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

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Abstract

This paper examines the competitive effects of joint ventures and antitrust immunity (ATI) in the U.S. international airline market. We quantify the extent to which joint ventures and ATI facilitate partial collusion among participating airlines and the consequential impact on market outcomes. Our structural model captures the changes in prices, capacities, and consumer welfare resulting from these partnerships. The counterfactual analysis reveals that while joint ventures generate efficiencies akin to mergers, they also enable substantial coordinated behavior, potentially leading to higher prices and reduced competition. However, we find no evidence of anticompetitive effects stemming from joint venture and ATI agreement. Leveraging a unique dataset that spans multiple joint venture agreements and market conditions in the transatlantic market, we provide robust empirical evidence of the dual nature of joint ventures as both collaborative and collusive entities.

Keywords Joint venture, partial collusion, demand estimation, coordination effect, efficiency gain

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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 (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 (noncooperative vs. fully cooperative). A common example is a joint venture, where two or more companies collaborate to pursue a specific common goal (not necessarily fully common objectives). During the last several decades, economists have 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 the impact of joint ventures is more limited. One reason for this limited understanding could be that joint ventures take on a wide range of specific forms across industries, and thus, it is difficult to evaluate how collusive joint ventures are, even within the same industry.

A deeper understanding of the relative collusiveness of mergers vs. ostensibly less-cooperative arrangements such as joint ventures can be beneficial to policymakers, practitioners, and even consumers. It can aid in how antitrust law is crafted and applied; for example, it can help set the bar on required synergies for antitrust approval. It can also inform affected parties about what to expect in terms of coordinated behavior for different types of cooperation. As a general point, if in practice, firms engaging in a joint venture tend to behave very similarly to merged firms (e.g., maximize joint profits), a joint venture would generate very different levels of concern (among regulators/judges) and predictions (for firms and consumers) than if they were found to behave very similarly to independent, competing firms (e.g., maximize individual profits without regard to the other firm's profits).

In this paper, we empirically assess the level of collusiveness for different types of cooperation 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 logit 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, which, to the best of our knowledge, have no prior research 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.

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. Fageda et al. (2019) 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 consider. 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 the 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).

Contrary to the argument that coordination expands the consumers' choice set, some international routes, where the JV partners offer competing non-stop flights, suffer from market foreclosure in the networks (Chen and Gayle, 2007; Bilotkach, 2007) and result in a decrease in frequency of flights by the competing carriers (Bilotkach and Hüschelrath, 2013). The theory argues that the heterogenous effects on the market that a higher degree of airline cooperation causes a pro-competitive effect in interline routes and an anti-competitive effect in interhub routes (Fageda et al., 2019). Tan & Zhang (2022) find joint venture leads to an increase in online flights prices, and as mentioned above, Miller and Weinberg (2017) find price increases following a retail beer joint venture.

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 across multiple arrangements. In doing so, we can 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 in the U.S. Airline Industry

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. The approval for joint ventures in the international airline industry should be accompanied with the granting of ATI. 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.

Before the advent of joint ventures among major full-service carriers, there were cases where airlines received ATI but did not reach the state of a joint venture. Joint venture agreements among major airlines generally involve price-fixing, and thus, must be accompanied by ATI. Conversely, receiving ATI does not necessarily imply that the airlines share profits and revenues. While the specific contractual agreements for each joint venture are typically not disclosed, it is inferred that joint venture firms often acquire mutual ownership stakes from each partner to deepen the degree of coordination in joint ventures compared to ATI firms, as demonstrated by the Delta Air Lines (Delta) case. In particular, 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.[1] Delta also acquired a 4.3% equity stake in Hanjin-KAL, the largest shareholder of Delta's joint venture partner Korean Air, paving the way for even closer cooperation between the two joint venture partners.[2] Delta also completed a tender offer for twenty percent (20%) of the issued and outstanding LATAM Shares (the "Equity Investment").[3] 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. It includes the start and end dates of each agreement, the U.S. carrier name, foreign carrier name, joint venture (JV) status, and the corresponding Department of Transportation (DOT) document number.

[Table 1 Here – List of ATI]

[1] Levine-weinburg, A. 2017, Aug 1. "Delta Air Lines Deepens Ties with European Partners", The Motley Fool
[2] Horton, W. 2019, June 20. "Delta invests in Korean Air to defend their JV and the Cho dynasty". Forbes
[3] 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."

The inaugural joint venture and ATI in the U.S. airline industry occurred between Northwest Airlines and KLM Royal Dutch Airlines in 1993, marking the beginning of their partnership formed in 1989 when KLM acquired a 19.3% stake in Northwest. Until the mid-2000s, all ATI partnerships in the global aviation market remained one-to-one agreements between foreign and U.S. airlines. The full-scale comprehensive joint venture agreements that included European airlines and transatlantic markets commenced with airlines in the SkyTeam alliance, which requested authority to operate a transatlantic alliance with antitrust immunity and received approval in May 2008. This joint venture included Air France (France), KLM (Dutch), Alitalia (Italy), and Czech Airlines (Czech). The same document also approved the subgroup joint venture among Delta, Air France, and KLM. Following the expanded coordination among airlines in the SkyTeam alliance in the transatlantic market, companies in the Star Alliance subsequently submitted an ATI approval among United, Air Canada (Canada), Lufthansa (Germany), SAS (Denmark, Norway, and Sweden), Austrian (Austria), BMI (British), LOT (Poland), Swiss (Swiss), TAP (Portugal), and Brussels (Belgium). Airlines in the Star Alliance also applied for subgroup joint ventures among United, Air Canada, and Lufthansa, approved in 2009. 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).

The distinction between opting for a joint venture instead of a merger within the international airline industry can be attributed to the strategic significance of the airline company as a fundamental or key industry for the individual country. Countries typically impose restrictions on foreign capital acquiring companies in industries deemed critical to national interests, such as defense, aerospace, energy, telecom, and aviation. The airline sector, being a vital component of a nation's infrastructure, often faces stringent regulations preventing outright mergers with foreign entities. For instance, the United States, through its foreign ownership rules, limits foreign ownership of U.S. airlines to 25%. This restriction is a clear illustration of the effort to maintain control and influence over domestic carriers, preventing foreign entities from acquiring substantial stakes or taking over these key players in the aviation sector. Similarly, India has historically adhered to stringent regulations concerning foreign investment in its airline industry. By imposing restrictions on foreign ownership, India aims to prevent outright takeovers or mergers with foreign entities, thereby preserving control and ownership of its essential airline assets. In Europe, the airline industry is marked by various joint ventures among national carriers, reflecting the region's emphasis on collaboration over outright mergers. For example, the joint venture between American Airlines, British Airways, and Iberia showcases how airlines from different countries can strategically align their operations without compromising national control. This approach allows for cooperation and coordination in the highly competitive aviation landscape while upholding the individual influence and ownership of each participating nation over its respective airline. Governments are inclined to safeguard control and ownership of their domestic airline companies, preserving their influence over a sector deemed crucial for economic, strategic, and national security reasons. Consequently, joint ventures emerge as a viable alternative, allowing collaboration and coordination without relinquishing control or ownership of the essential national asset to foreign entities.

While the intricacies of heightened coordination within the global aviation industry are vital to comprehend, a comprehensive exploration of the associated advantages and disadvantages for global aviation consumers remains an underexplored domain. The enhanced collaboration facilitated by antitrust immunity and joint ventures among airlines can potentially yield benefits such as enhanced route connectivity, improved scheduling, and optimized operational efficiency. However, delving into the implications for consumers requires a nuanced analysis of how these coordination efforts may impact competition, pricing dynamics, and service quality. In fact, the U.S. Government Accountability Office has highlighted the necessity for increased transparency in the Department of Transportation's (DOT) oversight of antitrust immunity effects in international air alliances[4]. Efforts to enhance transparency are crucial for evaluating the real-world impact of firms' cooperative behaviors, ensuring that the benefits translate into tangible advantages without unduly restricting market competition. This research addresses the existing gap in knowledge concerning the practical consequences of intensified collaboration in the airline industry, specifically focusing on ATI and joint ventures in the global aviation market. 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 – this study aims to contribute valuable insights into the distinctive nature of aviation alliances.

[4] U.S. Government Accountability Office, https://www.gao.gov/products/gao-19-237, accessed on December 7, 2023.

4. Data

We construct our dataset from two sources. The first is the international Origin & Destination flight data, which we obtained from Airline Data Inc. It contains basically everything we can observe from the domestic Origin & Destination data, including information on the ticket prices, origin/connecting/destination airport, operating/marketing carrier of each leg, and various flight- and route-level characteristics. The unique feature of this dataset is that it includes a scaled-up version of the international Origin & Destination 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 T-100f. It also contains information on the flights operated by non-U.S. carriers from the foreign origin city, not restricted to the trips operated solely by the U.S. airlines.

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 share operated by foreign carriers (Bilotkach, 2019). The importance of filling this data gap in the joint venture literature is twofold. Firstly, when analyzing the international airline industry, researchers often have data on routes operated by U.S. airlines only. This limited dataset can distort the true competitive landscape of a given market because it fails to account for competing airlines, including foreign carriers. Secondly, 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 counterfactual analysis shows that … [briefly introduce the key results of our counterfactual analysis]

We have chosen the time window of our dataset as the four quarters of 2005 and the four quarters of 2015. This was to ensure a significant temporal gap from the establishment of extensive joint ventures among airlines within alliances, such as SkyTeam in 2008, Oneworld in 2009, and Star Alliance in 2010. By doing so, we are better able to estimate a relatively "pure" effect of JV.

[Table 2 Here – Market Level Statistics]

Table 2 presents the market-level overview of our dataset. In 2015, there were a total of 2,309 transatlantic markets, marking a slight increase compared to 2005. As will be seen below, 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, British Airways is considered the owner of the aforementioned "MIA-JFK-LHR/AA-BA/AA-AA" product as it operates the aircraft across the Atlantic Ocean. Based on this definition, suppose there are three products in the MIA-LHR O&D directional market during the fourth quarter of 2015, with "owner" airlines being AA, BA, and United Airlines (UA), respectively. Since AA and BA established a joint venture agreement in 2010, two products by AA and BA are indicated as operating this market with JV partners, while a product by UA is marked as operating without ATI/JV partners. Then we calculate the share of products operating without ATI/JV coordination partners within each market. In 2005, among the 2,287 products, roughly 80.1% of products were operating without any ATI/JV partners. Note that this number encompasses both products operated by competitors (no ATI/JV) only and those operated by a single airline. However, this percentage decreased to 60.6% by 2015. This decline is supported by the increase in the share of products operating under JV agreements, which rose from 2.2% to 31.3%. Over the same period, the number of products for a given market changed from 7.756 to 9.418, and the unique number of airlines from 3.9 to 3.8.

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

[Table 3] provides descriptive statistics at the product level, illustrating the frequency and the revenue share of products operating under different coordination establishments. Over the period from 2005 to 2015, there was a 22.6% increase in the number of products, accompanied by a similar rise of 23.8% in revenue. The striking transformation lies in the revenue distribution among products operating under JV coordination agreements. While the proportion of revenue from products operating with no ATI/JV partners decreased by 45.8%, the revenue from products operating under JV agreements increased by more than 14 times. We interpret that as indicative of the U.S. airlines engaging in joint venture agreements with their European counterparts on routes where their revenue share was particularly significant. In 2005, approximately 37.5% of revenue was generated by products operating alongside their ATI/JV partners. This figure soared to 72.64% by 2015.

[Table 4 Here – Demand Summary Statistics]

[Table 4] provides the descriptive statistics of variables used in the demand-side model. *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 of the great circle distances between 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 number of destination gateway marketing carrier serve non-stop flight from the origin gateway. This is to capture ... .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 (code: DL) on SkyTeam to KLM Royal Dutch Airlines (code: KL) on SkyTeam. [Table 5] shows the descriptive statistics used in the supply-side model.

[Table 5 Here – Supply Summary Statistics]

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). While we consider simpler logit and nested logit models without random parameters, we expand our models to incorporate consumer heterogeneity. 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 chooses 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:

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

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

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

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 flight, multi-ticket flight, carrier alliances, and indicators for 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 and shares of those who took flights. 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), after we introduce the supply side of the model.

5-2. Supply Side

We posit that the supply side of the market is characterized by Bertrand-Nash competition among airlines and model the supply side by 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 competition and collusion/merger). 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 and include 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 9 variables: the percentage of flights operated by each group of carriers other than their own (ATI /JV partners and non-partners, separately), the percentage of flights marketed by each group of the other carriers, and their interactions. Notice that the mark-up, the second term with inverse in equation (6), 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, the mark-up term is endogenous. We construct two additional supply side instruments to address this endogeneity and identify the conduct parameters, which is discussed 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:

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

As in the demand side, we also partial out carrier, year-quarter, foreign country fixed effects to capture any uncontrolled left-over heterogeneity that may cause the 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 identifying 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 the instruments consists of the own-cost shifters from the marginal cost specification, which are excluded from our demand model. We use g_{jmt}, which are the excluded cost shifters. 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, does 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:

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

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}.

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

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:

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

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, in the context of JV and ATI within the US airline sector, 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[5]. 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 JV was implemented[6].

This variation mandated by regulators sheds light on cross-sectional differences in mark-ups 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

[5] DOT-OST-2001-10429
[6] DOT-OST-2007-28644

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 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 quarter, individual firm, and foreign country fixed effects. We also clustered the standard errors at market level to allow correlation between errors within each market. As a benchmark, we provide the results of the standard (fixed coefficients) logit with 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. 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 unable to re-accommodated on 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 infers the degree of substitution across the inside options (Berry and Jia, 2010). Our estimate of ρ at 0.53 (or 0.47 as λ in Berry and Jia (2010) style representation) suggests that alternatives within trans-Atlantic flights exhibit higher correlation compared to those within domestic flights, implying that consumers are less likely to substitute to the outside option The estimates reported in previous studies for domestic airlines were 0.72 (Berry and Jia, 2010) and 0.61 (Ciliberto and Williams, 2014), highlighting the unique nature of international flights.

The average and median of 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, 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[7], indicating a reasonable explanation of consumer behavior in the international flight market.

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 quarter, individual firm, and foreign country fixed effects and are clustered at the market level.

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

[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 and 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 $(\widetilde{mc}_j, \tilde{\kappa})$:

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

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:

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

Here, $\widehat{mc_j}$ 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:

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

(15) 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: $\widetilde{mc_j} = \widehat{mc_j} - (\lambda_{jv} - \lambda_{other} \ ) g_j{}^{JV} - (\lambda_{ati} - \lambda_{oth} \quad) g_j{}^{ATI}$

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:

$$(16) \qquad \pi_j = \left(\Omega(\tilde{\kappa}) \circ D_p^*(p^*, x, \xi, \theta)\right)^{-1} \cdot \ s^*(p^*, x, \xi, \theta) \cdot M$$

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:

$$(17) \qquad E(CS_i) = -\frac{1}{\alpha_i} \cdot \ \log\left(1 + e^{(1-\rho)\cdot \log D_i}\right)$$

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

[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]America West. America West was merged by U.S. Airways in 2005, and U.S. Airways by American in 2013.
[d]Northwest. Northwest merged with Delta in 2008.
[e]Continental. Continental merged with United in 2012.

[Table 2] Market Level Statistics

Year	Variable	Mean	Min	p10	Median	p90	Max	N
2005	Share of products operating without ATI/JV partners	0.801	0	0.357	1	1	1	2,287
	Share of products operating with JV partners	0.022	0	0	0	0	1	2,287
	Number of products	7.756	1	3	7	14	37	2,287
	Number of airlines	3.998	1	2	4	7	11	2,287
2015	Share of products operating without ATI/JV partners	0.606	0	0.125	0.583	1	1	2,309
	Share of products operating with JV partners	0.313	0	0	0.267	0.792	1	2,309
	Number of products	9.418	1	3	8	18	52	2,309
	Number of airlines	3.800	1	2	4	6	10	2,309
Total	Share of products operating without ATI/JV partners	0.703	0	0.2	0.833	1	1	4,596
	Share of products operating with JV partners	0.168	0	0	0	0.667	1	4,596
	Number of products	8.591	1	3	7	16	52	4,596
	Number of airlines	3.898	1	2	4	6	11	4,596

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

	Year			
	2005		2015	
	Frequency	Revenue (million)	Frequency	Revenue (million)
No ATI/JV partners	13,350 (75.27%)	8,104.02 (62.53%)	10,919 (50.21%)	4391.24 (27.36%)
ATI	3,870 (21.82%)	4,146.80 (31.99%)	1,666 (7.86%)	1,379.53 (8.59%)
JV	517 (2.91%)	710.35 (5.48%)	9,161 (42.13%)	10,281.16 (64.05%)
Total	17,737 (100%)	12,961.17 (100%)	21,746 (100%)	16,051.93 (100%)

[Table 4] Demand Side Statistics

Variable	Mean	Min	p10	Median	p90	Max	N
Sample: 2005							
Price (‘000s)	0.894	0.059	0.317	0.650	1.848	3.723	17,737
Distance	5.142	2.413	3.914	4.967	6.427	17.681	17,737
Distance^2	27.645	5.823	15.319	24.671	41.306	312.618	17,737
No. Coupons	2.145	1	1	2	3	5	17,737
Non-stop	0.129	0	0	0	1	1	17,737
No. Destinations	5.339	0	1	4	12	19	17,737
SkyTeam	0.332	0	0	0	1	1	17,737
Star Alliance	0.314	0	0	0	1	1	17,737
Oneworld	0.224	0	0	0	1	1	17,737
Sample: 2015							
Price (‘000s)	0.923	0.028	0.296	0.723	1.828	3.723	21,746
Distance	5.038	2.395	3.867	4.900	6.318	13.966	21,746
Distance^2	26.383	5.736	14.954	24.010	39.917	195.049	21,746
No. Coupons	2.019	1	1	2	3	5	21,746
Non-stop	0.153	0	0	0	1	1	21,746
No. Destinations	6.928	0	1	6	16	21	21,746
SkyTeam	0.169	0	0	0	1	1	21,746
Star Alliance	0.342	0	0	0	1	1	21,746
Oneworld	0.327	0	0	0	1	1	21,746
Total							
Price (‘000s)	0.910	0.028	0.306	0.690	1.835	3.723	39,483
Distance	5.085	2.395	3.878	4.932	6.362	17.681	39,483
Distance^2	26.950	5.736	15.039	24.325	40.475	312.618	39,483
No. Coupons	2.075	1	1	2	3	5	39,483
Non-stop	0.142	0	0	0	1	1	39,483
No. Destinations	6.214	0	1	5	15	21	39,483
SkyTeam	0.242	0	0	0	1	1	39,483
Star Alliance	0.329	0	0	0	1	1	39,483

[Table 5] Supply Side Statistics

Variable	Mean	Min	p10	p50	p90	Max	N
Sample: 2005							
Pct. of legs marketed by JV partner	0.010	0	0	0	0	1	17,737
Pct. of legs marketed by ATI partner	0.073	0	0	0	0.333	1	17,737
Pct. of legs marketed by own airline	0.812	0	0.5	1	1	1	17,737
Pct. of legs operated by JV partner	0.010	0	0	0	0	0.75	17,737
Pct. of legs operated by ATI partner	0.052	0	0	0	0.333	0.8	17,737
Pct. of legs operated by own airline	0.759	0.2	0.5	1	1	1	17,737
Sample: 2005							
Pct. of legs marketed by JV partner	0.173	0	0	0	1	1	21,746
Pct. of legs marketed by ATI partner	0.023	0	0	0	0	1	21,746
Pct. of legs marketed by own airline	0.726	0	0	1	1	1	21,746
Pct. of legs operated by JV partner	0.091	0	0	0	0.5	0.75	21,746
Pct. of legs operated by ATI partner	0.019	0	0	0	0	0.75	21,746
Pct. of legs operated by own airline	0.737	0.2	0.5	0.667	1	1	21,746
Total							
Pct. of legs marketed by JV partner	0.100	0	0	0	0.5	1	39,483
Pct. of legs marketed by ATI partner	0.045	0	0	0	0	1	39,483
Pct. of legs marketed by own airline	0.765	0	0	1	1	1	39,483
Pct. of legs operated by JV partner	0.055	0	0	0	0.333	0.75	39,483
Pct. of legs operated by ATI partner	0.034	0	0	0	0	0.8	39,483
Pct. of legs operated by own airline	0.747	0.2	0.5	0.667	1	1	39,483

[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 elasticicities	-2.175	-1.690	

[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	Profit	Consumer Surplus	Producer Surplus
Baseline	959	738,193	12,681,819	4,514,066
Scenario 1	973	736,093	12,738,816	4,512,371
Scenario 2	990	737,988	12,675,150	4,513,050
Scenario 3	963	737,959	12,689,639	4,513,474
Scenario 4	969	736,326	12,731,047	4,512,965
Scenario 5	960	738,719	12,662,448	4,517,036

[Table 11] Decomposition of average effect

		Price	Mark-up	Consumer Surplus	Producer Surplus
Baseline-(1)	Overall effect	-14	2,101	-56,997	1,695
(2)-(1)	Coordination effect	17	1,896	-63,666	679
Baseline-(2)	Efficiency gain	-31	205	6,669	1,016
Baseline-(3)	Overall effect (ATI)	-4	234	-7,821	592
Baseline-(4)	Overall effect (JV)	-10	1,867	-49,229	1,101
Baseline - (5)	M&A	-1	-526	19,371	2,970

[Table 12] Dep: Price difference

	Δp_{jm}^{1}	Δp_{jm}^{2}	Δp_{jm}^{3}	$\Delta \pi_{jm}^{1}$	$\Delta \pi_{jm}^{2}$	$\Delta \pi_{jm}^{3}$
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