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BALANCING COMPETITION AND COOPERATION: EVIDENCE FROM TRANSATLANTIC AIRLINE MARKETS

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Abstract
In the last two decades, airline alliances were not only successful in extending the size of their networks, but also received approvals by public authorities to intensify their cooperation through to merger-like revenue-sharing joint ventures (JVs). We empirically investigate the impact of the implementation of such joint ventures on both the respective airlines' competitive strategies as well as productive efficiency. Using U.S. DOT T100 International Segment data and applying airline-market fixed effects models, we find that joint ventures – compared to services with a lower degree of cooperation – lead to a 3-5 percent increase in capacity between the respective partner airlines' hub airports; however, this is done at the expense of services elsewhere in the network. Productive efficiency, as measured by load factors, is found to be 0.5-5 percent lower for joint venture routes compared to routes operated under antitrust immunity only. We use our empirical results to discuss implications for the balancing of competition and cooperation in transatlantic airline markets.

Keywords Air transportation, alliances, antitrust immunity, efficiencies, GMM estimator

JEL Class L41, L93, K21

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1 Introduction

Economists and philosophers have studied the benefits of competition in a multitude of ways. Notwithstanding the potential relevance of any of these efforts – some of which having been very influential, such as Adam Smith's 'invisible hand' or Friedrich August von Hayek's 'competition as a discovery procedure' – the most fundamental result of all these research efforts is probably the insight that competitive markets allocate resources efficiently because they provide products to all customers willing to pay the opportunity cost of production. Abstracting from possible market imperfections or failures, a society's welfare is therefore maximized by securing open and competitive markets.

Although competition certainly is a key driver of the wealth of nations, it is equally undisputed that cooperation between firms has the potential to drive substantial increases in economic welfare. For example, the pooling of (partly) complementary resources as part of research and development activities can not only reduce the fixed cost burden to society, but might also lead to quicker and/or better research outputs and (subsequently) improved products and services. However, although cooperation between firms can surely increase welfare, researchers have also identified forms of firm cooperation (e.g., price fixing or market sharing arrangements) that are likely to lead to detrimental welfare effects.

The existence of both costs and benefits of firm cooperation immediately suggests the question of the optimal degree of cooperation to maximize economic welfare. The transatlantic airline market renders itself very well to such an investigation. Cooperation between the airlines on this market has been in place for over two decades, and it has taken various forms. At this time, partnerships on transatlantic routes range from ad hoc codesharing agreements via partnerships covered by antitrust immunity through to revenue-sharing merger-like joint ventures (JVs). Airline joint ventures are a recent phenomenon, and effects of this new form of airline cooperation has not received any attention in the academic literature.

Against this background, we empirically investigate the impact of the implementation of airline revenue-sharing joint ventures (JVs) on both the respective airlines' competitive strategies as well as productive efficiency. Using U.S. DOT T100 International Segment data and applying airline-market fixed effects models, we find that joint ventures – compared to services with a lower degree of cooperation – lead to an increase in capacity between the respective partner airlines' hub airports of 3-5 percent; however, at the expense of services elsewhere in the network. Productive efficiency, as measured by load factors, is found to be 0.5-5 percent lower for joint venture routes compared to routes operated under antitrust immunity only. We use our empirical results to discuss implications for the balancing of competition and cooperation in transatlantic airline markets.

The remainder of the paper is structured as follows. Section 2 provides a general high-level description of the balancing of competition and cooperation in joint ventures. The subsequent Section 3 applies the general theories and concepts to the case of airline alliances. After a general introduction to the development of airline alliances in Section 3.1, Section 3.2 provides an overview of the general economic effects of such agreements as discussed in the existing literature. Section 4 presents our empirical analysis. While Section 4.1 provides a detailed description of the construction of the data set and the descriptive statistics, Section 4.2 continues with the characterization of our methodological approach. Section 4.3 closes the section with the presentation and discussion of our empirical results. Section 5 concludes the paper.

2 Balancing competition and cooperation in joint ventures

The general question of balancing competition and cooperation is closely connected to the determinants of firm boundaries, discussed extensively in the economics and business strategy literature over the last couple of decades. Differentiating between horizontal and vertical boundaries of the firm, cost considerations are typically presumed to be one important determinant of the former. With respect to the vertical boundaries, theoretical and empirical research has demonstrated the importance of the balance between investment incentives (specific assets) and performance incentives (Cabral, 2000). These incentives determine the efficient degree of cooperation; that is, the degree which minimizes the sum of production and transaction cost.

In addition to the two polar options of 'market' and 'integration', several hybrid organizational forms have emerged to reach the desired efficient solution for organizing economic activities (see Bilotkach and Hüschelrath, 2011 for a general discussion). Strategic alliances and joint ventures (JVs) can be interpreted as two available options for the optimization of a firm's horizontal and vertical organizational structure. Let us focus on joint ventures[1] for the time being. They generally occur when two or more firms pool some of their resources within a common legal organization (Kogut, 1988). The theoretical rationales for forming joint ventures rather than entering into regular contracts include transaction costs savings, strategic behavior, and capitalizing on the organizational knowledge. The former of the three is well in line with the traditional Stiglerian boundaries of the firm argument; the second relates to longer-term profit maximization; and the latter views joint ventures as a means by which the firms learn or retain their capabilities (Kogut, 1988). Some researchers also noted that the alliance structure can be determined by the social networks within which the firm is embedded (Gulati, 1998).

Shapiro and Willig (1990) point to the following potential benefits of joint ventures. First, joint ventures can be a mechanism for effective risk sharing in an uncertain environment. Second, they help the firms realize cost savings due to either the complementary nature of their products or economies of scale and scope. Furthermore, Barney (2002) reminds that joint ventures can be used as a vehicle to facilitate tacit collusion among the partner firms (in related markets), thereby increasing market power and profits. Additionally, joint ventures can help the firms to enter new markets, industries, or industry segments.

Empirical analysis of joint ventures in the economics and management literature mostly deals with evaluation of the realization of such benefits. For instance, Chan et al. (1997) and Koh and Venkatraman (1991) find a positive effect of alliances and joint ventures on stock prices. Rothaermel and Deeds (2004) and Kotabe and Swan (1995) examine new product development facilitated by alliances.

However, the potential benefits of such agreements have to be traded off against the potential costs. For example, when partners' goals differ, joint ventures may exacerbate the situation and hurt rather than help the parties involved. Also, Shapiro and Willig (1990) point to the potential for free riding by the venture partners as another possible problem associated with joint ventures.

[1] The business strategy literature does not provide a clear definition and delineation of strategic alliances and joint ventures. Barney (2002), for example, subdivides 'strategic alliances' into non-equity alliances, equity alliances, and joint ventures. The key difference between the latter and the former two is that only a joint venture leads to the creation of a legally independent new corporation in which the parent companies hold shares. Following this delineation, airline alliances must typically be categorized as 'non-equity alliances' rather than 'joint ventures'. However, in the remainder of this paper we follow the majority of the literature and use the term 'joint venture' for (revenue-sharing) airline alliances. In fact, both terms can be considered interchangeable, as both organizational forms are similar in their motivations and economic effects.

Furthermore, Walker (2004) identifies reduced control over decision making, strategic inflexibility, weaker organizational identity of the participating companies, and potential conflicts with antitrust law as additional disadvantages of cooperation among firms in general and joint ventures in particular. In fact, existing antitrust laws must be considered as key potential constraint of cooperation in transatlantic airline market as it will be shown in the following section.

3 Competition and cooperation in transatlantic airline markets

3.1 The development of airline alliances

Generally, the airline industry – defined here as commercial scheduled passenger transportation – deals with moving people and their luggage from point A to point B. The production process is rather complex and involves many aspects such as ticketing, luggage handling, passenger catering, fueling, air traffic control, and aircraft maintenance. The airlines differ in many ways, from pricing policies, over the fleet mix to the degree to which they choose to vertically integrate the various parts of the production process. Yet, there is one thing in common for all the carriers: no single airline's network encompasses all possible "point A to point B" combinations. This fact forces many passengers to 'interline' or change an airline during their journey.

Given these specifics of air transport, the early forms of cooperation between airlines on deregulated markets have appeared as a way to tackle this *interlining* problem more efficiently, making the 'joint' product more attractive to the customer as compared to other possible interlining options. At the perhaps most primitive level, the passenger would be more attracted to an interline service – other things equal and assuming no on-line service is available – which allows him/her to check the luggage through to the final destination, thus not having to worry about the checked bags beyond the customs requirements. The web of interlining agreements gradually gave rise to international airline alliances, even though numerous inter-alliance and out-of-alliance ad hoc partnerships to facilitate interline travel still exist. The three global alliances – SkyTeam, Star, and oneworld – currently carry about 75 percent of all passengers on the global market.

An advanced form of cooperation among airlines is called *codesharing*. Codesharing refers to including an airline's flights into the partner airlines' schedules. Thus, an airline via a codesharing arrangement is able to enlarge its network without having to service additional flights. Moreover, it can sell tickets for the interline flight as its own. The early forms of airline alliances in the late 1990s were guided by the codesharing principle, often complemented by agreements to jointly use airport facilities (e.g., gates). Additionally, sharing of customer loyalty (i.e., frequent flier) programs was very common (see generally Bilotkach and Hüschelrath (2011, 2012) for detailed discussions).

A further degree of cooperation is reached if the alliance partners enter into some form of *joint price setting arrangements* that typically also imply a joint coordination of scheduling (i.e. departure times and flight frequencies). Given the price fixing nature of such agreements, antitrust laws typically prohibit the implementation of this kind of joint venture. Granting of antitrust immunity is therefore a precondition for an implementation of such agreements. Limiting ourselves to U.S. enforcement actions with respect to transatlantic airline alliances, the U.S. Department of Transportation (DOT) as responsible public authority eventually approved – referring to the transatlantic market only – a total of 13 applications from core members of SkyTeam (from 1995[2] to 2001[3]) and Star alliances (from 1996[4] to 2005[5]). However, applications of the core oneworld alliance members – American Airlines and British Airways – in 1997[6] and 2001[7] were unsuccessful due to the dominant role of both airlines at London's Heathrow airport.

The most complete form of cooperation allowed under the current regulatory constraints is the establishment of a *merger-like revenue-sharing joint venture*. As part of such an agreement, the partner airlines are pooling revenues and costs of their operations thereby leading to a merger-like cooperation, in which the partners are indifferent as to which of them is actually carrying a particular passenger (so-called 'metal neutrality'). The first attempt to receive approval for such an extensive agreement was undertaken by the core SkyTeam (Delta-Air France) and Wings (Northwest-KLM) partnerships in 2004[8]. Based on fears that the close cooperation on international markets might have spillover effects on domestic competition, the DOT first denied

2 DOT-OST-1995-618 (Delta, Swissair, Sabena, Austrian).
3 DOT-OST-2001-10429 (Delta, Air France, Alitalia, Czech).
4 DOT-OST-1996-1116 (United, Lufthansa).
5 DOT-OST-2005-22922 (United, Austrian, bmi, LOT, Lufthansa, SAS, Swiss, TAP).
6 DOT-OST-1997-2058 (American, British Airways).
7 DOT-OST-2001-10387 (American, British Airways).
8 DOT-OST-2004-19214 (Delta, Northwest, Air France, KLM, Alitalia, Czech).

approval for the enlarged SkyTeam alliance.[9] Anticipating introduction of the U.S.-EU Open Aviation Area agreement and promoting the concept of metal-neutrality (which refers to the practice of revenue and cost pooling within the alliance), SkyTeam reapplied in 2007[10] and the DOT decided in May 2008[11] to approve the application as "… the proposed alliance is consistent with the public interest, will produce public benefits, and will not substantially reduce competition". Subsequently, in July 2009[12] and July 2010[13], the core members of Star and oneworld alliances were given approval to implement their respective revenue-sharing joint venture agreements. However, all approvals were subject to certain approval conditions (partly) including carve-outs (see Bilotkach and Hüschelrath (2011) for a detailed discussion).

Before we turn to a discussion of the economic effects of airline alliances in general and revenue-sharing joint ventures in particular, the identified existence of several degrees of airline cooperation raises the question of their relevance in practice. Figure 1 therefore provides the passenger-based shares of the three major route categories – no immunity, immunity without JV and JV – on the transatlantic market between 2007 and 2013.

9 DOT-OST-2004-19214 (Final Order), Order 2006-2-1 (Feb. 6, 2006). Other reasons to deny the initial request for antitrust immunity were the potential reduction of competitive pressures in gateway-to-gateway markets and the foreclosure of competitor's access to alliance hubs.

10 DOT-OST-2007-28644 (Delta, Northwest, Air France, KLM, Alitalia, Czech).

11 DOT-OST-2007-28644 (Final Order), Order 2008-5-32 (May 22, 2008).

12 DOT-OST-2008-0234 (United, Austrian, bmi, LOT, Lufthansa, SAS, Swiss, TAP, Air Canada, Brussels, Continental).

13 DOT-OST-2008-0252 (American, British Airways, Iberia, Finnair).

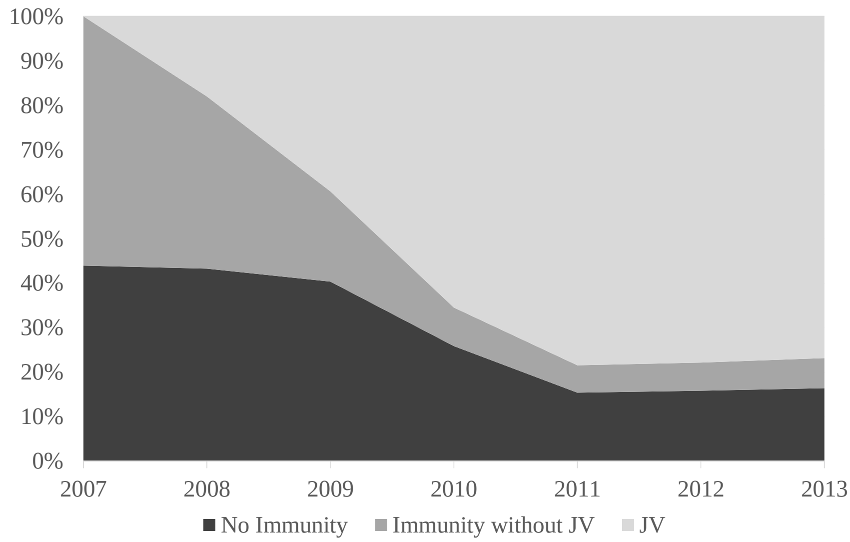

Figure 1: Passenger-based shares of different route categories

Source: own calculations based on DOT T100 data

As shown by Figure 1, the share of passengers traveling on JV routes increased dramatically from zero percent in 2007 to about 78 percent in 2011 mirroring the granting of transatlantic JVs in 2008 to SkyTeam, 2009 to Star and 2010 to oneworld. The share of immunity routes outside of JVs decreased accordingly from about 56 percent in 2007 to less than 10 percent in 2013. A comparable but less pronounced trend is found for routes on which neither immunity nor a joint venture form of cooperation was implemented. The share decreased from about 44 percent in 2007 to about 26 percent in 2010 to a rather stable share of about 15 percent since 2011.

3.2 Economic effects of airline alliances

A number of studies, both theoretical and empirical, evaluate the economic effects of international airline partnerships (see generally Bilotkach and Hüschelrath (2011, 2013)). Theoretical models of international airline consolidation include studies by Oum, Park and Zhang (1996), Park (1997), Brueckner (2001), Brueckner and Whalen (2000), Heimer and Shy (2006), Bilotkach (2005, 2007a, 2007b), Barla and Constantatos (2006), Chen and Gayle (2007) and Flores-Fillol and Moner-Colonques (2007). Most of these studies analyze motives for and effects of a single airline alliance, outside of the broader context.[14] Of the above cited papers, the

[14] Despite the various modeling approaches of airline alliances in recent years, most attempts in the literature frequently fail to differentiate between joint ventures and mergers between airlines. Alliances are also often found to be profitable for individual airlines. Sometimes such a conclusion comes with caveats: e.g., Bilotkach

issue of competition between alliances is considered by Brueckner and Whalen (2000), Bilotkach (2005), and Flores-Fillol and Moner-Colonques (2007). The general conclusion from those studies is that airline consolidation benefits interline passengers due to the complementary nature of the product and the removal of double marginalization. However, as soon as consolidation decreases competition, consumers may lose depending on the relative sizes of the cost-saving effect and the market power effect.

Generally, the size of the cost-saving effect is influenced to a great extent by the realized benefits of higher traffic due to cooperation between airlines reflected in the so-called economies of traffic density[15] (i.e. falling average cost with higher load factors). Furthermore, airline alliances are expected to realize further alliance-specific efficiencies due to cost reductions via shared back office functions, maintenance facilities and operational staff as well as joint marketing advantages of the integrated frequent flyer programs. These incremental advantages for consumers need to be traded off against the market power effect of airline consolidation. This effect is basically driven by the possibility that airline alliances might eliminate horizontal intra-alliance competition, thereby causing higher fares and a reduced choice on certain routes (see, e.g., Reitzes and Moss, 2008). The existence and magnitude of the market power effect is dependent on various competition parameters. For example, as argued by Oum et al. (2000)[16] the degree of overlap between the respective networks is typically a key determinant because the higher the overlap, the more severe are the competition concerns and the more likely are price increases as a consequence of cooperation. Furthermore, the participating airlines may use alliances to reduce competitive pressures by facilitating collusive behavior or restricting entry through the implementation of foreclosure strategies.

Empirical analyses of the effects of international airline alliances have been offered by Oum et al. (1996), Park and Zhang (2000), Brueckner and Whalen (2000), Brueckner (2003), Whalen (2007)

(2005), as well as Flores-Fillol and Moner-Colonques (2007) suggest setups where alliance formation can be an outcome of a Prisoners' Dilemma type of setting, where each pair of potential partners is individually better off outside of an alliance, but can increase profits by forming a partnership, provided the other pair remains unallied.

15 For instance, Brueckner and Spiller (1994), found that a 10 percent traffic increase lead to a 3.75 percent reduction in marginal costs.

16 Oum et al. (2000) classify alliances into 'complementary' and 'parallel' ones. While complementary alliances – i.e. the networks of the alliance partners largely feed traffic to each other – are likely to reduce fares, parallel alliances – i.e. the networks of the alliance partners partly overlap and competition on these routes is reduced – are likely to increase fares.

and Bilotkach (2007c).[17] All of these papers confirm that airline alliances benefit interline passengers by offering lower fares. Park and Zhang also find evidence for increasing market power of the alliance members at their hubs, even though they suggest that this effect is offset by the cost savings that the alliance brings about. While finding that alliances decrease interline fares, Brueckner and Whalen (2000) fail to observe a statistically significant increase in fares due to airline consolidation where such appears to decrease the number of competitors.

In general, the consensus of research on the economic effects of airline alliances is that interline partnerships benefit consumers thanks to the removal of double marginalization and economies of traffic density. These benefits might partly come in the form of lower ticket prices, but might also include higher flight frequency, more destinations within easy reach, or shorter travel times. All these factors tend to have a stimulating effect on demand and traffic growth. However, what need to be investigated closer in the following are the relative costs and benefits of several degrees of cooperation between airlines. In particular, an understanding needs to be developed whether, first, the granting of antitrust immunity and, second, the approval of full-fledged revenue-sharing joint ventures, are compulsory to realize the key benefits for the consumers to the fullest extent, or whether lower degrees of cooperation can reach comparable benefits levels (while avoiding the incremental costs). Our empirical analysis in the following section will shed light on these important questions.

4 Empirical analysis

4.1 Construction of the data set and descriptive statistics

Our main source of data is the T100 International Segment dataset, provided by the U.S. Department of Transportation. This dataset is essentially a census of all non-stop commercial international flights performed to and from the United States. The data are aggregated at the month-route-operating-carrier-aircraft-type level. Each entry contains information about the segment's endpoints, operating carrier, and monthly totals for the number of departures performed, seats offered, and passengers carried on this particular segment. This information

[17] There is also an older set of empirical papers available which study the effects of airline alliances on airline costs, revenues or profits, passenger traffic, passenger fares, and convenience and service quality. However, given the significant changes in the degree of cooperation among airlines we omit a detailed discussion of the results here as they might not be that relevant for contemporary alliances (see generally Button and Drexler (2006) and Morrish and Hamilton (2002) for overviews).

naturally allows us to compute the flights' load factors, also aggregated at the carrier-route-month level.

We have set up the sample for data analysis in the following way. From our main dataset, we have selected data for travel between the U.S. and all current EU members, plus Switzerland and Norway, for the years 2007 up to (and including) 2013. We have retained only passenger services, aggregated the data to the month-route-operating-carrier level (pooling together the data for services by the same airline between the same endpoints, performed on aircraft of different types), and removed directionality from the data (i.e., we pooled British Airways' London Heathrow to New York JFK airport flights together with the same carrier's flights in the opposite direction). To make sure our analysis remains focused on the market for scheduled commercial passenger services, we have eliminated services with fewer than thirty monthly departures[18]. We have further restricted our sample to services performed by the 'legacy' carriers; these include mostly EU countries' traditional flag carriers[19] and major U.S. airlines. In this way, we eliminate services by smaller and charter carriers, as well as by the airlines from other parts of the world (mostly Asian carriers) performing transatlantic services under the fifth freedom rights[20]. All these restrictions left us with nearly 17,000 airline-market-month level observations for 385 airline-market combinations on 263 non-directional airport-pair markets.

The transatlantic joint ventures have added another dimension to the transatlantic market structure. We have quite naturally created the corresponding *JV* indicator variable, tying it to the date of the venture's approval, and assuming the venture became operational the month after such approval has been obtained. Specifically, the *JV* variable takes on the value of 1 for the following services:

- Delta Air Lines, Northwest Airlines, KLM, and Air France services after May 2008;
- Lufthansa, United Airlines, and Continental Airlines services after July 2009;
- American Airlines, British Airways, and Iberia services after July 2010.

[18] Since we removed directionality, this means that we have only retained services that are operated at least as frequently as 3-4 times per week in every direction.

[19] Other European carriers with significant scheduled passenger services include such airlines as Virgin Atlantic, Air Berlin, and Norwegian.

[20] Fifth freedom rights allow the airline to carry revenue passengers between foreign countries as part of the service to/from its own country (e.g., under the fifth freedom right Air India is allowed to carry London-New York passengers on the respective segment of its New Delhi–London–New York service).

We also need to account for the two major mergers between the U.S. carriers, which occurred during the time period covered by our data, and directly relate to the joint ventures. Delta and Northwest merged in 2008, and in 2010 United merged with Continental Airlines. Following the consolidation events the airlines retained the Delta and United brands. However, due to the time it takes for the airlines to officially merge their operating certificates, the Northwest and Continental flights continued showing up in the data for at least a year after the merger has been approved. We have therefore re-coded Northwest observations after October 2008 as Delta Air Lines' services. Similarly, all Continental Airlines' flights after September 2010 have been recoded as United Airlines' services. The two dates correspond to approval of respective mergers by the U.S. Department of Justice.

Aiming at studying the effects of antitrust immunity and joint ventures, we have followed our previous work (Bilotkach and Hüschelrath (2013)) and created the following independent variables, corresponding to the be types of airline services, defined according to both the airline's membership in an alliance enjoying antitrust immunity, and the endpoints' status as a hub in one or the other airline's network. Referring to Figure 2 below, airports S1, H1, and H2 are assumed to be located across the Atlantic Ocean from H3, H4, and S2. The partnership between the airlines operating hubs H1 and H3 is called alliance 1, while alliance 2 consists of the airlines operating hubs H2 and H4.

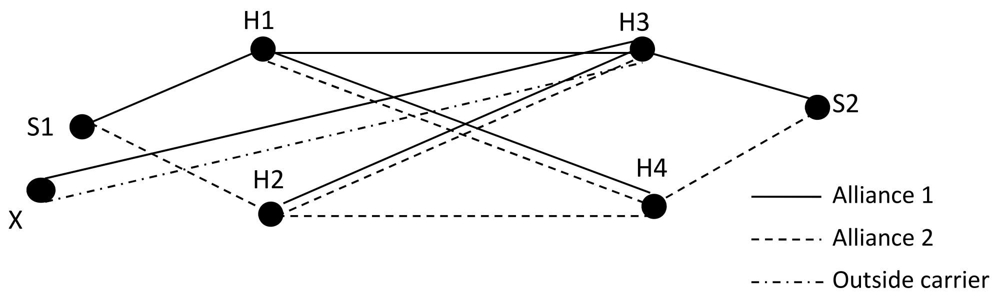

Figure 2: Simple network with two alliances

Source: Bilotkach and Hüschelrath (2013)

Given this set-up, we can differentiate between the following types of international markets:

- Immunized alliance members' services between their respective hub airports (H1-H3 and H2-H4 routes; e.g., KLM service from Amsterdam to Detroit, or Delta Air Lines and Air France flights between Paris and Atlanta); we will call those "*Alliance services between immunized hubs*". In the specifications we will estimate, this category will be denoted via the indicator variable $I_{HubHub}^{Immunity}$.

- Immunized alliance members' services from their hub airports to a hub airport of a competing alliance with antitrust immunity (H1-H4 and H2-H3 routes; e.g., KLM service from Amsterdam to Chicago O'Hare, or Delta Air Lines services from this carrier's hub to Frankfurt); to be denoted "*Alliance services between competitors' hubs*". The corresponding notation is $I_{HubOtherHub}^{Immunity}$.

- Immunized alliance members' services from their hub airports to airports which do not serve as hubs for any immunized alliance member (S1-H3, S1-H4, S2-H1 and S2-H2 routes; e.g., KLM service from Amsterdam to Boston, or Lufthansa flights from Frankfurt to such airports as Phoenix, Boston, or Seattle); we will refer to those as "*Other immunized alliance services*", and denote the corresponding indicator variable $I_{HubOther}^{Immunity}$.

- Services to immunized alliance members' hub airports by airlines which are themselves not immunized alliance members (H3-X route; e.g., British Airways services to airports such as Chicago O'Hare or Denver *before British Airways obtained immunity*, or Continental Airlines or U.S. Airways' services to the respective EU hubs, such as Paris, Amsterdam, or Frankfurt). This category will be called "*Other services to alliance hubs*". The notation we will use is $I_{ToImmuneHub}^{NoImmunity}$.

Altogether, the above-defined four categories of markets represent all possible direct services to/from the hub airports of members of airline alliances with antitrust immunity. The baseline category will include all the services (by all the airlines) outside of the hub airports of the alliance members with immunity – i.e., services elsewhere on the network. We will ultimately disentangle the effects of joint ventures from antitrust immunity by using the interaction dummy variables involving the JV indicator variable we introduced previously and the airline-route-specific dummies above. Interestingly, the four categories above cover all the services involving the transatlantic joint venture partners. Services that involve antitrust immunity but not covered by a joint venture include all the immune services before the JV was granted (remember that our data starts from 2007, and the last JV was approved in 2010), as well as the services by immunized alliance partners not covered by the JV grant (i.e., the non-core alliance members, such as Finnair, Alitalia, Czech Airlines, or LOT Polish Airlines).

Hub airports have been designated based on the structure of the airlines' networks. EU airlines' hubs mostly correspond to the respective countries' capitals (except for Lufthansa, which operates hubs at both Frankfurt and Munich airports; Alitalia, using both Rome Fuimicino and Milan Malpensa as hubs[21]; and SAS, operating hubs at Copenhagen, Stockholm, and Oslo). For the U.S. airlines participating in airline partnerships with antitrust immunity, we have designated the following airports as hubs:

- American Airlines: Chicago O'Hare, Dallas Ft. Worth, Miami
- United Airlines: Chicago O'Hare, Denver, San Francisco, Washington Dulles
- Northwest Airlines: Detroit, Minneapolis, Memphis.
- Delta Air Lines: Atlanta, Cincinnati, Salt Lake City, New York JFK
- Continental Airlines: Newark and Houston.

Following the Delta-Northwest and United-Continental mergers, we designated Northwest and Continental hub airports as Delta and United hubs, respectively.

The key dependent variables we will be using are the number of passengers, seats, flight frequency, and the load factor. All the observations represent monthly airline-route level totals (for the first three variables) or averages (for the load factor). Of the four measures, load factor is the closest measure of efficiency we can obtain from publicly available data.

Additionally, our specifications will include an airport-market-level passenger-based Herfindahl-Hirschman index, geometric average real GDP per capita for the US metropolitan area and the corresponding EU country, and the trade volume between the U.S. and the respective European country. Table 1 below includes the conventional descriptive statistics for our key variables.

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[21] In 2008, Alitalia opted for a single-hub strategy, gradually moving all its transatlantic services into Rome.

Table 1: Descriptive statistics of variables

	Mean	Std. Dev.	Minimum	Maximum
Dependent variables				
Frequency	75.42	47.15	30	532
Passengers	15,556	11,486	477	135,149
Seats	19,108	13,824	992	157,922
Load factor	0.8093	0.0987	0.1197	0.9877
Control variables				
HHI	0.7410	0.2668	0.2509	1
Trade volume (annual, million US$)	78,438	44,580	1,692	161,706
Average real GDP per capita, EUR, 2010 prices	34,235	4,464	15,144	51,009
Key variables				
Joint venture	0.5059	0.4999	0	1
Route classification dummies				
Between immunized hubs	0.2222	0.4157	0	1
Other immunized alliance services	0.2671	0.3674	0	1
Between competitors' hubs	0.2141	0.4102	0	1
Other services to immunized hubs	0.1608	0.3674	0	1

Table 1 shows that on average a service on the transatlantic market involves an airline flying a bit more often than twice per day using a smaller sized wide-body aircraft (the average aircraft size in our sample is about 250 seats, roughly corresponding to the capacity of a Boeing 767 in the usual two-class configuration). About half of the observations we have correspond to the services by the partner airlines covered by the joint venture.

Table 2 demonstrates that over the years covered by our data about half of all the passengers have been carried on the joint venture services. However, we can also see that by 2013 the share of passengers carried by joint venture flights on the transatlantic market has exceeded 75 percent, increasing in jumps as the three JVs have been approved in 2008 to 2010.

Table 2: Total passenger volumes depending on alliance relationships

Year	No Immunity	Immunity without JV	JV	All
2007	20,664,339	26,349,654	---	47,013,993
2008	20,735,955	18,526,190	8,636,166	47,898,311
2009	18,110,593	9,099,327	17,642,297	44,852,217
2010	11,731,344	3,925,622	29,688,732	45,345,698
2011	7,293,634	2,908,733	37,108,899	47,311,266
2012	7,486,906	3,010,547	36,810,313	47,307,766
2013	7,956,158	3,278,286	37,223,818	48,458,262
2007-2013	93,978,929	67,098,359	167,110,225	328,187,513

As first rough look at the effects of antitrust immunity and joint ventures on efficiency, Table 3 presents descriptive statistics on the average load factors for services covered by the joint ventures, immunity without joint ventures, as well as the flights not covered by the antitrust immunity. Considering passenger load factor as a measure of productive efficiency, we see from this Table that initially JVs have led to higher load factors as compared to routes that were covered by antitrust immunity, but not included into the joint ventures. These benefits appear to have dissipated over time, and in 2013 the average load factor on the few remaining routes covered by antitrust immunity (but not included into JVs) is virtually the same as that on many markets covered by the transatlantic joint ventures. Our empirical analysis in the following section will account for market and airline heterogeneity, and include conventional control variables.

Table 3: Descriptive statistics for load factor depending on alliance relationships

Year		No Immunity	Immunity without JV	JV	All
2007	Mean	0.7633	0.8180	---	0.7850
	St.Dev	0.1503	0.0859	---	0.1314
2008	Mean	0.7511	0.7999	0.8081	0.7734
	St.Dev	0.1492	0.0957	0.0981	0.1316
2009	Mean	0.7606	0.7768	0.8203	0.7836
	St.Dev	0.1469	0.1362	0.1113	0.1366
2010	Mean	0.7951	0.8052	0.8258	0.8128
	St.Dev	0.1395	0.1047	0.0880	0.1119
2011	Mean	0.7923	0.7907	0.8057	0.8008
	St.Dev	0.1466	0.1278	0.1051	0.1202
2012	Mean	0.7908	0.8317	0.8261	0.8162
	St.Dev	0.1491	0.0942	0.0997	0.1171
2013	Mean	0.7916	0.8360	0.8375	0.8232
	St.Dev	0.1476	0.0976	0.0930	0.1149
2007-2013	Mean	0.7720	0.8068	0.8221	0.7982
	St.Dev	0.1485	0.1031	0.0995	0.1254

4.2 Methodological approach

Our methodological approach largely follows Bilotkach and Hüschelrath (2013), with adjustments precipitated by the establishment of transatlantic joint ventures. The goal of the data analysis is to evaluate whether JVs have changed the respective airlines' competitive strategies as well as (productive) efficiency in comparison to the services with antitrust immunity but not covered by the joint ventures. When performing the data analysis, it is important to keep in mind the structure of the partner airlines' joint networks, as changes in the network flows might reflect changes in the market players' competitive strategies, and ultimately consumer welfare. For instance, the JV partners might prioritize services between their hub airports over offering more flights elsewhere in their joint networks (e.g., SkyTeam partners might add flights between Atlanta and Paris instead of offering a non-stop Atlanta-Berlin flight, channeling the traffic on the latter market via Paris, depriving the customers of the non-stop flight option).

Our estimation techniques of choice are airline-market fixed effects. The hub-and-spoke network structure operated by the major players on the transatlantic market implies, among other things, that flight frequency decisions, especially on spoke-hub routes, are not driven by spoke-hub demand, but by demand on various spoke-spoke markets, going through the hub. To deal with this problem, we follow Bilotkach (2011), as well as Bilotkach and Hüschelrath (2013), and estimate an airline-airport-pair-market fixed-effects model. Additionally, we also follow Bilotkach and Hüschelrath (2013) in treating market concentration as potentially endogenous. We deal with this issue by instrumenting the Herfindahl-Hirschman Index with the market-level passenger volume, lagged six months.

To address the potential autocorrelation issue, we estimate a dynamic panel data model where the lagged dependent variable is introduced as a right-hand side regressor. Yet, dynamic panel data models can result in biased coefficient estimates due to the obvious endogeneity in the lagged dependent variable. In order to address this endogeneity threat, we will employ the Generalized Method of Moments (GMM) estimator for dynamic panel data. Specifically, we will use the system estimator proposed by Arellano and Bover (1995) which built on and improved the Arellano and Bond (1991) GMM estimator. System GMM analysis is specifically designed to address endogeneity issues with dynamic panel data models (i.e., biases in the coefficient estimate for the lagged dependent variable). We determined that the dynamic panel data GMM technique we employ produces valid estimates when the first four lags of dependent variable are included on the right-hand side, and all further lags are used to construct the instruments.

Our data analysis will be based on the following specifications:

$$\log(Y_{ij}) = X\beta + \alpha_1 I_{HubHub}^{Immunity} + \alpha_2 I_{HubOtherHub}^{Immunity} + \alpha_3 I_{HubOther}^{Immunity} + \alpha_4 I_{ToImmuneHub}^{NoImmunity} + error$$

and

$$\log(Y_{ij}) = X\beta + I_{JV}\left(\gamma_1 I_{HubHub}^{Immunity} + \gamma_2 I_{HubOtherHub}^{NoImmunity} + \gamma_3 I_{HubOther}^{Immunity} + \gamma_4 I_{ToImmuneHub}^{NoImmunity}\right) + I_{NoJV}^{Immune}\left(\delta_1 I_{HubHub}^{Immunity} + \delta_2 I_{HubOtherHub}^{NoImmunity} + \delta_3 I_{HubOther}^{Immunity} + \delta_4 I_{ToImmuneHub}^{NoImmunity}\right) + error$$

Where:

- Y_{ij} is flight frequency, number of seats, passengers, or load factor of airline *i* on market *j*;
- X is the vector of control variables, as discussed in the previous section of the paper;
- Indicator variables $I_{HubHub}^{Immunity}$; $I_{HubOtherHub}^{Immunity}$; $I_{HubOther}^{Immunity}$; and $\mathrm{I}_{\mathrm{ToImmuneHub}}^{\mathrm{NoImmunity}}$ represent the four key categories of services, also defined above;
- I_{JV} and I_{NoJV}^{Immune} are the indicator variables for services of the joint venture partners, as well as the services of immunized alliance members not covered by joint ventures, respectively.

These two specifications will be implemented using the airline-market fixed effects model, as discussed earlier in this section. The dynamic panel data GMM specifications will also include lagged dependent variables. The former specification is essentially similar to the main model used by Bilotkach and Hüschelrath (2013). We however include fewer control variables, due to both data availability and lack of within-variation in some of the variables included into our previous work[22]. The latter specification modifies the former one by postulating different effects depending on whether or not the partner airlines operating under antitrust immunity are also members of a transatlantic (revenue-sharing) joint venture.

The focus of our data analysis exercise is twofold. First, by simply applying the data analysis conducted in Bilotkach and Hüschelrath (2013), we will be able to check whether the relationships discovered in that study are also present under the new institutional structure on the transatlantic market. Second, we aim at examining whether joint venture partners develop their network differently from the partner airlines that enjoy antitrust immunity, but are not part of the joint ventures.

As a reminder, Bilotkach and Hüschelrath (2013) found that antitrust immunity leads to the partner airlines increasing traffic between their hubs, and also from their hubs to non-hub airports. Results for the effect of antitrust immunity on traffic to the hub airports of the airlines

[22] For instance, no new Open Skies Agreements have been signed over the time period covered by our data, and no new countries have joined the Visa Waiver Program.

that participate in competing alliances with immunity varied across sub-samples. Notably, that study discovered that antitrust immunity led to reduction in passenger traffic by the airlines, which were not themselves members of immunized partnerships, to the hub airports of carriers covered by immunity. This result was interpreted as being consistent with market foreclosure.

As for the analysis of differences between services included into and not covered by the transatlantic joint ventures, our focus will be on the differences between γ_i and δ_i coefficients. The null hypotheses will naturally be that the joint ventures have not had any effect on the partners' competitive strategies or productive efficiency (as proxied by the load factor), that is $\gamma_i = \delta_i;\ i = \overline{1{,}4}$. If JV is indeed the closest arrangement to the full-scale merger, possible under the current regulatory and institutional framework on the transatlantic market, we can expect the partner airlines to increase traffic on the routes between their hub airports, facilitating interline connections. Bilotkach et al. (2013), examining network reorganization following the Delta-Northwest merger, concluded that the two airlines have re-organized their network to prioritize their largest hubs. An interesting question then is whether any increase in traffic between the joint venture partners' hubs will be at the expense of the rest of the network.

Last but not least, our analysis has to take into account an important difference between the three major alliances. Specifically, as discussed in Section 3.1 above, while both SkyTeam and Star alliances have been cooperating under antitrust immunity arrangements for a good number of years before approval of their respective joint venture application, this is not the case for the oneworld alliance. Until approval of the JV involving key oneworld alliance partners in July 2010, the only working antitrust arrangement within this alliance covered American Airlines and Finnair services[23]. Thus, the American Airlines-British Airways-Iberia partnership status changed from codeshare without immunity straight to joint venture (skipping the intermediate 'immunity without the joint venture' state). We can therefore suspect approval of the joint venture for the AA-BA partnership might not have led to the same sort of network restructuring and changes in partner airlines relationships as for the JVs covering SkyTeam and Star alliances.

We decided to approach this issue by treating American-British-Iberia services following approval of their joint venture as services *covered by antitrust immunity but excluded from the*

[23] Interestingly, the American – Finnair partnership was not covered by the JV rights granted to oneworld partners.

joint venture. Here is what we hope to accomplish by doing this: if approval of oneworld joint venture has indeed led the partner airlines to restructure their network in the same way as done by SkyTeam and Star alliances, the reclassification of oneworld services will diminish the magnitude of any JV-specific effects. Otherwise, the JV effects will become more pronounced, suggesting that it does take time for the partner firms to establish close relationships, and the way the alliance ends up working does not necessarily depend on the freedoms the partners obtain from the public authority.

4.3 Empirical results and discussion

Results of our data analysis are presented in Tables 4 to 9. Specifically, Table 4 reports the outcomes of specifications, similar to those employed in Bilotkach and Hüschelrath (2013). Tables 5 and 6 show the estimates of the effects of joint ventures in the airline-market fixed effects model context. The dynamic panel data GMM results are included in Tables 7 and 8. Tables 5-8 include results for both the entire sample, as well as for the sub-sample of what we call "stable" services, or airline-market combinations, which appear in our dataset for at least 50 months. We have in this exercise assumed that services changing their operating carrier following a merger (e.g., Continental Airlines' services operated by United after these two carriers merged) or as a result of a joint venture (e.g., services reassigned to a partner airline under the "metal neutrality" arrangements) were continuation of the previously operated routes rather than the new services. In this way, we aspire to reduce the possibility of seasonal and/or discontinued services affecting our results.

Finally, Table 9 reports the fixed effects model results for the alternative treatment of oneworld alliance services. As a reminder, we have decided to recode flights by this alliance partners following approval of the respective JV as those covered by antitrust immunity, but not by joint venture arrangements. Such treatment is precipitated by the fact that, unlike SkyTeam and Star alliance partners, oneworld partners have had very limited experience operating under antitrust immunity prior to obtaining JV rights.

Table 4, when compared to the results reported by Bilotkach and Hüschelrath (2013), reveals a number of substantial changes on the transatlantic market in the age of joint ventures. Specifically, our previous research has demonstrated that granting of antitrust immunity has led to the partner airlines increasing service frequency and passenger volumes on all the routes within their network (with the possible exception of routes between the competing alliance members' hubs, where no robust relationship has been established). We also showed that airlines excluded from alliances have reduced their passenger numbers and flight frequency to hub airports of the alliance members – we interpreted this evidence as being consistent with market foreclosure.

Our data analysis this time demonstrates that antitrust immunity leads to lower frequency, seats, and passenger traffic, as compared to the baseline category, with one notable exception: partner airlines with immunity (recall that in Table 4 we do not make distinction between immunized services within and outside of JVs) increase traffic on routes between their hub airports. The magnitude of this effect is however smaller than what we have reported in our previous paper. For instance, Bilotkach and Hüschelrath (2013) indicated that gaining antitrust immunity leads to about 20 percent higher passenger volumes on routes between the partner airlines' hubs. According to Table 4, the magnitude of this effect is now only 7.1-7.7 percent.

We do however find that services operated by partner airlines with antitrust immunity are characterized by higher load factors (an indicator of increased productive efficiency). Compared to our previous work, the magnitude of this effect has declined substantially for services between partner airlines' hub airports (from nearly 10 percent to less than 2 percent), and increased somewhat for other services by the immunized carriers. Last but not least, we now observe no evidence consistent with market foreclosure. This could be the sign of either a market in equilibrium (with, for instance, immunized alliance members occupying the role of the dominant firm, and outside of alliance airlines being established fringe), or immunized carriers being more accommodating of the services of outside of alliance airlines. Also, most of the within-variation in this variable over the time period covered by our study comes from services to and from London Heathrow airport. Services into this airport do not generally require beyond-gateway traffic (i.e., passengers continuing their journeys beyond London) to be sustainable. However, this issue is outside of the scope of this paper.

Looking at our main results – those relating to the changes specific to joint ventures – we can say the following. First, the fixed effects and dynamic panel data GMM estimates are nearly the same qualitatively (with the exception of the effect of JVs on passenger volumes on routes between the alliance partner hubs). Quantitatively, dynamic panel data GMM suggests smaller differences between joint ventures and services covered by the antitrust immunity, but excluded from JVs. Also, treating oneworld joint venture services as those not covered by the joint ventures does not change the results qualitatively, but in most cases points to modest increases in the effect of JVs.

The main takeaway message from our analysis is that the only clear and robust effect of joint ventures as compared to the immunized services that are not part of the JVs is the increase in capacity between the respective partner airlines' hub airports. Moreover, this increase appears to happen at the expense of services elsewhere within the respective networks. Specifically, our results indicate that joint ventures lead to an increase in the number of seat capacity on routes between hub airports of the respective partner airlines (by 3-5 percent, depending on the estimation methodology). There is however no robust evidence to conclude that JV partners actually increase flight frequency or passenger volumes on the same routes, as compared to the situation before approval of transatlantic joint ventures. We do see robust evidence of lower traffic on routes between hub airports of competing JV hubs (such as, for instance, Atlanta-Frankfurt or London-San Francisco markets). Compared to other immunized services, joint venture partners offer 3-5 percent fewer seats, 1.5-5 percent fewer flights, and carry 1.5-11 percent fewer passengers[24] on those routes. Also, joint venture partners carry 2.5-5 percent fewer passengers, and offer 1.6-4.3 percent fewer seats and 1-4.3 percent fewer flights on routes from their hubs to other airports (e.g., Amsterdam-Los Angeles, Frankfurt-Philadelphia, or Newark-Edinburgh markets).

Investigation of the effect of joint ventures on flight load factors shows the following: load factors on flights covered by the antitrust immunity tend to be higher than in the baseline category, indicating that immunity does allow the partner carriers to better fill up their flights. However, at the same time, we also find that joint ventures lead to the partner airlines reducing their load factors throughout the joint network by 0.5-5 percent. It is thus clear that JVs do not appear to yield (productive) efficiency benefits in this dimension. Although admittedly

[24] The lower estimates of the effect of JVs on passenger volumes come from dynamic panel data GMM models, while fixed effects models suggest much higher effects.

speculative, a possible explanation for the observed effect would be an increase in market power of the respective alliances (suggesting price increases for transatlantic flights).

5 Conclusion

In the last two decades, the three (currently remaining) airline alliances – Star, SkyTeam and oneworld – were not only successful in extending the size of their networks by attracting new members, but also received approvals by public authorities to successively intensify their cooperation. What started in the 1990s as small and rather simple code-sharing agreements between pairs of carriers later was extended to (already far-reaching) joint price-setting and scheduling agreements (demanding the grating of antitrust immunity by the responsible public authorities) and – most recently – the founding of revenue-sharing joint ventures that aim at mimicking full-fledged mergers to the largest degree possible under the existing regulatory constraints. In approving the respective extensions of the alliances, the responsible public authorities aimed at balancing competition and cooperation in a way that the difference between public cooperation benefits and possible costs in the form of reductions in competition is maximized.

As the merger-like revenue-sharing joint ventures of the core members of SkyTeam, Star and oneworld were approved by the U.S. Department of Transportation in 2008, 2009 and 2010, respectively, a sufficient amount of time has now passed to empirically study their impact on both the respective airlines' competitive strategies as well as productive efficiency. Using U.S. DOT T100 International Segment data and applying airline-market fixed effects models, we find that joint ventures – compared to services with a lower degree of cooperation – lead to an increase in capacity between the respective partner airlines' hub airports by 3-5 percent; however, this appears to occur at the expense of services elsewhere in the network. Productive efficiency, as measured by load factors, is found to be 0.5-5 percent lower for joint venture services, as compared to services operated under antitrust immunity only.

Although our empirical analysis is unable to isolate significant (incremental) benefits of revenue-sharing joint ventures, far-reaching conclusions such as the termination of such joint ventures – or even the end of airline cooperation under antitrust immunity – should be handled with great care. First, our empirical results show a higher efficiency (as measured by load factors) for flights under antitrust immunity compared to simple code-sharing flights, suggesting measurable benefits of higher degrees of airline cooperation. Second, it is important to remark that our analysis is limited to several quantity and efficiency-related measures, leaving the potential price and (cost) efficiency effects of different degrees of airline cooperation outside the scope of the study. However, such analyses appear to be compulsory before definite conclusions on the welfare effects of especially revenue-sharing joint ventures can be drawn.

Third, although several years have gone by since the formation of merger-like airline joint ventures, it appears likely that the respective partner airlines continue to optimize their respective networks possibly leading to additional consumer benefits in the future. Last but not least, our study only provides limited insights into the workability of competition between the three remaining alliances in transatlantic markets. Although limited in scope (due to, e.g., the dominance of particular alliances at particular hubs), the respective pressures created by inter-alliance competition might be strong enough to sufficiently discipline the pricing behavior of airline alliances thereby increasing consumer welfare.

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Table 4: Fixed effects results without joint venture variables

	Log(Seats)	Log(Passengers)	Log(Load Factor)	Log(Frequency)
	All	All	All	All
From Immune Hubs to Other Airports	-0.0332** (0.0077)	-0.0016 (0.0079)	0.0315** (0.0038)	-0.0349** (0.0074)
Between competing hubs	-0.0816** (0.0118)	-0.0536** (0.0120)	0.0279** (0.0064)	-0.0407** (0.0107)
Between own hubs	0.0589** (0.0114)	0.0763** (0.0121)	0.0174** (0.0058)	0.0255** (0.0104)
Other to immune hub	-2.3E-05 (0.0095)	0.0078 (0.0095)	0.0079 (0.0070)	0.0055 (0.0077)
Log(HHI)	-0.1224** (0.0441)	-0.1633** (0.0484)	-0.0039 (0.0222)	-0.0531 (0.0378)
Log(Trade)	-0.0457* (0.0250)	0.0272 (0.0262)	0.0730** (0.0105)	-0.0176 (0.0221)
Log(Average GDP per capita)	0.1559* (0.0858)	-0.2763** (0.0899)	-0.4323** (0.0395)	-0.0957 (0.0719)
Observations	16946	16946	16946	16946
Adjusted R-squared	0.8991	0.9017	0.5978	0.8727
Durbin-Watson Statistic	0.5389	0.6262	1.0178	0.4291

Notes:

1. Methodology used – airline-market fixed effects model. HHI is instrumented by six month lagged market passenger volume.
2. Heteroscedasticity consistent White standard errors reported in parentheses
3. Year and month dummies included in all regressions, but not reported
4. Significance: ** - 5%; * - 10%

Table 5: Main results – Seats and passengers, fixed effects

		Log(Seats)		Log(Passengers)	
		All	Stable	All	Stable
JV interaction with	From Immune Hubs to Other Airports	-0.0437** (0.0082)	-0.0477** (0.0085)	-0.0189** (0.0084)	-0.0230** (0.0087)
	Between competing hubs	-0.0844** (0.0121)	-0.0988** (0.0128)	-0.0715** (0.0124)	-0.0912** (0.0132)
	Between own hubs	0.0647** (0.0117)	0.0650** (0.0126)	0.0701** (0.0125)	0.0650** (0.0135)
Immunity w/o JV interaction with	From Immune Hubs to Other Airports	-0.0057 (0.0108)	-0.0099 (0.0114)	0.0282** (0.0112)	0.0242** (0.0118)
	Between competing hubs	-0.0487** (0.0139)	-0.0548** (0.0145)	0.0124 (0.0138)	-0.0090 (0.0147)
	Between own hubs	0.0312** (0.0142)	0.0280* (0.0150)	0.0731** (0.0156)	0.0656** (0.0164)
Other to immune hub		0.0007 (0.0096)	-0.0034 (0.0098)	0.0019 (0.0097)	-0.0064 (0.0098)
Log(HHI)		-0.1238** (0.0440)	-0.1460** (0.0452)	-0.1682** (0.0483)	-0.1656** (0.0493)
Log(Trade)		-0.0542** (0.0250)	-0.0939** (0.0280)	0.0108 (0.0262)	-0.0295 (0.0295)
Log(Average GDP per capita)		0.1506** (0.0871)	0.1548** (0.0952)	-0.2037** (0.0910)	-0.2440** (0.0991)
Observations		16946	13714	16946	13714
Adjusted R-squared		0.8993	0.8831	0.9021	0.8864
Durbin-Watson Statistic		0.5490	0.5128	0.6289	0.5795

Notes:

1. Methodology used – airline-market fixed effects model. HHI is instrumented by six month lagged market passenger volume.
2. Heteroscedasticity consistent White standard errors reported in parentheses
3. Year and month dummies included in all regressions, but not reported
4. Significance: ** - 5%; * - 10%

Table 6: Main results – Frequency and load factor, fixed effects

		Log(Load Factor)		Log(Frequency)	
		All	Stable	All	Stable
JV interaction with	From Immune Hubs to Other Airports	0.0248** (0.0039)	0.0248** (0.0040)	-0.0417** (0.0078)	-0.0465** (0.0081)
	Between competing hubs	0.0129** (0.0062)	0.0075 (0.0065)	-0.0454** (0.0110)	-0.0596** (0.0117)
	Between own hubs	0.0053 (0.0059)	-6.6E-05 (0.0062)	0.0245** (0.0107)	0.0217* (0.0117)
Immunity w/o JV interaction with	From Immune Hubs to Other Airports	0.0340** (0.0054)	0.0341** (0.0055)	-0.0215** (0.0100)	-0.0242** (0.0107)
	Between competing hubs	0.0612** (0.0086)	0.0457** (0.0086)	-0.0198* (0.0114)	-0.0292** (0.0120)
	Between own hubs	0.0419** (0.0069)	0.0332** (0.0072)	0.0248** (0.0131)	0.0169 (0.0139)
Other to immune hub		0.0011 (0.0069)	-0.0030 (0.0070)	0.0038 (0.0079)	-0.0007 (0.0081)
Log(HHI)		-0.0443** (0.0221)	-0.0205 (0.0208)	-0.0544 (0.0378)	-0.0596 (0.0389)
Log(Trade)		0.0650** (0.0104)	0.0644** (0.0117)	-0.0231 (0.0222)	-0.0545** (0.0251)
Log(Average GDP per capita)		-0.3543** (0.0393)	-0.3988** (0.0431)	-0.0734 (0.0729)	-0.1144 (0.0795)
Observations		16946	13714	16946	13714
Adjusted R-squared		0.6014	0.5798	0.8727	0.8680
Durbin-Watson Statistic		1.0267	1.0003	0.5838	0.5438

Notes:

1. Methodology used – airline-market fixed effects model. HHI is instrumented by six month lagged market passenger volume.
2. Heteroscedasticity consistent White standard errors reported in parentheses
3. Year and month dummies included in all regressions, but not reported
4. Significance: ** - 5%; * - 10%

Table 7: Main results – Seats and passengers, dynamic panel data GMM

		Log(Seats)		Log(Passengers)	
		All	Stable	All	Stable
Lagged dependent, first lag		0.3494** (0.0009)	0.4752** (0.0011)	0.3685** (0.0012)	0.4821** (0.0044)
Lagged dependent, second lag		0.0126** (0.0007)	0.0385** (0.0005)	-0.0065** (0.0006)	0.0110** (0.0032)
Lagged dependent, third lag		0.0239** (0.0003)	0.0046** (0.0006)	0.0237** (0.0005)	0.0103** (0.0034)
Lagged dependent, fourth lag		-0.0284** (0.0004)	-0.0834** (0.0006)	-0.0228** (0.0003)	-0.0842** (0.0028)
JV interaction with	From Immune Hubs to Other Airports	-0.0163** (0.0050)	-0.0272** (0.0068)	-0.0102** (0.0052)	0.0324 (0.0330)
	Between competing hubs	-0.0334** (0.0100)	-0.0488** (0.0092)	-0.0412** (0.0052)	-0.0159 (0.0376)
	Between own hubs	0.0539** (0.0094)	0.0412** (0.0079)	0.0484** (0.0062)	0.1063** (0.0450)
Immunity w/o JV interaction with	From Immune Hubs to Other Airports	0.0102 (0.0083)	-0.0090 (0.0063)	0.0150** (0.0067)	0.0592* (0.0368)
	Between competing hubs	-0.0186 (0.0152)	-0.0299** (0.0107)	0.0162** (0.0084)	0.0313 (0.0381)
	Between own hubs	0.0082 (0.0171)	0.0118 (0.0088)	0.0416** (0.0112)	0.1055** (0.0386)
Other to immune hub		0.0120** (0.0053)	0.0031 (0.0051)	0.0018 (0.0054)	0.0075 (0.0200)
Log(HHI)		-0.0082 (0.0079)	-0.0192 (0.0122)	0.0123** (0.0050)	0.0415 (0.0461)
Log(Trade)		-0.0463 (0.0350)	-0.0743 (0.0580)	-0.0138 (0.0222)	-0.0471 (0.0595)
Log(Average GDP per capita)		0.1323** (0.0612)	0.1067 (0.0821)	-0.1832** (0.0894)	-0.0901 (0.0843)
Observations		16591	13509	16591	13509
Hansen J-Statistic (p-value)		486 (0.4474)	205 (0.5652)	367 (0.7130)	218 (0.3204)

Notes:

1. Model employed – dynamic panel data GMM (Arellano and Bover, 1995) with airline-market fixed effects and lagged market level passenger volume used as instrument for HHI.
2. Year and month fixed effects included in all regressions, but not reported.
3. Heteroscedasticity consistent standard errors reported in parentheses.
4. Significance: ** - 5%; * - 10%

Table 8: Main results – Frequency and load factor, dynamic panel data GMM

		Log(Load Factor)		Log(Frequency)	
		All	Stable	All	Stable
Lagged dependent, first lag		0.4049** (0.0010)	0.4448** (0.0017)	0.3091** (0.0002)	0.4288** (0.0043)
Lagged dependent, second lag		0.0266** (0.0016)	0.0174** (0.0020)	0.0085** (0.0001)	0.0380** (0.0009)
Lagged dependent, third lag		0.0116** (0.0008)	-0.0031** (0.0012)	0.0187** (0.0001)	0.0027** (0.0009)
Lagged dependent, fourth lag		-0.0211** (0.0008)	0.0034** (0.0010)	-0.0337** (0.0001)	-0.0862** (0.0012)
JV interaction with	From Immune Hubs to Other Airports	0.0094** (0.0023)	0.0106** (0.0024)	-0.0287** (0.0008)	-0.0170 (0.0383)
	Between competing hubs	0.0013 (0.0019)	0.0041* (0.0022)	-0.0290** (0.0015)	-0.0304 (0.0402)
	Between own hubs	-0.0035 (0.0036)	-0.0001 (0.0036)	0.0195** (0.0010)	0.0145 (0.0448)
Immunity w/o JV interaction with	From Immune Hubs to Other Airports	0.0154** (0.0025)	0.0162** (0.0033)	-0.0198** (0.0015)	-0.0036 (0.0402)
	Between competing hubs	0.0362** (0.0027)	0.0356** (0.0028)	-0.0155** (0.0023)	-0.0129 (0.0265)
	Between own hubs	0.0268** (0.0037)	0.0247** (0.0034)	0.0178** (0.0024)	0.0151 (0.0439)
Other to immune hub		-0.0036** (0.0008)	-0.0018 (0.0014)	0.0056** (0.0013)	-0.0041 (0.0124)
Log(HHI)		0.0124** (0.0023)	0.0116** (0.0024)	-0.0004 (0.0010)	0.0040 (0.0124)
Log(Trade)		0.0354** (0.0178)	0.0337** (0.0123)	-0.0184 (0.0124)	-0.0419 (0.0236)
Log(Average GDP per capita)		-0.2312** (0.0512)	-0.2116** (0.0675)	-0.0564 (0.0734)	-0.0532 (0.0633)
Observations		16591	13509	16591	13509
Hansen J-Statistic (p-value)		364 (0.7260)	379 (0.8091)	371 (0.6737)	285 (0.2538)

Notes:

1. Model employed – dynamic panel data GMM (Arellano and Bover, 1995) with airline-market fixed effects and lagged market level passenger volume used as instrument for HHI.
2. Year and month fixed effects included in all regressions, but not reported.
3. Heteroscedasticity consistent standard errors reported in parentheses.
4. Significance: ** - 5%; * - 10%

Table 9: Results with reassigned oneworld services, fixed effects

		Log(Seats)	Log(Passengers)	Log(Frequency)	Log(Load Factor)
JV interaction with	From Immune Hubs to Other Airports	-0.0738** (0.0100)	-0.0512** (0.0104)	-0.0704** (0.0082)	0.0226** (0.0044)
	Between competing hubs	-0.1200** (0.0136)	-0.1180** (0.0138)	-0.0765** (0.0127)	0.0019 (0.0065)
	Between own hubs	0.0824** (0.0130)	0.0781** (0.0139)	0.0232** (0.0120)	-0.0042 (0.0066)
Immunity w/o JV interaction with	From Immune Hubs to Other Airports	-0.0196** (0.0087)	0.0059 (0.0089)	-0.0256** (0.0082)	0.0256** (0.0045)
	Between competing hubs	-0.0569** (0.0119)	-0.0136 (0.0119)	-0.0216** (0.0099)	0.0433** (0.0074)
	Between own hubs	0.0445** (0.0119)	0.0609** (0.0128)	0.0188* (0.0109)	0.0161** (0.0059)
Other to immune hub		-0.0019 (0.0095)	0.0030 (0.0095)	0.0023 (0.0078)	-0.0049 (0.0069)
Log(HHI)		-0.1091** (0.0437)	-0.1458** (0.0480)	-0.0429 (0.0377)	-0.0367 (0.0221)
Log(Trade)		-0.0485 (0.0251)	0.0235 (0.0264)	-0.0184 (0.0222)	0.0720** (0.0104)
Log(Average GDP per capita)		0.1464** (0.0881)	-0.2329** (0.0919)	-0.0612 (0.0732)	-0.3794** (0.0398)
Observations		16946	16946	16946	16946
Adjusted R-squared		0.8997	0.9026	0.8731	0.6020
Durbin-Watson Statistic		0.5510	0.6322	0.5857	1.0287

Notes:

1. Methodology used – airline-market fixed effects model. HHI is instrumented by six month lagged market passenger volume.
2. Compared to the results reported in Tables 5-8, JV variable here excludes oneworld services covered by the respective joint venture. Such services are instead included into the Immunity without JV variable.
3. Heteroscedasticity consistent White standard errors reported in parentheses
4. Year and month dummies included in all regressions, but not reported
5. Significance: ** - 5%; * - 10%