif_i$	1.198	(0.264)	1.048	(0.126)
$D(nonstop)_i$	0.119	(0.324)	0.665	(0.472)
$D(LCConline)_i$	0.112	(0.316)	0.312	(0.463)
$D(LCCinterline)_i$	0.012	(0.109)	0.000	(0.020)
$D(allied)_i$	0.151	(0.358)	0.014	(0.119)
$D(online)_i$	0.911	(0.285)	0.996	(0.065)
$D(codeshare)_i$	0.134	(0.340)	0.014	(0.116)
$D(case1)_i$	0.803	(0.398)	0.984	(0.124)
$D(case2)_i$	0.046	(0.209)	0.001	(0.038)
$D(case3)_i$	0.018	(0.132)	0.001	(0.027)
$D(case4)_i$	0.025	(0.157)	0.002	(0.045)
$D(case5)_i$	0.064	(0.245)	0.005	(0.067)
$D(case6)_i$	0.044	(0.206)	0.007	(0.083)
Observations	73,379		37,564,020	

Table 6: Model with Market Fixed Effects

	(1)	(2)
Dependent Variable	$ln(fare)_i$	$ln(fare)_i$
Itinerary Specific Variables		
$orgshare_i$	0.304†	0.304†
	(0.013)	(0.013)
$distdif_i$	-0.032†	-0.033†
	(0.011)	(0.011)
$D(nonstop)_i$	-0.128†	-0.128†
	(0.029)	(0.029)
$D(LCConline)_i$	-0.295†	-0.295†
	(0.064)	(0.064)
$D(LCCinterline)_i$	-0.165†	-0.204†
	(0.033)	(0.034)
Cooperation/Integration Variables: W_i		
$D(codeshare)_i$	-0.032	
	(0.021)	
$D(allied)_i$	-0.024	
	(0.021)	
$D(online)_i$	-0.141†	
	(0.011)	
$D(case\,1 : Pure\ Online)_i$		Base Case
$D(case\,2 : Non-Allied\ Interline)_i$		0.180†
		(0.014)
$D(case\,3 : Allied\ Interline)_i$		0.116†
		(0.019)
$D(case\,4 : Traditional\ Codeshare)_i$		0.064†
		(0.014)
$D(case\,5 : Semi\ Virtual\ Codeshare)_i$		-0.046†
		(0.010)
$D(case\,6 : Fully\ Virtual\ Codeshare)_i$		-0.056†
		(0.010)
N	73,379	73,379
R^2	0.910	0.910

Notes: Standard errors in parentheses. *Significant at 5%; †Significant at 1%. Carrier specific effects are controlled for, but estimates have been suppressed in the table.

Table 7: Baseline Model - Without Market Fixed Effects

	(1)	(2)
Dependent Variable	$ln(fare)_i$	$ln(fare)_i$
Itinerary Specific Variables		
$orgshare_i$	$0.151^\dagger$	$0.150^\dagger$
	(0.005)	(0.005)
$distdif_i$	$0.065^\dagger$	$0.065^\dagger$
	(0.009)	(0.009)
$D(nonstop)_i$	$-0.126^\dagger$	$-0.127^\dagger$
	(0.018)	(0.018)
$D(LCConline)_i$	$-0.517^\dagger$	$-0.517^\dagger$
	(0.019)	(0.019)
$D(LCCinterline)_i$	$-0.274^\dagger$	$-0.325^\dagger$
	(0.045)	(0.049)
Market Specific Variables		
$\#itineraries_j$	$-0.006^\dagger$	$-0.006^\dagger$
	0.000	0.000
$ln(pop\ origin)_j$	$0.025^\dagger$	$0.025^\dagger$
	(0.001)	(0.001)
$ln(pop\ dest)_j$	$0.006^\dagger$	$0.006^\dagger$
	(0.001)	(0.001)
$D(sunbelt)_j$	$-0.069^\dagger$	$-0.069^\dagger$
	(0.002)	(0.002)
$mkthhi_j$	$0.262^\dagger$	$0.262^\dagger$
	(0.006)	(0.006)
$lccshare_j$	$-0.472^\dagger$	$-0.472^\dagger$
	(0.004)	(0.004)
$ln(dist)_i$	$0.334^\dagger$	$0.334^\dagger$
	(0.005)	(0.005)
Cooperation/Integration Variables: W_i		
$D(allied)_i$	-0.023	
	(0.034)	
$D(online)_i$	$-0.210^\dagger$	
	(0.016)	
$D(codeshare)_i$	-0.068^*	
	(0.034)	
$D(case\,1 : Pure\ Online)_i$		Base Case
$D(case\,2 : Non\ Allied\ Interline)_i$		$0.260^\dagger$
		(0.026)
$D(case\,3 : Allied\ Interline)_i$		$0.187^\dagger$
		(0.031)
$D(case\,4 : Traditional\ Codeshare)_i$		$0.094^\dagger$
		(0.019)
$D(case\,5 : Semi\ Virtual\ Codeshare)_i$		$-0.054^\dagger$
		(0.013)
$D(case\,6 : Fully\ Vitrual\ Codeshare)_i$		$-0.109^\dagger$
		(0.010)
N	73,379	73,379
R^2	0.680	0.680

Notes: Standard errors in parentheses. *Significant at 5%; †Significant at 1%. Carrier specific effects are controlled for, but estimates have been suppressed in the table.

References

Armantier, O., and O. Richard (2003): "Domestic Airline Alliances and Consumer Welfare," Unpublished Manuscript.

Bamberger, G., D. Carlton, and L. Neumann (2004): "An Empirical Investigation of the Competitive Effects of Domestic Airline Alliances," *Journal of Law and Economics*, XLVII, 195–222.

Brueckner, J. (2001): "The Economics of International Codesharing: An Analysis of Airline Alliances," *International Jouranl of Industrial Organization*, 19, 1475–1498.

——— (2003): "International Airfares in the Age of Alliances: The Effects to Codesharing and Antitrust Immunity," *Review of Economic Statistics*, 85, 105–118.

Brueckner, J., and T. Whalen (2000): "The Price Effects of International Airline Alliances," *Jounal of Law and Economics*, 43, 503–545.

Clougherty, J. (2000): "US domestic airline alliances: does the national welfare impact turn on strategic international gains?," *Contemporary Economic Policy*, 18, 304–314.

Evans, W., and I. Kessides (1993): "Localized Market Power in the U.S. Airline Industry," *Review of Economics and Statistics*, 75, 66–75.

Ito, H., and D. Lee (2005): "The Impact of Domestic Codesharing on Market Airfares: Evidence from the U.S.," Forthcoming in *Advances in Airline Economics, Volume 1, Competition Policy and Antitrust*, Darin Lee Ed. Amsterdam: Elsevier.

Lee, D., and M. Luengo Prado (2005): "The Impact of Passenger Mix on Reported Hub Premiums in the U.S. Airline Industry," Forthcoming in *Southern Economic Journal*.

Morrison, S. A. (2001): "Actual, Adjacent and Potential Competition: Estimating the Full Effect of Southwest Airlines," *Journal of Transport Economics and Policy*, 35, 239–256.

Oum, T., J. H. Park, and A. Zhang (1996): "The effects of airline codesharing agreements on firm conduct and international airfares," *Journal of Transport Economics and Policy*, 30, 187–202.

Park, J. H., and A. Zhang (2000): "An Empirical Analysis of Global Airline Alliances: Cases in the North Atlantic Markets," *Review of Industrial Organization*, 16, 367–384.

Transportation Research Board (1999): "Entry and Competition in the U.S. Airline Industry: Issues and Opportunities," National Research Council, Special Report 255, Washington, D.C.

U.S. Department of Transportation (2000): "International Aviation Developments: Transatlantic Deregulation, The Alliance Network Effect," Office of the Secretary, U.S. Department of Transportation, Washington, D.C.

Whalen, W. T. (1999): "The Welfare Effects of Domestic Airline Alliances," Unpublished Manuscript, Department of Economics, University of Illinois, Urbana-Champaign.