Competitive Effects of Joint Ventures in the U.S. International Airline Market

Hong Lee, Jaehak Lee, Jeffrey Prince and Daniel Simon*

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Abstract

We construct a structural model designed to disentangle the collusive effect of cooperative firm arrangements from cost impacts. Using an expansive international airline dataset, we estimate our model to determine the level of joint profit consideration among firms in an antitrust immunity arrangement (ATI) and joint venture (JV) partnership and compare both to competition and merger. We find for a JV a net price decline of about 1.6%, which we decompose into a price increase of 1.9% due to increased collusion and a price decrease of 3.5% due to cost savings. Perhaps surprisingly, we didn't find any evidence of joint profit maximization among antitrust immunity arrangements (ATI) partners. We discuss applications, including as a method to establish a lower bound on cost efficiencies needed to expect of price decrease from a JV.

Keywords: Joint venture, antitrust immunity, partial collusion, firm conduct, demand estimation

*Hong Lee and Jeffrey Prince are at the Kelley School of Business at Indiana University, 1309 E. Tenth Street, Bloomington, IN 47405. Jaehak Lee is at the Department of Economics at the University of Albany – SUNY. Daniel Simon is at the O'Neill School of Public and Environmental Affairs at Indiana University. They can be reached at hgle@iu.edu, jlee82@albany.edu, jeffprin@indiana.edu, and simond@indiana.edu, respectively.

1. Introduction

A typical focus of U.S. antitrust policy concerns mergers, as evidenced by specific documentation providing merger rules and guidelines (e.g., Hart-Scott-Rodino, 2023 Merger Guidelines). This is natural, since a major impetus for antitrust law concerns over welfare impacts from firm cooperation, and merger is effectively an extreme form of cooperation where the firms join together in common ownership and thus common objectives. A similar extreme form of cooperation is a cartel, where separate firms set prices and possibly choose other actions in their joint interest. Antitrust law treats these two extremes differently—using rule of reason to assess mergers and deeming price fixing per se illegal—recognizing that mergers can generate efficiencies that can benefit consumers whereas price fixing generally will not.

In practice, the level of cooperation among firms need not be binary, i.e., either noncooperative or fully cooperative. A common example is a joint venture, where two or more companies collaborate to pursue a specific common goal, which is not necessarily fully common objectives. During the last several decades, economists have long conducted extensive research on how mergers and acquisitions impact market outcomes (e.g., Mueller, 1969; Harris and Winston, 1983; Vennet, 1996; Fan, 2013; Gowrisankaran et al., 2015). However, even though the business partnership of joint ventures is analogous to mergers in that it enables participants to collude on prices, costs, scheduling, and other competitively sensitive matters, our understanding of joint ventures on collusive behavior is more limited. One reason for this limited understanding could be that joint ventures take on a wide range of specific forms, and thus, it is difficult to evaluate how collusive joint ventures are, even within the same industry. Another reason stems from challenges in disentangling collusive behavior from cost efficiencies, since both can be impacted by the joint venture and both typically affect observable outcomes, such as price.

In this paper, we empirically evaluate the level of collusiveness for different types of co-operation among international airlines. The types of cooperation we consider are: competition, antitrust immunity (ATI), joint venture (JV), and merger. International airlines are a particularly good setting for such analysis, as they not only have joint ventures, which we observe in a number of other industries, but also have antitrust immunity designations – a different, and rarer, type of cooperation compared to joint ventures, which adds another dimension to the analysis and potential insights.

We use a random-coefficients nested logit (RCNL) demand model to estimate the route-level demand between city-pairs in different countries. Our cost-side specification allows us to disentangle the competitive effects of joint ventures and ATI from cost impacts, which, to the best of our knowledge, no prior research has done. The market of interest is trans-Atlantic routes, the largest air transportation global market for the U.S. airlines. The principal participants in the three major international alliances are considered. We estimate our model using an enhanced version of the Origin and Destination data from Airline Data, Inc. combined with data from the U.S. Bureau of Economic Analysis and Eurostat. The data span two, three-year periods—2004-2006 and 2014-2016—allowing us to efficiently leverage substantial variation in ATI and JV status among airlines between those two periods.

Our results show, via our measures of levels of joint profit consideration among members, that JV members exhibit substantially greater collusive behavior compared to ATI members. Considering the full spectrum, we find that ATI leads to a significant increase in collusive behavior, and while JV leads to substantially more collusive behavior than ATI, it is still notably less than merger. Quantitatively, we find that ATI members weight other members' profits at about 27.4% and JV members weight other members' profits at 61.4% (compared to 0% in competition and

100% in merger). We break down the relationship between JV/ATI and price by disentangling cost effects from collusive effects. Here, we find that JV's lead to an overall decline in price by $14 per ticket on average (about 1.6% of the average ticket price), which is comprised of a cost effect of $31 and a collusive effect of $17. That is, were there only a cost effect, tickets would have declined in price by $31 (about 3.5%), and if there were only a collusive effect, tickets would have *increased* by $17 (about 1.9%). In other words, to avoid an increase in price from the collusive effect of a JV, there needed to be at least a $17 decrease in price due to cost efficiencies, which was exceeded for the JV's in our sample.

We conclude by conducting counterfactuals to assess welfare impacts of JV's and ATI's. By empirically assessing the level of collusiveness associated with different types of cooperation among airlines – ranging from competition and antitrust immunity to joint ventures and mergers, and by disentangling collusive effects from cost efficiencies, this study enhances our understanding of the competitive impacts of different forms of coordination, while also providing valuable insights into the distinctive nature of aviation alliances.

Our findings have several implications. First, they provide empirical evidence of both the collusive effects of cooperative arrangements, as well as the cost efficiencies. By disentangling the cost efficiencies and collusive effects, our results illustrate how cost savings can disguise the collusive effects and quantify the amount of cost savings needed to offset the higher prices resulting from increased collusive behavior. Second, our findings reveal that the extent of collusive behavior varies substantially with the nature of the cooperative arrangement; cooperative arrangement are not all the same. We should not expect members of a JV to coordinate as closely in their price setting as firms that merge together.

These findings can be useful to policymakers, practitioners, and even consumers. For antitrust policy, it is important to recognize that not all cooperative agreements are equally collusive. Our findings suggest that policymakers should be less concerned about joint ventures than mergers, and even less concerned about ATI agreements. Moreover, it is important for policymakers to consider the cost efficiencies as well as the collusive effects of these arrangements. Our findings suggest that despite their collusive effects, joint ventures are actually beneficial to consumers.

2. Related Literature

This paper contributes to three streams in literature. The first concerns empirical measurement of firm collusion. Our paper builds on Shen (2017) and Miller and Weinberg (2017), who examine airline code sharing and a joint venture in retail beer, respectively, and applies their methods to airline ATI and joint ventures. Shen (2017) estimates the profit sharing between the operating and marketing airline for a route, finding the vast majority of profit goes to the operating airline. Miller and Weinberg (2017) demonstrate that the joint venture between Miller and Coors likely led to price coordination rather than a new competitive equilibrium. Also related is Fageda et al. (2019), who develop a theoretical model which can account for different types of cooperation, ranging from a joint venture to a merger, by defining parameters for a degree of cooperation. They identify the optimal cooperation for each market condition they considered. Based on theoretical grounds, they find that the joint venture affected the traffic positively in both interline (i.e., multiple flights with multiple airlines) and interhub (flights from one airline's hub to another's) markets.

The second stream concerns the impact of joint ventures. Existing papers have focused on the impact of ATI and joint ventures on market outcomes, finding both procompetitive and anticompetitive effects. One of the pro-competitive effects that has been reported is decreased prices due to the elimination of double marginalization (Whalen, 2007; Brueckner, 2003). Using late 1990s data from DB1B, Brueckner (2003) shows that ATI lowers the airfares of international interline routes by 15%-21%. Pro-competitive impacts also stem from cost reductions through joint marketing and joint operations of airports, which can expand flight frequencies (Bilotkach and Hüschelrath, 2012). This research shows that noncooperative pricing of an interline route by two carriers leads to excessively high fares, which does not maximize joint profit. Cooperative pricing, by contrast, internalizes the negative externalities from the pricing decision, which arise because an interline trip is a joint product, and leads to a lower fare (Brueckner and Whalen, 2000; Brueckner, 2001).

While research suggests that airline cooperation causes a pro-competitive effect on interline routes, research also offers reasons why cooperation may lead to anti-competitive effects on interhub routes (Fageda et al., 2019). For example, contrary to the argument that coordination expands the consumers' choice set, international routes where the JV partners offer competing non-stop flights may suffer from market foreclosure in the networks (Chen and Gayle, 2007; Bilotkach, 2007), resulting in a reduction in the frequency of flights by the competing carriers (Bilotkach and Hüschelrath, 2013). Additionally, Tan & Zhang (2022) find joint venture leads to an increase in online flight prices, and as mentioned above, Miller and Weinberg (2017) find price increases following a retail beer joint venture.

Finally, our paper contributes to the large body of research examining competition in the airline industry. Prior work has examined the impact of mergers, hubbing, entry and potential entry, vertical integration, and multimarket contact in the airline industry on outcomes such as price, on-time performance, scheduling, etc.[1]

[1] E.g., see Brueckner (2002), Mazzeo (2003), Borenstein and Shepard (2002), Prince and Simon (2015)

Our paper takes the theoretical insights of Fageda et al. (2019) and the structural econometric framework of Shen (2017) and Miller and Weinberg (2017) to construct and estimate a structural econometric model for the airline industry that can disentangle the level of collusion from cost efficiencies across multiple arrangements. In doing so, we can empirically assess both quantitatively and qualitatively the level of collusion commensurate with ATI and joint venture in the airline industry and gauge their relative similarities – in both form and consequences for market outcomes – to the cooperative extremes of independent competition and merger.

3. Antitrust Immunity and Joint Ventures Involving U.S. Airlines in the trans-Atlantic Market

Antitrust immunity (ATI) refers to special permissions or exceptions from federal antitrust regulations that are provided to companies operating within specific industries. These dispensations provide the enterprises with a notable degree of exemption from certain or all federal antitrust regulations, affording them some freedom from the stringent oversight governing competition. When it comes to the international airline industry, the U.S. Department of Transportation (DOT) holds legal jurisdiction over the granting of antitrust immunity. Domestic and international airlines that are granted ATI are exempt from U.S. antitrust laws, allowing them to collaboratively decide on various operational functions such as scheduling, route planning, pricing, profit/cost sharing, marketing, sales, and inventory controls, among others. Joint ventures tend to involve closer coordination than do non-joint venture ATIs. In particular, in the case of joint ventures the airlines agree to share revenues on the routes served by the joint venture; this may or may not be the case in other ATIs. For this reason, any joint venture that is approved will also be granted ATI.

While the specific contractual agreements for each joint venture are typically not disclosed, joint venture firms often acquire mutual ownership stakes to deepen the degree of coordination in joint ventures compared to ATI firms.[2] For example, Delta acquired a 10% stake in its joint venture partner Air France-KLM, and Air France-KLM bought a 31% stake in Virgin Atlantic, whose largest shareholder is Delta.[3] In addition, Delta acquired a 4.3% equity stake in Hanjin-KAL, the largest shareholder of Delta's joint venture partner Korean Air. Delta also completed a tender offer for twenty percent (20%) of the issued and outstanding LATAM Shares (the "Equity Investment"). [4,5] It is therefore potentially valuable to understand and dismantle the competitive impacts of international coordination among airlines in ATI and joint ventures separately. This approach allows for a more precise assessment of the competitive dynamics within the airline industry.

[Table 1] presents the complete chronological list of Antitrust Immunity (ATI) agreements in the U.S. airline industry involving U.S. and foreign carriers. The inaugural ATI approved in the U.S. airline industry was a joint venture between Northwest Airlines (now Delta Airlines) and KLM Royal Dutch Airlines in 1993.[6] After this, there was not another joint venture approved until 2008.

Until the mid-2000s, nearly all partnerships that received ATI in the global aviation market were one-to-one agreements between foreign and U.S. airlines. The first full-scale comprehensive joint venture agreement that included European airlines in trans-Atlantic markets was the SkyTeam alliance, which received approval in May 2008. The SkyTeam applicants for ATI

[2] Many countries have stringent regulations preventing outright mergers with foreign entities in industries such as the airline industry that are deemed critical to national interests. For instance, the United States limits foreign ownership of U.S. airlines to 25%.
[3] Levine-weinburg, A. 2017, Aug 1. "Delta Air Lines Deepens Ties with European Partners", The Motley Fool
[4] Horton, W. 2019, June 20. "Delta invests in Korean Air to defend their JV and the Cho dynasty". Forbes
[5] U.S. Securities and Exchange Commission (SEC). 2019, Sep 26. "Framework Agreement by and between Latam Airlines Group S.A. and Delta Air Lines, Inc."
[6] Their partnership formed in 1989 when KLM acquired a 19.3% stake in Northwest but did not receive DOT approval of the joint venture (and ATI) until January, 1993.

agreement included Delta, Air France (France), KLM (Dutch), Alitalia (Italy), and Czech Airlines (Czech). The same document also approved the joint venture among Delta, Air France, and KLM. The next year (2009), companies in the Star Alliance subsequently received ATI approval including United, Air Canada (Canada), Lufthansa (Germany), SAS (Denmark, Norway, and Sweden), Austrian (Austria), BMI (British), LOT (Poland), Swiss (Swiss), TAP (Portugal), and Brussels (Belgium). At the same time, airlines in the Star Alliance also received approval for a joint venture among United, Air Canada, and Lufthansa. The Oneworld Alliance was the last of the three major airline alliances to receive approval for a joint venture in 2010, involving American, British Airways (UK), and Iberia (Spain).

[Table 1 Here – List of ATI]

4. Data

We construct our dataset from two sources. The first is the international Origin & Destination (O & D) flight data, which we obtained from Airline Data Inc. It contains the same information as that included in the domestic O & D data—including information on the ticket prices, origin/connecting/destination airport, operating/marketing carrier of each leg, and various flight- and route-level characteristics—with two important enhancements. First, it includes a scaled-up version of the international O & D dataset—the data vendor recreates the full population (rather than the 10% sample) of international flights to and from the U.S. cities carried by the U.S. carriers using the T-100f dataset, which measures passenger volume on international flights at the carrier-route-month level. It also contains information on flights into and out of the U.S. operated by non-

U.S. carriers unlike the O & D dataset, which is restricted to international trips operated solely by U.S. airlines.

This expanded dataset offers two important advantages for our analysis. First, a challenge that researchers face in developing a structural model to measure the competitive effects of international coordination has been the limited information available on the market shares of foreign carriers (Bilotkach, 2019). By including information on flights operated by non-U.S. carriers, our dataset allows us to address this challenge. Second, our comprehensive dataset allows us to observe variations in airline partnerships over time and across different markets. For instance, American Airlines and British Airlines were competitors in 2005 but obtained antitrust immunity (ATI) and entered into a joint venture agreement in 2010. By observing these changes in partnership arrangements, we can accurately estimate the conduct parameters and better understand the dynamics of international airline competition. Our second data source is from the U.S. Bureau of Economic Analysis and Eurostat. We use these data to construct market size and to account for the demographic characteristics of the U.S. and European markets.

We define a market as a directional origin and destination (O&D) airport pair with the market size being a geometric mean of populations between the two airports. For U.S. airports, we consider the airport's population as the number of people residing within a 50-mile radius of each airport. For European airports, we calculate the relevant population of an airport by dividing the total number of population of a country by the number of airports observed in the data for that country. Next, we define a product as a sequence of origin, connecting, and destination airports, paired with the marketing and operating carriers for each leg of a route. For example, consider a route from Miami International Airport (MIA) to John F. Kennedy International Airport (JFK) to London Heathrow Airport (LHR), where the MIA to JFK leg is both operated and marketed by

American Airlines (AA), and the JFK to LHR leg is operated by British Airways (BA) but marketed by American Airlines (AA). In our data, this product would be represented as "MIA-JFK-LHR/AA-BA/AA-AA" and defined as a unique product. Drawing a clear distinction between the operating and marketing carriers is important in order to take the efficiency gains into account in joint venture agreements; if a carrier can fill its planes without shouldering marketing expenses, it can operate more cost-effectively.

Our data span two, three-year periods – 2004-2006 and 2014-2016 – allowing us to efficiently leverage substantial variation in ATI and JV status among airlines between those two periods. The gap between the two periods provides us with a relatively clean pre- and post-period around the series of transatlantic alliances formed between 2007-2010. There was only one alliance granted ATI status during either of these periods, an alliance between American and SN Brussels, which was not a joint venture. This pre- and post-period setup helps us to identify the effect of joint ventures.

[Table 2 about Here]

Table 2 provides an overview of the quarterly product frequencies for major airlines operating in the U.S. transatlantic market between 2004-2006 and 2014-2016. In this table, the airline operating the transatlantic leg from a gateway airport (i.e., the airport of international exit) is considered the owner of the product.[7] The table captures the service frequencies of five major

[7] Our supply-side model requires us to identify product owners, which poses challenges due to the intricate definition of a product in the aviation industry. Following the approach outlined by Shen (2017), where the operating carrier of a route acquires 92% of profits and the marketing carrier takes the remaining 8%, we assumed that the operating airline handling the transatlantic leg is the product owner. For instance, we consider British Airways to be the owner of the aforementioned “MIA-JFK-LHR/AA-BA/AA-AA” product, as it operates the flight across the Atlantic Ocean.

airlines—United Airlines, American Airlines, Delta, US Airways, and Lufthansa—and categorizes each product based on three types of operating agreements: Antitrust Immunity (ATI), Joint Venture (JV), and independent operations (without ATI or JV agreements).

Over the observed period, the data shows a substantial increase in the total frequency of products offered by these airlines in the transatlantic market. In 2004-Q1, the total product frequency was 2,902, which grew to 5,548 by 2016-Q3. This expansion highlights the rising demand and strategic importance of transatlantic routes for these carriers. Notably, American Airlines demonstrated significant growth, increasing its quarterly product frequency from 603 in 2004-Q1 to 1,491 in 2016-Q3, reflecting its expanded role in this competitive market. Similarly, United Airline's frequencies rose from 570 to 1,367 over the same period, illustrating its growing transatlantic footprint.

The table also reveals a shift toward collaborative agreements, particularly joint ventures (JV). In 2004-Q1, only 310 products operated under JV agreements, a figure that surged to 4,937 by 2016-Q3. This trend underscores a shift in the industry towards closer partnerships and coordination among airlines. By 2016, JV agreements had become the dominant arrangement for these airlines, suggesting a strategic alignment that allows for coordinated planning, pricing, and capacity-sharing on transatlantic routes. For example, in 2014-Q2, of the total 5,605 products offered, around 80% were operated under JV agreements, showing the extensive adoption of this collaborative model. Conversely, the frequency of independently operated products (those without ATI or JV agreements) declined notably over time. In 2004-Q1, there were 680 such independent products, but by 2016-Q3, this number had decreased to 460. This decline reflects a shift away from independent operations, as airlines increasingly sought the operational efficiencies and market advantages associated with ATI and JV partnerships. ATI agreements also played a significant role, with consistent numbers across quarters but eventually being outpaced by JV growth as the primary mode of coordination by 2016.

[Table 3 Here – Revenue of Products Operating Different Agreements]

Table 3 provides a breakdown of product frequency and revenue for U.S. transatlantic airline services under different coordination agreements—No ATI/JV partners, Antitrust Immunity (ATI), and Joint Venture (JV)—across two periods, 2004-2006 and 2014-2016. The frequency column shows the number of products operating under each type of agreement, while the revenue column presents the total revenue (in millions) generated by those products. The percentages indicate the share of each type within the total frequency and revenue for that period.

In the 2004-2006 period, products without ATI or JV partners accounted for 20.68% of total products and generated 54.37% of total revenue, indicating that independently operated routes were more profitable on average. ATI products made up the largest share of total frequency at 69.9% but contributed a bit lower revenue share of 39.29%, suggesting that while ATI partnerships were widely used, they generated less revenue per product. In contrast, JV products had the smallest share of frequencies at 9.41% and accounted for only 6.34% of revenue share. By 2014-2016, there was a notable shift. Joint Venture products saw a substantial increase, comprising 84.7% of total frequencies and generating 71.36% of total revenue. This increase indicates that airlines increasingly relied on JV agreements to coordinate on transatlantic routes. Conversely, the share of products without ATI/JV agreements decreased to 12.33% of total frequencies, and their revenue share dropped to 17.16%. ATI-only products became much less common, accounting for just 2.97% of frequencies and 11.48% of revenue.

This shift aligns with the patterns observed in Table 2, where we see an increase in JV frequencies and a decline in independent operations over time. The differences in frequency and revenue shares across Table 3 may rationalize the idea that airlines strategically choose JV partnerships on routes with high competitive pressure, where collaboration could help maintain market presence despite lower profitability per product. In 2004-2006, the independent routes generated a high revenue share (54%) with only a 20% frequency share, implying that airlines were able to command higher profits independently in less competitive markets. In contrast, the increased reliance on JV agreements in 2014-2016, with a frequency share of 85% but a revenue share of 71%, suggests that airlines used JV agreements on routes with stronger competition, where collaboration helped them sustain efficient operations likely with narrower profit margins. This pattern suggests that airlines may opt for joint ventures on routes where competitive pressures are high and independent operation would yield lower profitability. Conversely, routes with higher expected profitability tend to be operated independently, allowing airlines to maximize revenue without sharing it with partners.

[Table 4 Here – Demand Summary Statistics]

[Table 4] provides the descriptive statistics for demand-side variables across two periods, 2004-2006 and 2014-2016. *Price* is the average of all the fares paid between the origin and destination for fared passengers. It's calculated as total revenue divided by the total number of fared passengers, with units in thousand US Dollars. *Distance* refers to the total distance traveled along the route of a product itinerary, calculated as the sum distances of each pair of consecutive airports in the itinerary. *No. Coupons* indicate the total number of coupons or segments in a journey where the passenger is required to deplane and enplane an aircraft. *Non-stop* is an indicator variable equals to one if a product has no intermediary stop and goes directly from origin to destination airport. *No. Destination* refers to the total number of cities to which marketing carrier of a gateway airport serves direct flights from the gateway airport.[8] .SkyTeam, Star Alliance, and Oneworld are indicator variables set to one if the connection stays on the same airline alliance, such as a connection from Delta Airlines on SkyTeam to KLM Royal Dutch Airlines on SkyTeam.

In the 2004-2006 period, the mean ticket price per product was $757 (in thousands). By 2014-2016, the mean price increased to $879. The median price also rose from $562 to $696, while the 90th percentile increased from $1,592 to $1,764. The distance variable represents the average miles for each route, with the average route length slightly decreasing from 5.297 (in thousands of miles) in 2004-2006 to 5.226 in 2014-2016. The squared distance variable, which captures the impact of long-haul routes, follows a similar pattern, with a slight decrease in the mean. The number of coupons decreased slightly from a mean of 2.089 to 1.984. This decline may suggest a shift towards more direct flights, which is further supported by the increase in non-stop flights from 14.4% in the earlier period to 15.9% in the later period. Star Alliance products had the highest representation in both periods, increasing slightly from 30.6% in 2004-2006 to 34.1% in 2014-2016. Oneworld products also grew from 21.6% to 32.4%, while SkyTeam products declined from

[8] This variable is constructed to capture the positive utility stemming from the larger choice set provided by marketing carrier in a given gateway airport. Ciliberto and Williams (2014) used the similar metrics to proxy the network size. For more details, see Berry and Jia (2010).

27.2% to 16.1%. This shift in alliance memberships reflects changes in airline partnerships and strategic realignments over time.

[Table 5 Here – Supply Summary Statistics]

[Table 5] provides the description of supply-side statistics, showing the distribution of flight segments (or "legs") within a product that are either marketed or operated by different types of partners—Joint Venture (JV), Antitrust Immunity (ATI), or non-partners—as well as by the owner airline itself. The table compares these distributions across two periods: 2004-2006 and 2014-2016. In the 2004-2006 period, the majority of legs were marketed and operated by the airline itself, with an average of 80.0% of legs marketed and 75.5% operated solely by the gateway operating airline. This high percentage indicates that airlines primarily relied on their own resources for both marketing and operating their transatlantic flights during this period. JV partnerships played a minimal role, with only 1.3% of legs marketed and 1.2% operated by JV partners, while ATI partners were responsible for marketing 7.6% and operating 5.4% of legs, reflecting limited use of formal partnerships.

By the 2014-2016 period, there was an increase in reliance on JV partnerships. The percentage of legs marketed by JV partners rose significantly to 18.7%, and the percentage operated by JV partners increased to 10.0%. This growth in JV involvement reflects a broader trend toward closer collaboration among airlines on transatlantic routes, consistent with patterns observed in Table 2. Meanwhile, the role of ATI-only agreements diminished, with ATI partners marketing just 2.5% and operating 1.9% of legs. This decrease suggests that airlines are shifting away from

ATI agreements in favor of more formalized joint ventures, which likely offer greater coordination benefits.

5. Structural Model

5-1. Demand Side

We model consumers' demand of air travel in a similar manner to that of Berry and Jia (2010) and Shen (2017). Following the random coefficient nested logit (RCNL) model of Grigolon and Verboven (2014), we detail the general expression of our models below. For each quarter t, the consumer i in market m chooses the product j among the set of available products J_{mt} or selects the outside option $j = 0$. Then, the indirect utility of consumer i is given by:

$$(1)\ u_{ijmt} = x_{jmt}\beta_i - \alpha_i p_{jmt} + \xi_{jmt} + v_{igmt}(\rho) + (1-\rho)\varepsilon_{ijmt}$$

where x_{jmt} is a row vector of product $j's$ observed characteristics in market m at quarter t, p_{jmt} is an average price of product j in market m at quarter t, and ξ_{jmt} is the unobserved product characteristic encapsulating departure time and quality of a product that we do not observe from our data. The term v_{igmt} denotes consumer i's utility for air travel, while ρ serves as a nesting parameter which characterizes the preference for air travel over the outside option (i.e., no trip). Lastly, ε_{ijmt} represents independent and identically distributed residual utility, assumed to follow the type 1 extreme value distribution.

We assume that the random coefficients β_i consist of two components: mean valuations and individual-specific valuations, specified as

$$\beta_i = \beta + \Sigma\nu_i$$

where β represents the mean value component of product characteristics, while the vector ν_i captures the individual-specific heterogeneity. ν_i follows a standard normal distribution and is scaled by Σ, which has standard deviations on its diagonal, and its off-diagonal elements that allow for correlations between the random coefficients. We nest all products as one group, while assigning the outside option of not flying to the other group. We further normalize the utility of not flying to zero. Then, suppressing the subscripts m and t for brevity, the probability of consumer i choosing to fly is given by:

$$(2)\ \frac{D_i^{(1-\rho)}}{1+D_i^{(1-\rho)}}$$

where D_i is the inclusive value defined as:

$$(3)\ D_i = \sum_{j \in J_{mt}} e^{(x_j\beta_i - \alpha_i p_j + \xi_j)/(1-\rho)}$$

Hence, the choice probability of consumer i for product j is given by:

$$(4)\ s_{ij} = \frac{e^{(x_j\beta_i - \alpha_i p_j + \xi_j)/(1-\rho)}}{D_i} \cdot \frac{D_i^{(1-\rho)}}{1+D_i^{(1-\rho)}}$$

where the market share of product j is obtained by integrating s_{ij} over the distribution of consumer types. Specifically, in addition to the logit and nested logit (Shen, 2017), we provide model estimates for discrete consumer types (Berry and Jia, 2010; Ciliberto and Williams, 2014), as well as for normally distributed preferences (Grigolon and Verboven, 2014; Miller and Weinberg, 2017).

As our exogenous product characteristics, we include: the total distance of a product and its square, the number of connecting flights in the product, the number of destination gateway airports, dummies for non-stop flights, multi-ticket flights, carrier alliances, and whether the origin or destination airport is a gateway airport. For all of the models we consider, we also control for carrier-specific, year-quarter-specific, and foreign country-specific fixed effects to reduce the unobserved characteristics the variables above may not capture.

From the demand side, we face two endogenous variables in our estimation: prices p_{jmt} and market shares in nesting utility of inside options $v_{igmt}(\rho)$. As it is highly likely that the unobserved product characteristics ξ_{jmt}, such as preferred seats and departure time, are correlated with the prices and shares, we discuss a set of instruments to account for the endogeneity in the instrument section (Section 5.3).

5-2. Supply Side

Our supply model is characterized by Bertrand-Nash competition among airlines incorporating the firms' conduct parameter in their profit function. Let firm f's profit from its own products j be denoted by π_f. The objective function of firm f, Q_f, consists of three parts: the profit from its own products, the profit from all of its ATI-only partners k, and the profit from all of its JV partners . We formulate the objective function of firm f as:

$$(5)\ Q_f = \pi_f + \kappa_1 \cdot \sum_{k \in K} \pi_k(p_k, mc_k) + \kappa_2 \cdot \sum_{l \in \mathrm{L}} \pi_l(p_l, mc_l)$$

where κ_1 and κ_2 are the profit weights, or conduct parameters, of firm f, which firm f assigns to its ATI-only partner k and JV partner l, respectively. They represent the extent to which firm f internalizes its profits with partners. That means firm f considers firm k's profit as \$$\kappa_1$ per \$1, and firm l's profit as \$$\kappa_2$ per \$1. As points of contrast, if firm h and firm f have no ATI or JV relationship, firm h's profits do not enter firm f's objective function (κ_1 and κ_2 are zero); if firm h and firm f merge, the objective function for firm f now fully incorporates firm h's profits, meaning they would enter the formula with coefficient of one. The conduct parameter, therefore, implies the degree of collusive behavior between the firms (somewhere between perfect competition of coefficient zero and full collusion/merger of coefficient one). Likewise, if forming a joint venture fosters more intensive joint behaviors than ATI, it will give us $\kappa_1 \leq \kappa_2$, and the difference between the two, $\kappa_2 - \kappa_1$, shows incremental collusive behavior due to movement from ATI to a joint venture.

We assume that the conduct parameters are symmetric across the firms, and further assume that the conduct parameters are constant across time and markets. Then, solving the first order condition determines the equilibrium price level as:

$$(6)\ p_{jmt} = mc_{jmt} + \left(\Omega_t(\kappa) \circ D_p(p, x, \xi, \theta)\right)^{-1} \cdot s_{mt}(p, x, \xi, \theta)$$

where $D_p(p, x, \xi, \theta)$ is a matrix of own and cross demand derivatives with respect to price and $\Omega_t(\kappa)$ is the ownership matrix contains the conduct parameters such as:

$$(7)\ \Omega_t = \begin{bmatrix} 1 & \kappa_1 & \cdots & 0 \\ \kappa_1 & 1 & \cdots & \kappa_2 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & \kappa_2 & \cdots & 1 \end{bmatrix}$$

We specify that the marginal cost of firm f, which consists of cost variables w and cost savings λ from the joint ventures, namely:

$$(8)\ mc_{jmt} = \gamma w_{jmt} - \lambda g_{jmt} + \omega_{jmt}$$

The cost variables w consist of the product characteristics from the demand side, excluding the square of route distance. Additionally, to capture potential cost savings from the partnerships, we construct the variables (g_{jmt}) that measure the extent of shared ticketing and operating behaviors. These variables reflect the level of collaboration between partners and the associated efficiency gains. Specifically, g_{jmt} includes nine variables: the percentage of flights operated by ATI partners, JV partners, and non-partners, respectively; the percentage of flights marketed by each group of carriers; and their interactions. Notice that the mark-upin equation (6), $p_{jmt} - mc_{jmt}$, is expressed as a function of ξ and price. Since the price is also determined by the marginal cost, which includes the unobserved cost shock ω, this mark-up term is endogenous. Thus, we construct two additional supply-side instruments to address this endogeneity and identify the conduct parameters, which we discuss in section 5.3. Then, we estimate the parameters through two-step GMM analogous to the demand estimation. The supply side moments are written out as:

$$(9)\ h_s = E\left[Z^s \omega_{jmt}\right]$$

As in the demand side, we also partial out carrier, year-quarter, and foreign country fixed effects to capture any unobserved heterogeneity that may create a correlation with the price coefficient.

5-3. Instruments and identification

In this subsection, we provide a detailed account of the instruments and the variation we leverage to identify parameters. Our model involves three endogenous variables that require instruments. From the demand side, we have prices and shares to be instrumented. Instruments should help identify cross-elasticities, especially type-specific or random coefficients that govern substitution patterns within a market. With that understanding, we consider four sets of instruments. The first set comprises exogenous product characteristics, x_{jmt}, included in the demand specification, which are assumed to be uncorrelated with the unobserved determinants of demand. The second set of instruments consists of the own-cost shifters g_{jmt} from the marginal cost equation (8), which are excluded from our demand model. These variables capture the efficiency gains from products that are partially operated or marketed by each type of partner and are included in our supply-side estimation, but they do not enter consumers' utility directly. Instead, they affect consumers utility indirectly by affecting prices through marginal costs, satisfying the valid exclusion restrictions for instruments.

The third set involves the differentiation IV of Gandhi and Houde (2019), a variant of BLP-type instruments. In particular, we construct the quadratic version of the differentiation IV as follows:

$$(10) \qquad Z_{diff} = \left\{ \sum_{j,k \in J_f, k \notin J_f} \left(d_{jk}^{l}\right)^2, \ \sum_{j,k \in J_f, k \notin J_f} \left(d_{jk}^{l} \times d_{jk}^{l'} \right) \right\}$$

where d_{jk}^{l} is a distance in a characteristic l between the product j and k. The first term represents a sum of squared distances of characteristics between products, while the second term is an interaction of the distances for characteristics l and l'. We further divide each term into two: the sum of the squared distances between firm f's product j and firm f's other products k, and the sum of the squared distances between firm f's product j and others' products k'.

Aside from its mechanical properties, the differentiation IV has an intuitive interpretation. It measures how much the product j is differentiated from other products in characteristics l. As a product with closer substitutes is likely to face more competition, that product will face more downward pressure on price. Following Gandhi and Houde (2019) and Backus et al. (2021), we also construct the predicted price from the following regression model and include $\hat{p}_{jmt}$ as a product characteristic when we build Z_{diff}.

$$(11) \qquad p_{jmt} = \phi_1 x_{jmt} + \phi_2 g_{jmt} + \phi_3 Z_{diff} + \delta_f + \delta_t + \delta_{m'} + u_{jmt}$$

Here, x_{jmt} , g_{jmt}, and Z_{diff} are the three sets of instruments above. We incorporate firm carrier-specific, quarter-specific, and foreign country-specific fixed effects in equation (11), mirroring our approach in the demand model. While the differentiation instruments are highly effective for identifying random coefficients, Σ, one issue is that they produce a large number of instruments that may be highly correlated (Backus et al., 2021). To address this, we apply the dimension reduction methods described in Backus et al. (2021) or Conlon (2017), projecting the differentiation instruments onto principal components that span to capture at least 99% of the variance.

We include the number of available products within a market as our last set of instruments, which is another standard BLP-type instrument. To help identify the nesting parameter ρ, the instrument should be correlated to the conditional share (share of product j over the share of a nest), while remaining exogenous to the unobserved characteristics, ξ_{jmt} (Berry, 1994). Given the strong correlation between the inclusive value and the number of products in a nest, it functions as a valid instrument provided it remains uncorrelated with the unobserved characteristics. [Table 6] shows variables we constructed as instruments.

[Table 6 about here]

On the supply side, the mark-up term is endogenous. The endogeneity within the supply model becomes apparent when we rearrange the first order condition in section 5.2:

$$p_{jmt} = \gamma w_{jmt} - \lambda g_{jmt} + \underbrace{\left(\Omega_t(\kappa) \circ D_p(p, x, \xi, \theta)\right)^{-1} \cdot s_{mt}(p, x, \xi, \theta)}_{Mark\ up} + \omega_{jmt} \tag{12}$$

The mark-up component implicitly includes the unobserved costs, ω_{jmt}, through the price. A valid IV, therefore, should explain the mark-up while remaining excluded from the marginal cost. Since the BLP-type IV is a valid instrument (Berry and Haile, 2014), we include the differentiation IV and the number of available products in a market defined on the demand side as first and second sets of instruments for our supply moments.

The final set of instruments is an indicator variable that flags products subject to carve-outs. To address potential anti-competitive effects, the DOT often imposes certain requirements when granting ATI or JV to applicants. A carve-out refers to the prohibition of coordinated price setting for specific markets while permitting coordination in others (Brueckner and Proost, 2010). For instance, during our sample periods, when Delta-Air France-Alitalia-Czech Airlines received ATI in 2001, the carve outs were enforced in markets between Atlanta-Paris, and Cincinnati-Paris[9]. Later in 2007, when the expanded alliance of Air France-Alitalia-Czech Airlines-Delta-KLM-Northwest and applied for JV approval, DOT removed the carve outs after the JV was implemented[10].

This variation mandated by regulators sheds light on cross-sectional differences in markups between markets with and without ATI. Moreover, the removal of carve-outs as the ATI alliance transitioned into JV may further aid in understanding mark-up differences attributed to JV partnerships. Given that carve-outs exogenously remove partnerships from certain markets, the instrumental variable (IV) should be valid if there are no systematic differences in unobserved marginal costs between carved-out and non-carved-out markets.

We conclude by addressing possible endogeneity concerns about the ATI and JV measures in our marginal cost equation. Here, we see the concern being that ATI and JV are voluntary activities by airlines, which could be related to unobserved-to-the-econometrician route costs. We note that there is little to suggest that airlines would choose ATI/JV as a function of route costs per se (e.g., enter into a JV on routes that are low-cost and not on routes that are high-cost, or vice versa); rather, it seems more plausible that airlines may choose ATI/JV based on the potential cost savings, i.e., enter into ATI/JV when there are material cost savings to be had and not where there aren't. In that case, our estimates for the effect of ATI/JV on costs are essentially estimates of the "effect of the treatment on the treated," that is, they are estimates for the

[9] DOT-OST-2001-10429
[10] DOT-OST-2007-28644

effect of the ATI/JV status on the set of airlines that chose such agreements, and not necessarily for the full population of airlines. We address consequences of this possible limitation in our results and counterfactuals.

6. Results

6.1 Demand parameters

We begin by presenting the demand estimates in Table 7, where each column reports the estimates for the two specifications. All specifications include year-quarter, airline, and foreign country fixed effects. We also cluster the standard errors at the market level to allow correlation between errors within each market. As a benchmark, we provide the results of the standard (fixed coefficients) logit with and without 2SLS.

[Table 7 about here]

Most of the coefficients fall within reasonable ranges and exhibit expected signs. The mean price coefficient, standing at -1.449, is significant, aligning with our expectations. The average and median own price elasticities from our model are -2.62 and -1.97, respectively, significantly smaller than -3.46 from Ciliberto and Williams (2014). This suggests that consumers in the international flight market are less responsive to price increases, again reflecting the limited alternatives available for trans-Atlantic flights. Our estimates closely align with the International

Air Transport Association's (IATA) reported route-level demand elasticity for international flights at -1.9[11].

Additionally, the model highlights a distinct preference for fewer connections, observed by a coefficient on number of connections (coupons) of -0.048. This implies that, on average, consumers are willing to pay $33 for one less connection. Similarly, consistent with previous research, the coefficient for route distance is negative, indicating a preference for shorter flights. The square of the route distance has a significant positive coefficient, suggesting that while consumers prefer shorter flights, this preference diminishes as the route lengthens. We also find that the random component for non-stop flights is insignificant, while the random component for the interaction between price and non-stop flights is significantly large and negative. This suggests that heterogeneity in consumers' preferences for non-stop flights is largely driven by differences in consumers' price sensitivity, with a strict preference for non-stop options. Additionally, consumers perceive multi-ticketed (multi-marketed) flights as less attractive than single-ticketed flights and are, on average, willing to pay $275 more for single-ticketed options. This preference likely stems from the perceived risk of missing connecting flights and being unable to easily be seated pm another flight (Bilotkach, 2005). Similarly, consumers place significant value on flights where the origin or destination airport is a gateway airport, indicating a preference for airports that offer direct international flights.

The most noticeable difference from previous research is our estimate of the nesting parameter, ρ. The nesting parameter governs the substitution pattern toward an outside option, which is the use of other means of transportation or not traveling. It also implies the degree of substitution across the inside options (Berry and Jia, 2010). Our estimate of ρ at 0.53 (or 0.47 as

[11] Air Travel Demand, IATA Economics briefing N'9, 2008

λ in Berry and Jia (2010) style representation) are lower (higher) than what has been found in previous studies of domestic airlines -- 0.72 (Berry and Jia, 2010) and 0.61 (Ciliberto and Williams, 2014) -- indicating that alternatives within trans-Atlantic flights exhibit higher correlation compared to those within domestic flights. This implies that consumers are less likely to substitute to the outside option, highlighting the relative lack of substitutes for international flights.

6.2 Marginal cost and Conduct parameters

Table 8 and Table 9 report our estimates of the marginal cost and conduct parameters, respectively, as detailed in Section 5. Similar to the demand side, supply-side estimates are estimated with year-quarter, carrier, and foreign country fixed effects and are clustered at the market level.

[Table 8 and Table 9 about here]

A critical aspect to distinguishing JV or ATI from collusion is capturing the gains in cost efficiencies. The marginal cost parameters in our model serve as a proxy measure of the cost efficiency attained by the airlines under different partnerships. A lower marginal cost indicates higher operational efficiency, which can translate into lower prices for consumers (hence, improved consumer surplus) and higher profits for the airlines.

The first two coefficients in Table 8, corresponding to the percentage of legs marketed by Joint Venture (JV) partners and Antitrust Immunity (ATI) partners, indicate that an additional 10% of legs marketed by ATI partners reduces costs by $4.8, while additional legs marketed by JV partners do not result in any cost change. In contrast, an additional 10% of legs marketed by non-partner carriers increases costs by $15.4. This effectively means that, compared to non-partner carriers, marketing by JV and ATI partners saves $15.4 and $20.2 per passenger, respectively, assuming the carrier cannot market all tickets on its own in the short term.

Conversely, we find that an additional 10% of legs operated by JV partners or ATI partners increases marginal costs by $18 and $29.7, respectively—$1.9 less and $9.8 more than the $19.9 increase observed when legs are operated by non-partner carriers. These estimates account for two types of joint operations: code-sharing and interlining (due to multi-ticketing). Specifically, in the case of multi-ticketed interlining, an additional 10% of legs operated by a JV partner reduces marginal costs by $13.2, thereby enhancing cost savings.

This suggests that when a product is jointly operated by JV or ATI partners under a code-sharing agreement, there are no significant cost savings from the joint operation itself. Instead, the cost savings appear to arise from sharing airport facilities, such as terminals, as the cost reduction is more prominent when the flight is multi-ticketed. This finding aligns with one of the primary reasons for the Department of Transportation's (DOT) endorsement of such partnerships.

The coefficients on other product characteristics are also reasonably estimated. A 1,000-mile increase in route distance raises marginal costs by $49, while non-stop flights incur $370 more in costs compared to connecting flights. Interestingly, changes in the number of connections do not significantly affect marginal costs, except for non-stop flights. Additionally, all three alliance dummies have positive coefficients, indicating an extra cost of $66 to $108.The conduct parameters in our model reflect the degree of coordination exhibited by each JV and ATI partnership. As detailed in Section 5-2, values close to 1 for each partnership's parameters, κ_1 or κ_2, suggest that these partnerships function almost as a single entity. This aligns with the notion of partnerships as partial mergers, where partners coordinate operations to maximize joint profits. Table 9 shows estimated conduct parameters for the ATI and JV partnership, κ_1 and κ_2, which are 0.274 and 0.614, respectively. It confirms that the JV partnership exhibits a higher degree of coordination compared to the ATI partnership.

7. Counterfactuals

To assess the impact of two partnerships on consumer surplus and firms' profits for international airline markets, we begin by computing new equilibrium prices and market shares under each scenario specified below. This entails solving the first-order condition outlined in Section 5.2. Specifically, within each market m, we derive the new equilibrium price p_j^* and the market share s_j^* by solving the following first order condition for each counterfactual scenario that substitutes $(\widetilde{mc}_J, \tilde{\kappa})$:

$$(13) \qquad p_j^* - \widetilde{mc}_J - \left(\Omega(\tilde{\kappa}) \circ D_p^*(p^*, x, \xi, \theta)\right)^{-1} \cdot \ s^*(p^*, x, \xi, \theta) = 0$$

We explore equilibrium outcomes under following scenarios:

(1) All airlines compete in Bertrand-Nash

(2) Both ATI and JV are operating without efficiency gains

(3) Only JV is operating with efficiency gains

(4) Only ATI is operating with efficiency gains

(5) ATI is operating with efficiency gains and M&A takes place instead of JV

In each scenario, adjustments are made to marginal costs ($\widetilde{mc_j}$) and conduct parameters ($\tilde{\kappa}$) to reflect changes in efficiency gains and partnership status, respectively. Depending on the scenario, the marginal costs are also adjusted according to:

$$\widetilde{mc_j} = \widehat{\text{mc}_j} + \lambda g_j \qquad (14)$$

Here, $\widehat{\text{mc}_j}$ represents the estimated marginal cost from our model, λ is a vector of estimates from the supply side, and g_j is a vector of the 9 variables (discussed in Section 5.2) that capture efficiency gains from partnerships: the percentage of flights operated and marketed by each group of carriers other than their own – ATI partners, JV partners and non-partners – as well as their interactions. To provide a clearer breakdown, we decompose λg_j into three components:

$$\lambda g_j = \lambda_{jv} {g_j}^{JV} + \lambda_{ati} {g_j}^{ATI} + \lambda_{other}\ {g_j}^{othe}$$

Each component includes relevant variables and parameters, for instance, $\lambda_{jv} {g_j}^{JV}$ will be $\lambda_1 g_1 + \lambda_2 g_2 + \lambda_3 g_3$ where g_1, g_2, g_3 are percentage of coupons operated by JV partner, percentage of coupons marketed by JV partner, and their interaction. In the first scenario where all airlines compete in Bertrand-Nash, we set $\widetilde{\kappa_1} = \widetilde{\kappa_2} = 0$ as neither JV nor ATI are in operation, and replace the marginal cost to:

$$\widetilde{mc_j} = \widehat{\text{mc}_j} - (\lambda_{jv} - \lambda_{others}) {g_j}^{JV} - (\lambda_{ati} - \lambda_{othe}) {g_j}^{ATI}$$

The first term represents cost savings from the JV partnership, as it captures the difference in marginal costs between having flights operated by JV partners versus non-partners; if the JV did not exist, the portion of flights currently operated by the JV would be handled by non-partners, typically at a higher cost. Likewise, the second term stands for the cost savings from ATI.

Subsequently, with the newly derived equilibrium prices and the shares, we calculate the new profit of product j as:

$$(15) \qquad \pi_j = \left(\Omega(\tilde{\kappa}) \circ D_p^*(p^*, x, \xi, \theta)\right)^{-1} \cdot s^*(p^*, x, \xi, \theta) \cdot M$$

where M is the size of market m. Meanwhile, as derived in Train (2009) and Small and Rosen (1981), the expected surplus of consumer i is computed as:

$$(16) \qquad E(CS_i) = -\frac{1}{\alpha_i} \cdot \log\left(1 + e^{(1-\rho)\cdot \log D_i}\right)$$

where D_i is the sum of inclusive values for consumer i defined in Section 5.1. We calculate the consumer surplus in market m by multiplying the market size by the consumer surplus, as defined in equation (16), for each market,

We use predicted prices, mark-ups, and consumer surplus from our main model as a baseline to represent what is expected when both ATI and JV are operating with efficiency gains. Comparing scenario (1) to the baseline offers insight into the combined effect of both JV and ATI partnerships, while scenarios (4) and (5) against the baseline decompose the overall effects into the effect by each partnership type. Similarly, comparing the outcomes of scenario (1) and (2) reveals the anti-competitive effects attributed to the partnership (coordination effect), while scenario (2) against the baseline highlights the pro-competitive aspect of the partnerships through savings in marginal costs (efficiency gains). Additionally, comparing the outcomes between scenario (5), where M&A replaces JV, and the baseline indicate the difference between JV and M&A.

Table 10 reports a summary of the outcomes for each counterfactual scenario. The first two columns display product-level averages of the new equilibrium prices and profits, while the third and fourth columns present market-level averages of consumer and producer surplus. Further, Table 11 provides how we interpret the differences between the outcomes.

[Table 10 and Table11 About Here]

Our simulations show that the price per person decreased by an average of $14 due to the combined effects of antitrust immunity (ATI) and joint ventures (JV). The efficiency gains from JV reduced the overall price by $31, while the coordination effect raised it by $17.

Our sample shows minimal variation in prices, mark-ups, and surpluses around the median. This is likely because, in 50% of the markets in our data (2,280 out of 4,596), there is no simultaneous operation of an airline and its JV or ATI partner, indicating the absence of the coordination effect in these markets. However, when we restrict our analysis to products partially operated by JV partners, the overall impact of JV and ATI is an average price increase of $37, while the mark-up decreases by $764 on average per flight. Conversely, for products partially marketed by JV partners, the average price effect is a decrease of $62, while the mark-up increases by $1,208 on average.

The decomposition of these overall effects is presented in the second and third rows of Table 11. The average price decrease of $4 due to JV and ATI is the net effect of two opposing forces: the upward pressure on prices due to coordinated pricing in the market, and the downward pressure due to cost savings from partnerships. The data suggest that the cost efficiencies derived from partnerships outweigh the coordination effect, resulting in an overall decrease in product prices. At the market level, JV and ATI result in a reduction in consumer surplus by $6,764 on average, offset by an increase in producer surplus of $1,695. This leads to an intriguing finding: despite the average price decrease of $4, consumer surplus also declines by $6,764.

The counterintuitive result that consumer surplus declines despite a decrease in average prices underscores the complexity of the market dynamics at play and necessitates a more granular analysis. To this end, we proceed to a regression analysis with changes in prices, profits, and consumer surpluses. The coefficients obtained provide a more nuanced understanding of the factors driving these outcomes and offer a plausible explanation for the observed decrease in consumer surplus. This detailed analysis allows us to reconcile the seemingly contradictory findings and provides a more comprehensive view of the effects of ATI and JV on market outcomes.

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Tables

[Table 1] List of Antitrust Immunity (ATI) in the U.S. Airline Industry[a]

	Start date	End date	U.S. carrier[b]	Foreign carrier	JV	DOT document #
1	1993-01-11	Linked	Delta[c]	KLM	✓	DOT-OST-1995-579
2	1996-05-20	Linked	United	Lufthansa		DOT-OST-1996-1116
3	1996-07-15	2000-06-01	American	Canadian International		DOT-OST-1995-792
4	1996-11-01	Linked	United	Lufthansa/SAS		DOT-OST-1996-1411
5	1997-09-19	Linked	United	Air Canada		DOT-OST-1996-1434
6	1999-09-13	2021-07-28	American	LAN		DOT-OST-1997-3285
7	2000-05-11	2001-11-08	American	Swissair/Sabena		DOT-OST-1999-6528
8	2001-01-26	Linked	United	Austrian/Lufthansa/SAS		DOT-OST-2000-7828
9	2001-04-03	Active	United	Air New Zealand		DOT-OST-1999-6680
10	2001-05-03	Active	United[d]	Copa		DOT-OST-2000-8577
11	2002-01-18	Linked	Delta	Air France/Alitalia/Czech Airlines		DOT-OST-2001-10429
12	2002-06-18	Active	Delta	Korean Air/Air France/Alitalia/Czech Airlines		DOT-OST-2002-11842
13	2002-07-30	Linked	American	Finnair		DOT-OST-2002-12063
14	2002-11-22	2007-05-24	American	Swiss International Air Lines		DOT-OST-2002-12688
15	2003-05-14	Active	United	Asiana		DOT-OST-2003-14202
16	2004-04-15	2009-10-26	American	SN Brussels		DOT-OST-2003-16530
17	2005-01-27	2007-05-24	American[e]	Royal Jordanian		DOT-OST-2004-18613
18	2005-10-13	2021-07-28	American	LAN/LAN Peru		DOT-OST-2004-19964
19	2007-02-13	Linked	United	Austrian/Lufthansa/SAS/Air Canada/BMI/LOT/Swiss/TAP		DOT-OST-2005-22922
20	2007-09-12	Linked	United	Austrian/Lufthansa/SAS/BMI		DOT-OST-2001-10575
21	2008-05-22	Active	Delta	Northwest/Air France/KLM/Alitalia/Czech Airlines		DOT-OST-2007-28644
22	2008-05-22	Active	Delta	Northwest/Air France/KLM	✓	DOT-OST-2007-28644
23	2009-07-10	Active	United	Continental/Air Canada/Lufthansa/SAS/Austrian /BMI/LOT/Swiss/TAP/Brussels		DOT-OST-2008-0234
24	2009-07-10	Active	United	Continental/Air Canada/Lufthansa	✓	DOT-OST-2008-0234
25	2010-07-08	Active	American	British Airways/Iberia/Finnair/Royal Jordanian		DOT-OST-2008-0252
26	2010-07-08	Active	American	British Airways/Iberia	✓	DOT-OST-2008-0252
27	2010-11-10	Active	American	Japan Airlines		DOT-OST-2010-0059
28	2010-11-10	Active	United	All Nipp on Airways	✓	DOT-OST-2010-0059
29	2011-06-10	2022-02-03	Delta	Virgin Australia/Pacific Blue Airlines		DOT-OST-2009-0155
30	2016-12-14	Active	Delta	Aeroméxico	✓	DOT-OST-2015-0070
31	2018-05-01	Active	Delta	Korean Air	✓	DOT-OST-2002-11842

[a] The ATI agreement between Aloha Airlines and Hawaiian Airlines, the only one among domestic airlines, lasted from September 30, 2002, to October 1, 2003. We omitted that case since the purpose of Table 1 is to display agreements between U.S. and foreign carriers. For additional details on the ATI agreement between Aloha Airlines and Hawaiian Airlines, refer to DOT-OST-2002-13002.

[b] The U.S. carrier's name reflects the current name of the company.

[c] Northwest. Northwest merged with Delta in 2008.

[d] Continental. Continental merged with United in 2012.

[e] America West. America West was merged by U.S. Airways in 2005, and U.S. Airways by American in 2013.

[Table 2] Quarterly Product Frequencies for Major Airlines in the U.S. Transatlantic Market (2004-2006 and 2014-2016)

	Airlines								
	Total	United Airline	American Airline	Delta	US Air-ways	Lufthansa	Operating Under Agreements		
Year-Quarter	Freq.						ATI	JV	Neither
2004-Q1	2,902	570	603	404	222	179	1,912	310	680
2004-Q2	3,688	696	749	501	271	269	2,411	379	898
2004-Q3	3,776	713	805	519	291	241	2,490	349	937
2004-Q4	3,159	598	649	455	214	201	2,052	330	777
2005-Q1	3,274	631	638	462	200	201	2,300	344	630
2005-Q2	3,928	770	791	547	269	270	2,858	343	727
2005-Q3	4,205	848	896	590	280	237	3,080	377	748
2005-Q4	3,411	617	792	459	186	202	2,408	343	660
2006-Q1	3,244	604	698	462	168	212	2,289	355	600
2006-Q2	4,196	784	900	626	252	305	3,080	338	778
2006-Q3	4,501	747	1,000	607	383	314	3,268	337	896
2006-Q4	3,536	650	795	380	288	227	2,484	320	732
2014-Q1	4,483	1,486	889	517	401	314	132	3,736	615
2014-Q2	5,605	1,629	1,067	734	631	342	159	4,491	955
2014-Q3	6,177	1,640	1,244	859	685	377	203	4,926	1,048
2014-Q4	4,436	1,439	718	670	440	261	143	3,587	706
2015-Q1	3,997	1,329	640	550	443	239	104	3,222	671
2015-Q2	5,126	1,462	879	752	665	318	137	3,996	993
2015-Q3	5,208	1,539	1,242	925	0	291	161	4,657	390
2015-Q4	4,431	1,304	1,166	722	0	218	128	4,019	284
2016-Q1	3,883	1,156	1,013	586	0	208	109	3,482	292
2016-Q2	5,064	1,333	1,351	851	0	258	133	4,486	445
2016-Q3	5,548	1,367	1,491	989	0	289	151	4,937	460
2016-Q4	4,411	1,192	1,123	723	0	245	175	3,899	337
Total	102,189	25,104	22,139	14,890	6,289	6,218	32,367	53,563	16,259

[Table 3] Revenue of Products Operating under Different Coordination Agreements

	Time Period			
	2004-2006		2014-2016	
	Frequency	Revenue (million)	Frequency	Revenue (million)
No ATI/JV partners	9,063 (20.68%)	21,341.05 (54.37%)	7,196 (12.33%)	7,894.55 (17.16%)
ATI	30,632 (69.90%)	15,419.83 (39.29%)	1,735 (2.97%)	5,281.88 (11.48%)
JV	4,125 (9.41%)	2,490.31 (6.34%)	49,438 (84.70%)	32,832.14 (71.36%)
Total	43,820 (100%)	39,251.19 (100%)	58,369 (100%)	46,008.57 (100%)

[Table 4] Demand Side Statistics

Variable	Mean	Min	p10	Median	p90	Max	N
Sample: 2004-2006							
Price ($'000s)	0.757	0.012	0.236	0.562	1.592	3.194	43,820
Distance	5.297	2.413	3.930	5.033	6.798	16.698	43,820
Distance^2	29.682	5.823	15.445	25.331	46.213	278.823	43,820
No. Coupons	2.089	1	1	2	3	5	43,820
Non-stop	0.144	0	0	0	1	1	43,820
No. Destinations	5.058	0	1	4	9	20	43,820
SkyTeam	0.272	0	0	0	1	1	43,820
Star Alliance	0.306	0	0	0	1	1	43,820
Oneworld	0.216	0	0	0	1	1	43,820
Sample: 2014-2016							
Price ($'000s)	0.879	0.008	0.238	0.696	1.764	3.750	58,369
Distance	5.226	2.395	3.872	4.995	6.691	15.826	58,369
Distance^2	28.802	5.736	14.992	24.950	44.769	250.462	58,369
No. Coupons	1.984	1	1	2	3	5	58,369
Non-stop	0.159	0	0	0	1	1	58,369
No. Destinations	6.588	0	1	6	16	20	58,369
SkyTeam	0.161	0	0	0	1	1	58,369
Star Alliance	0.341	0	0	0	1	1	58,369
Oneworld	0.324	0	0	0	1	1	58,369
Total							
Price ($'000s)	0.827	0.008	0.237	0.634	1.696	3.750	102,189
Distance	5.257	2.395	3.888	5.016	6.750	16.698	102,189
Distance^2	29.179	5.736	15.117	25.160	45.563	278.823	102,189
No. Coupons	2.029	1	1	2	3	5	102,189
Non-stop	0.152	0	0	0	1	1	102,189
No. Destinations	5.932	0	1	5	15	20	102,189
SkyTeam	0.208	0	0	0	1	1	102,189
Star Alliance	0.326	0	0	0	1	1	102,189

[Table 5] Supply Side Statistics

Variable	Mean	Min	p10	p50	p90	Max	N
Sample: 2004-2006							
Pct. of legs marketed by JV partner	0.013	0	0	0	0	1	43,820
Pct. of legs marketed by ATI partner	0.076	0	0	0	0.33	1	43,820
Pct. of legs marketed by non-JV/ATI partner	0.111	0	0	0	0.5	1	43,820
Pct. of legs marketed by own airline	0.800	0	0.5	1	1	1	43,820
Pct. of legs operated by JV partner	0.012	0	0	0	0	0.75	43,820
Pct. of legs operated by ATI partner	0.054	0	0	0	0.33	0.8	43,820
Pct. of legs operated by non-JV/ATI partner	0.178	0	0	0	0.5	0.8	43,820
Pct. of legs operated by own airline	0.755	0.2	0.5	0.75	1	1	43,820
Sample: 2014-2016							
Pct. of legs marketed by JV partner	0.187	0	0	0	1	1	58,369
Pct. of legs marketed by ATI partner	0.025	0	0	0	0	1	58,369
Pct. of legs marketed by non-JV/ATI partner	0.074	0	0	0	0.5	1	58,369
Pct. of legs marketed by own airline	0.714	0	0	1	1	1	58,369
Pct. of legs operated by JV partner	0.100	0	0	0	0.5	0.8	58,369
Pct. of legs operated by ATI partner	0.019	0	0	0	0	0.8	58,369
Pct. of legs operated by non-JV/ATI partner	0.147	0	0	0	0.5	0.8	58,369
Pct. of legs operated by own airline	0.734	0.2	0.5	0.67	1	1	58,369
Total							
Pct. of legs marketed by JV partner	0.112	0	0	0	0.5	1	102,189
Pct. of legs marketed by ATI partner	0.047	0	0	0	0	1	102,189
Pct. of legs marketed by non-JV/ATI partner	0.090	0	0	0	0.5	1	102,189
Pct. of legs marketed by own airline	0.750	0	0	1	1	1	102,189
Pct. of legs operated by JV partner	0.062	0	0	0	0.5	0.8	102,189
Pct. of legs operated by ATI partner	0.034	0	0	0	0	0.8	102,189
Pct. of legs operated by non-JV/ATI partner	0.160	0	0	0	0.5	0.8	102,189
Pct. of legs operated by own airline	0.743	0.2	0.5	0.67	1	1	102,189

[Table 7] Demand Estimates

	(1)	(2)	(3)
	RCNL	Nested Logit	2SLS
Price ($‘000s)	-1.449	-1.499	-1.737
	0.110	0.124	0.108
Non-stop	0.616	2.684	2.961
	0.259	0.078	0.072
Price sd	0.401		
	0.058		
Non-stop sd	0.271		
	2.116		
Price*Non-stop sd	-3.012		
	0.221		
	0.533	0.164	
	0.023	0.015	
Number of coupons	-0.048	-0.114	-0.183
	0.019	0.033	0.029
Distance	1.452	0.881	0.665
	0.089	0.125	0.098
	-0.105	-0.063	-0.045
	0.007	0.010	0.008
Multi-ticket	-0.398	-0.827	-1.054
	0.022	0.035	0.036
origtw	0.434	0.583	0.539
	0.044	0.065	0.058
desgtw	0.404	0.497	0.482
	0.041	0.063	0.055
No. Destinations	0.009	0.015	0.016
	0.002	0.003	0.003
SkyTeam	-0.065	-0.142	-0.169
	0.026	0.042	0.046
Star Alliance	-0.107	-0.168	-0.206
	0.023	0.039	0.043
Oneworld	0.074	0.048	0.080
	0.025	0.034	0.036
Fixed effects			
Airline	✓	✓	✓
Year-month	✓	✓	✓
Foreign countries	✓	✓	✓
Average own elasticities	-1.690	-2.175	

[Table 8] Cost Estimates

	(1)
Pct. of legs marketed by JV partner	-0.002
(pct_eqmkt_JV)	0.014
Pct. of legs marketed by ATI partner	-0.048
(pct_eqmkt_ATI)	0.022
Pct. of legs marketed by others	0.154
(pct_mkt_other)	0.078
Pct. of legs operated by JV partner	0.180
(pct_eqop_JV)	0.025
Pct. of legs operated by ATI partner	0.297
(pct_eqop_ATI)	0.039
Pct. of legs operated by others	0.199
(pct_op_other)	0.019
Pct. of legs operated # marketed by JV partner	-0.132
mkt#pct_op_jv	0.043
Pct. of legs operated # marketed by ATI partner	-0.068
mkt#pct_op_ATI	0.068
Pct. of legs operated # marketed by others	-0.030
mkt#pct_op_other	0.173
Gateway (Origin)	-0.033
(origtw)	0.017
Gateway (Destination)	0.009
(desgtw)	0.016
Nonstop	0.370
(nonstop)	0.019
Skyteam	0.066
	0.013
Staralli	0.108
	0.014
Oneworld	0.102
	0.013
Distance	0.049
	0.004
No. Connections	0.002
	0.008
No. destinations	-0.002
	0.001
Fixed effects	
Airline	✓
Year-month	✓
Foreign Airport	✓
Average Marginal Costs	0.541

[Table 9] Conduct Parameters

	(1)
κ_1 (ATI)	0.274
	(0.148)
κ_2 (JV)	0.614
	(0.094)

[Table 10] Average price, mark-up, and consumer welfare by counterfactual scenarios

	Price	Mark-up	Consumer Surplus	Producer Surplus
Baseline	972	525,458	4,702,611	4,514,066
Scenario 1	976	525,260	4,709,375	4,512,371
Scenario 2	984	525,339	4,701,422	4,513,050
Scenario 3	975	525,389	4,703,109	4,513,474
Scenario 4	973	525,330	4,708,879	4,512,965
Scenario 5	956	525,803	4,705,627	4,517,036

[Table 11] Decomposition of average effect

		Price	Mark-up	Consumer Surplus	Producer Surplus
Baseline-(1)	Overall effect	-4	197	-6,764	1,695
(2)-(1)	Coordination effect	8	79	-7,954	679
Baseline-(2)	Efficiency gain	-12	118	1,190	1,016
Baseline-(3)	Overall effect (ATI)	-3	69	-498	592
Baseline-(4)	Overall effect (JV)	-1	128	-6,267	1,101
(5) - Baseline	M&A	-16	346	3,016	2,970

[Table 12] Dep: Price difference

	Δp^1_{jm}	Δp^2_{jm}	Δp^3_{jm}	$\Delta \pi^1_{jm}$	$\Delta \pi^2_{jm}$	$\Delta \pi^3_{jm}$
No. of products	-0.177*	-0.174*	-0.003***	4.909**	2.839*	2.070
	(0.105)	(0.104)	(0.001)	(2.141)	(1.660)	(1.320)
No. of products by ATI partners	2.381***	2.383***	-0.003	9.124	24.303***	-15.179**
	(0.318)	(0.319)	(0.008)	(8.226)	(6.821)	(6.734)
No. of products by JV partners	4.749***	4.733***	0.016**	101.530***	85.157***	16.373***
	(0.715)	(0.712)	(0.006)	(23.250)	(22.696)	(5.091)
Distance	-0.885	-1.013	0.128***	-448.697***	-287.545***	-161.152***
	(0.753)	(0.751)	(0.028)	(155.306)	(104.031)	(62.317)
Distance^2	0.037	0.046	-0.009***	33.752***	19.759***	13.993***
	(0.053)	(0.053)	(0.002)	(11.789)	(7.632)	(4.978)
No. of connections	0.746***	0.748***	-0.003	-154.673***	-75.110***	-79.563***
	(0.262)	(0.260)	(0.011)	(18.329)	(9.415)	(16.268)
No. Destination	0.196**	0.194**	0.002	5.805	1.816	3.988**
	(0.076)	(0.076)	(0.001)	(5.870)	(5.230)	(1.637)
Percent of legs operated by JV partners	229.698***	5.333*	224.364***	-4,771.31***	-296.359***	-4,474.95***
	(3.196)	(3.172)	(0.089)	(153.734)	(63.133)	(126.923)
Percent of legs operated by ATI partners	136.292***	6.905***	129.388***	-2,374.04***	120.593**	-2,494.63***
	(1.447)	(1.414)	(0.102)	(329.782)	(49.412)	(321.730)
Percent of legs self-operated	0.787	0.959	-0.172***	544.094***	320.222***	223.871***
	(0.878)	(0.875)	(0.035)	(84.521)	(65.624)	(34.127)
Percent of legs marketed by JV partners	-198.939***	-0.913	-198.026***	3,041.221***	-346.155***	3,387.376***
	(0.953)	(0.936)	(0.053)	(110.108)	(69.006)	(137.988)
Percent of legs marketed by ATI partners	-193.104***	0.074	-193.178***	3,338.544***	-156.036***	3,494.580***
	(0.905)	(0.890)	(0.091)	(383.665)	(52.514)	(386.411)
Percent of legs self-marketed	-4.089***	-4.149***	0.060**	-167.423***	181.873***	-349.296***
	(0.812)	(0.810)	(0.028)	(37.554)	(41.574)	(40.955)
Observations	39,478	39,478	39,478	39,478	39,478	39,478
R-squared	0.924	0.307	1.000	0.259	0.067	0.345
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Foreign Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

[Table 13] Dep: Consumer Surplus difference

	ΔCS_m^1	ΔCS_m^2	ΔCS_m^3
No. of products	-765.492***	-967.041***	201.549***
	(231.727)	(240.086)	(34.772)
No. of products by ATI partners	-1,605.093	-1,953.885*	348.792
	(1,058.662)	(1,006.558)	(288.419)
No. of products by JV partners	-18,425.760***	-19,368.222***	942.462***
	(2,252.608)	(2,384.177)	(291.932)
Distance	9,260.018	12,978.512**	-3,718.495***
	(5,979.692)	(6,588.032)	(1,004.393)
Distance^2	-441.730	-730.353	288.623***
	(473.304)	(519.238)	(81.499)
No. of connections	4,629.291***	5,049.212***	-419.922
	(1,695.175)	(1,749.299)	(278.086)
No. Destination	-76.324	-17.502	-58.822*
	(231.890)	(241.814)	(31.315)
Percent of legs operated by JV partners	-69,372.955***	-38,496.449***	-30,876.507***
	(9,960.066)	(10,217.391)	(2,112.482)
Percent of legs operated by ATI partners	-51,067.643***	-39,657.921***	-11,409.722***
	(7,351.474)	(7,857.102)	(2,124.882)
Percent of legs self-operated	-29,744.710***	-32,305.206***	2,560.496*
	(7,850.590)	(8,701.620)	(1,369.299)
Percent of legs marketed by JV partners	44,721.725***	22,236.382**	22,485.344***
	(9,649.832)	(10,264.963)	(1,913.491)
Percent of legs marketed by ATI partners	32,727.287***	12,055.782*	20,671.505***
	(6,167.135)	(6,208.804)	(1,876.768)
Percent of legs self-marketed	21,308.713***	22,242.505***	-933.791
	(6,042.629)	(6,551.640)	(887.167)
Observations	4,596	4,596	4,596
R-squared	0.342	0.354	0.325
Year-Quarter FE	Yes	Yes	Yes
Foreign Country FE	Yes	Yes	Yes