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Airline Alliances, Antitrust Immunity and Market Foreclosure

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Non-technical summary

The development of international airline markets has led to the dominance of three global airline alliances – Star, SkyTeam and oneworld. As part of an overall assessment of the competitive effects of such agreements, the theoretical literature has suggested that members of an international airline partnership might have an incentive to foreclose the beyond-the-gateway markets to the airlines excluded from the respective alliance. It has also been suggested that such foreclosure will likely be most effective when alliance partners have the right to jointly set fares for the interline services, and engage in revenue sharing arrangements – a privilege otherwise known as antitrust immunity. This paper analyzes and quantifies effects of such market foreclosure.

We conduct an extensive analysis of the data on non-stop services on the transatlantic scheduled commercial passenger airline market. Merging the data with the information on the structure of the airlines' networks and dynamics of the airline partnerships on the same market over the time period from 1992 to 2008, we are able to analyze whether the airlines enjoying antitrust immunity take steps to exclude interline passengers arriving on the rival carriers' flights. We find that antitrust immunity leads to a 4.2 to 5.4 percent (0.7 to 1.5 percent in dynamic panel data GMM estimation) decrease in frequency of service by the non-alliance carriers serving a newly immunized hub. The effect on the passenger volumes is even greater (6.7 to 9.0 percent drop in fixed effects, 4.1 to 5.4 percent in GMM; and generally 1.5 to 2 times the effect on frequency). This suggests that excluded airlines switch to smaller aircrafts and/or end up with lower load factors on their services to the newly immunized hubs. We also find evidence (less robust, however) that antitrust immunity may lead to lower passenger volumes on routes between the competing alliances' hubs.

Das Wichtigste in Kürze

Die Marktentwicklungen im internationalen Luftverkehr haben zur Dominanz dreier großer und global agierender Allianzen von Fluggesellschaften geführt – Star, SkyTeam und oneworld. Als Teil einer ganzheitlichen Untersuchung der wettbewerblichen Effekte solcher Allianzen hat die theoretische Literatur die Hypothese aufgestellt, dass die Mitglieder einer solchen Allianz möglicherweise einen Anreiz haben, Märkte für Zubringerflüge für Fluggesellschaften zu verschließen, die nicht Mitglied in der jeweiligen Allianz sind. In diesem Zusammenhang wird auch behauptet, dass die Implementierung solcher Abschottungsstrategien dann am effektivsten ist, wenn die Allianzmitglieder die Preise der Interline-Verbindungen absprechen und die dadurch generierten Umsätze untereinander aufteilen dürfen – also Antitrust-Immunität genießen.

Dieser Aufsatz analysiert und quantifiziert die Effekte einer solchen Form der Abschottung in Luftverkehrsmärkten. Wir führen eine umfassende empirische Analyse auf Basis von Daten für direkte Linienflüge für Passagiere im transatlantischen Markt zwischen Europa und den USA durch. Durch die Zusammenführung dieser Daten mit Daten zur Struktur der Streckennetze der Fluggesellschaften und der dynamischen Entwicklung der Luftverkehrsallianzen für den Zeitraum von 1992 bis 2008 sind wir in der Lage zu untersuchen, ob die Fluggesellschaften mit Antitrust-Immunität Schritte unternehmen, die Interlining-Passagiere von außenstehenden Fluggesellschaften auszuschließen. Die Ergebnisse der Untersuchung zeigen, dass die Gewährung von Antitrust-Immunität zu einer 4,2-5,4%-igen Reduktion der Flugfrequenzen (zu den jeweiligen ‚immunisierten Drehkreuzen') derjenigen Fluggesellschaften führt, die nicht der betreffenden Allianz angehören. Der Effekt auf das Passagieraufkommen ist noch deutlicher. Es findet sich ein Rückgang zwischen 6,7% und 9,0% bei der ‚fixed effects' Modellierung bzw. zwischen 4,1% und 5,4% bei GMM. Grundsätzlich ist der Effekt auf das Passagieraufkommen 1,5 bis 2 Mal stärker als bei den Flugfrequenzen. Die Ergebnisse legen nahe, dass abgeschottete Fluggesellschaften zu kleineren Flugzeugen wechseln oder aber niedrigere Auslastungen ihrer Flüge zu den jeweiligen ‚immunisierten Drehkreuzen' zu verzeichnen haben. Darüber hinaus finden wir (wenn auch schwächere) Belege dafür, dass die Gewährung von Antitrust-Immunität zu einem niedrigeren Passgieraufkommen auf Strecken zwischen im Wettbewerb stehenden Drehkreuzen führt.

Airline Alliances, Antitrust Immunity, and Market Foreclosure

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Abstract

We examine the issue of market foreclosure by airline partnerships with antitrust immunity. Overlapping data on frequency of service and passenger volumes on non-stop transatlantic routes with information on the dynamics of airline partnerships, we find evidence consistent with the airlines operating under antitrust immunity refusing to accept connecting passengers from the outside carriers at respective hub airports. Following the antitrust immunity, airlines outside the partnership reduce their traffic to the partner airlines' hub airports by 4.1-11.5 percent. We suggest regulators should take possible market foreclosure effects into account when assessing the competitive effects of antitrust immunity for airline alliances.

Keywords: Air transportation, alliances, antitrust immunity, foreclosure

JEL Codes: L41, L93, K21

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"[I]t has become much harder to negotiate good deals for flights from Paris and Frankfurt since immunity was granted."

Travel manager of a big European Bank (2009)[3]

1. Introduction

A crucial feature of the airline industry is that the level of demand on most city-pair markets is not sufficient to sustain regular non-stop services. The airlines' response has been to operate hub-and-spoke networks, channeling passengers via one or several airports (hubs). While in the domestic US airline industry most of the travelers do not have to change the operating carrier en route, the situation is different on international markets, where scale and regulatory restrictions do not allow setting up 'mega airlines' with networks encompassing the entire world. The carriers' response has been to form partnerships to facilitate interline trips by the consumers. A number of such partnerships on the routes originating from the US operate under so-called 'antitrust immunity'. In general, antitrust immunity refers to exemptions from some or all of the antitrust laws granted to firms operating in specific sectors. In the context of international airline partnerships, antitrust immunity allows the partner carriers to cooperatively make scheduling and pricing decisions on the corresponding joint networks; revenue sharing may also be allowed.

We examine whether international airline partnerships operating under antitrust immunity could result in market foreclosure – a practice that generally involves denying the actual or potential competitors access to either an essential input or customers with the intent of extending monopoly power from the bottleneck segment of the market to the potentially competitive segment of the market (Rey and Tirole, 2007). Antitrust immunity can facilitate market foreclosure, as respective alliance members will be reluctant to accept interline passengers from the outside airlines. In fact, such a concern has been specifically raised by American Airlines: the carrier claimed that it has become more difficult for it to feed its passengers to Air France's flights at Paris Charles de Gaulle airport following the granting of antitrust immunity to the Air France – Delta partnership within the SkyTeam alliance[4]. Foreclosing on the outside carriers can be a rational strategy for the alliance members, as it not only increases their revenue (the passenger spends all his/her money 'within' the alliance), but also lowers

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3. All together now – Why antitrust immunity granted in Washington may not wash in Europe, The Economist, Oct 29th 2009.
4. Report of James D. Reitzes, Dorothy Robyn & Kevin Neels (The Brattle Group) as part of the first investigation of the SkyTeam alliance by the U.S. Department of Transportation (SkyTeam I), Docket No. OST-2004-19214, (June 24, 2005).

their cost via economies of traffic density (and increases the rivals' cost for the same reason). Foreclosure strategies can be implemented either by a direct refusal to deal, or by setting prohibitively high fees for accepting such passengers. Whatever the exact mechanism, the end result will be higher traffic by the partner airlines with antitrust immunity, and lower traffic by the outside airlines on routes to/from the partner airlines' hub airports. This is the contention tested in this study. Our empirical strategy involves developing a classification of transatlantic routes relative to hub airports of the airlines that enjoy(ed) antitrust immunity for their partnerships, and applying this classification to the data on non-stop frequency and passenger volumes on the transatlantic routes. Our dataset covers the period from 1992 to 2008, over which several partnerships have fallen apart, and some airlines have changed their alliance affiliation.

The findings of the data analysis are clearly consistent with our hypothesis. Our estimation results indicate that outside airlines carry up to eleven percent fewer passengers to immunized alliance members' hubs as compared to other routes within their networks. At the same time, antitrust immunity increases traffic on routes operated by the respective member airlines out of their hubs by over four percent (as compared to the otherwise equal outside airlines' services), and leads to a dramatic (up to 25 percent) increase in total passenger volume on the routes between the alliance members' hub airports. The same effects, about half the size of those estimated for the passenger volumes, are observed for the frequency of flights. At the same time, airlines enjoying antitrust immunity increase their traffic to most of the non-hub endpoints in their networks. Net effects (in terms of passenger volumes and frequency of service) of this foreclosure vary for different categories of markets, and are either ambiguous (at worst implying a small reduction in traffic with potentially anti-competitive outcomes), or indicate higher total traffic.

The paper is organized as follows. The next section characterizes airline alliances and antitrust immunity, followed by a detailed assessment of the relationship between antitrust immunity and market foreclosure in Section 3. The analysis includes both a brief overview of the economics of market foreclosure, and a detailed discussion on the assessment of market foreclosure in airline networks with antitrust immunity. Section 4 describes the data, and presents the estimation methodology and results. Section 5 concludes the paper by summarizing the key results and deriving policy implications.

2. Airline Alliances and Antitrust Immunity

Airline partnerships in their modern form appeared in the early 1990s, with airlines coordinating handling of interline passengers via various agreements. The most common and policy relevant form of such agreements involves codesharing, whereby flights are assigned the partner airlines' flight number(s), and are effectively incorporated into those carriers' networks. Such services are oftentimes jointly marketed by the partner airlines, and are sometimes supplemented with blocked-space arrangements, whereby a certain number of seats on the flight are sold directly by the partner airline. Multi-airline codesharing agreements led to the emergence of global airline alliances, each of which started from a partnership between an US and an EU carrier. Oneworld developed around the partnership between American Airlines and British Airways; SkyTeam evolved from the Delta Air Lines – Air France alliance; and the current Star Alliance is the expanded United Airlines – Lufthansa partnership.

The last ten to fifteen years witnessed a substantial increase in the size and depth of airline alliances in international air transportation. From the size perspective, more and more individual airlines have decided to join one of the three remaining global airline alliances. For example, while the respective alliances were founded between 1997 and 2000 by a total of 14 airlines, the number of member airlines grew to 52 in 2010 – 27 in Star, 13 in SkyTeam, and 12 in oneworld. The alliances are currently occupying a dominant position on the global aviation market. Specifically, in 2008 the combined world-wide market share of the three 'mega alliances' was about 59 percent.[5] Airline alliances have particularly high market shares (at least 70 percent, based on network capacity) on inter-continental markets, such as the market between North America and Europe.

From the depth perspective, members of all three global alliances receive increasingly more freedom in coordinating various aspects of joint operations, including scheduling and pricing decisions, as well as the right to form revenue-sharing joint ventures in international markets. On the transatlantic market in 2008, for example, seven out of ten flights involved at least one airport used as a hub by an airline participating in airline alliances with antitrust immunity.[6] The granting of antitrust immunity by the respective antitrust authorities is a precondition for the implementation of airline agreements, which involve cooperation on essential competition parameters such as pricing or scheduling.[7]

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[5] Data Sources: International Civil Aviation Organization (www.icao.int, accessed on 19 February 2011); Websites of Star Alliance (www.staralliance.com, accessed on 19 February 2011), SkyTeam (www.skyteam.com, accessed on 19 February 2011) and oneworld (www.oneworld.com, accessed on 19 February 2011).

[6] Computed by authors from US Department of Transportation T-100 Dataset for International Airline Services (www.rita.dot.gov, accessed on 19 February 2011).

[7] Between 1992 and 2009, the US DOT investigated 35 applications for antitrust immunity for the international services of various airline alliances. Only three applications were disapproved (American Airlines - British Airways (1999), American Airlines - British Airways (2002), Delta Air Lines - Northwest Airlines - Air France - Alitalia - CSA Czech

Given the identified increase in the size and depth of international airline cooperation, the question whether such a development is in the interest of the consumer immediately suggests itself. Although it is undisputed that consumers gain from airline alliances, it is unclear whether the observed increase in the degree of cooperation is necessary to maximize these benefits. Furthermore, a detailed understanding of the economic effects of airline alliances is pivotal for an overall assessment of the respective costs and benefits for society.

The analysis of airline partnerships in the literature has mostly dealt with the price effects of airline alliances. These studies often do not clearly distinguish between alliances with and without antitrust immunity. Several theoretical models (e.g. Park, 1997, Brueckner, 2001, Brueckner and Whalen, 2000) treat alliances as effective mergers. Of the empirical studies of international airline partnerships (Oum et al., 1996, Park and Zhang, 2000, Brueckner and Whalen, 2000, Whalen, 2007, Brueckner, 2003) only the latter two attempt to empirically distinguish the effect of antitrust immunity on airfares. The general consensus in the literature is that partnerships with immunity benefit interline passengers, who enjoy lower prices due to removal of double marginalization. At the same time, some models (e.g., Bilotkach, 2005) suggest that antitrust immunity may not lower interline fares below the level achieved by codesharing. Theoretically, airline partnerships are expected to lead to higher fares for trips between the partners' hub airports; however, empirical support for this contention is weak (partly because the loss of competition comes with substantial efficiency advantages, see Brueckner and Proost, 2010).

A recent survey paper on the competitive effects of antitrust immunity by Bilotkach and Hüschelrath (2011) points out that beyond the price effects, airline cooperation can affect the non-price product characteristics, such as schedule coordination and flight frequency; and might also have implications for tacit collusion and network development of the partner airlines. The study also points to the possibility of market foreclosure as a result of antitrust immunity, as previously suggested by theoretical models of Chen and Gayle (2007), and Bilotkach (2007). Although foreclosure will be the focus in the remainder of this study, it is important to state that a regulatory investigation of antitrust immunity for an airline alliance has to take account of all potential pro-competitive and anti-competitive effects, and must come to a decision by comparing the respective incremental costs and

Airlines - KLM (2006)), two are pending as of February 2009, and two applications were dismissed on request of the airlines before a final decision was announced. All of the remaining 28 applications were approved subject to conditions. Excluding the twelve applications of alliances without any involvement of a European carrier leaves 16 approved transatlantic applications for antitrust immunity. All antitrust immunity granting decisions that fall into the time period covered by our data are described in the Appendix.

benefits. In other words evidence for foreclosure strategies being applied by airline alliances under antitrust immunity does not allow us to immediately conclude that the entire alliance immunity agreement is anti-competitive. Such a conclusion can only be drawn from the identification and measurement of all incremental costs and benefits.

3. Antitrust Immunity and Market Foreclosure

Given the brief delineation of airline alliances and antitrust immunity, this section narrows the view down to one specific potentially anti-competitive effect of the granting of antitrust immunity: market foreclosure. The section is subdivided into a brief review of the economics of market foreclosure, followed by a detailed discussion on why market foreclosure in airline networks with antitrust immunity can be an issue, and how it can be assessed empirically.

3.1 The economics of market foreclosure

According to Rey and Tirole (2007, p. 2148), market foreclosure refers to "… a dominant firm's denial of proper access to an essential good it produces, with the intent of extending monopoly power from that segment of the market (the bottleneck segment) to an adjacent segment (the potentially competitive segment)". The tools in the foreclosing firm's toolbox include vertical integration with competitors, refusal to deal, exclusive arrangements, and price discrimination (Steuer, 2008). In either case, the visible outcome of such interaction is lower quantity (market share) for the firm being foreclosed on. Rational foreclosure strategies do not necessarily have to cause the exit of the rival; however, they have to somehow negatively affect its ability or incentives to compete.

The two basic forms of foreclosure are input and customer foreclosure. In the context of vertical relations, input foreclosure involves the upstream firm restricting access to its input to some of the downstream firms. This raises the corresponding downstream firms' costs, reducing competition and increasing prices at the downstream level. In the case of customer foreclosure, the downstream firm restricts its purchases from some of the upstream firms, leading to a loss in economies of scale – and therefore higher prices – at the upstream level. This in turn allows the downstream firms to raise their prices (Ordover, Salop & Saloner (1990, 1992); Riordan (1998)). Generally, foreclosure as such is not necessarily an anti-competitive practice, but may very well be socially beneficial as soon as it triggers sufficient efficiencies in the form of, e.g., cost advantages, or helps to avoid excessive entry or free-riding by downstream units (Rey and Tirole, 2007).

From an antitrust perspective, it is important to differentiate between market foreclosure in general and *anti-competitive* market foreclosure in particular. While the former term generally refers to the foreclosure mechanics described above, anti-competitive foreclosure additionally demands that consumers are harmed by the foreclosure strategy.[8] As a consequence, the identification of an anti-competitive market foreclosure strategy not only needs to provide convincing evidence on the ability and incentive to foreclose, but also has to assess whether such a foreclosure strategy would have a significant detrimental effect on competition downstream (European Commission, 2008, par. 18, 32).

The existing empirical studies of market foreclosure confirm the inconclusiveness of theoretical research on the welfare effects of foreclosure. Chipty (2001) examines the effects of vertical integration between programming and distribution in the cable television industry. Her results on the one hand suggest that integrated operators tend to exclude rival program services. However, on the other hand, she finds vertical integration may actually benefit consumers because of the associated efficiency gains. Mullin and Mullin (1997) argue that US Steel's acquisition of one of its suppliers led to substantial efficiency gains rather than market foreclosure. Slade (1998) shows that divestiture of pubs by breweries – effective removal of the possibility to foreclose – yielded higher prices for beer at pubs. More recently, Hortacsu and Syverson (2007) found no evidence of anti-competitive effects of vertical foreclosure in the cement and ready-mixed concrete industries; instead, the authors suggest that vertical integration yields lower prices, higher quantity, and does not create any additional entry barriers. Shenoy (2012), using an event study analysis covering a large sample of vertical mergers, claims that efficiency (not foreclosure or collusion) is the main rationale for vertical mergers. Derdenger (2009) studies foreclosure effects and efficiency effects in the video game console industry, and finds that vertical integration with foreclosure is pro-competitive. An opposing side is represented by Hastings' (2004) study of the gasoline market in Southern California. The author shows that the takeover of independent Thrifty stations by ARCO resulted in higher gasoline prices at the nearby stations, indicating lower competition following the vertical integration. Also referring to the gasoline market, Hastings and Gilbert (2005) find evidence for vertical integration leading to higher wholesale prices as a consequence of incentives to raise rivals' costs.

[8] Depending on country legislation, it can be possible to heal anti-competitive foreclosure concerns by providing convincing evidence that the efficiencies potential is substantially larger. As part of such an 'efficiency defence', the parties typically not only have to *verify* potential efficiencies but are also committed to show that, first, a significant share of the expected benefits is likely to be *passed on to consumers* (in the form of lower prices), and, second, that the efficiencies are *transaction-specific*, that is, they are unlikely to be produced or available absent the transaction that raised the anti-competitive foreclosure concerns (see International Competition Network, 2006).

3.2 Assessing market foreclosure in airline networks with antitrust immunity

The possibility of foreclosure in airline partnerships has been suggested by theoretical contributions. Chen and Gayle (2007) and Bilotkach (2007) both model alliances with antitrust immunity and profit sharing. In either model, where an airline can choose from a variety of potential alliance partners, the airline not chosen as a partner is unable to carry its passengers beyond its network. In the following, we divide our discussion on the assessment of market foreclosure into two subsections. While the forthcoming Section 3.2.1 assumes a simple airline network, the subsequent Section 3.2.2 makes use of an extended airline network.

3.2.1 Market foreclosure in a simple airline network

Given the apparent general relevance of foreclosure strategies in airline markets with antitrust immunity, this section develops a framework for assessing foreclosure empirically in international airline markets. The development of an extended airline network that is able to capture many essential characteristics of the actual transatlantic airline networks follows a discussion of foreclosure strategies in the very simple network structure shown in Figure 1.

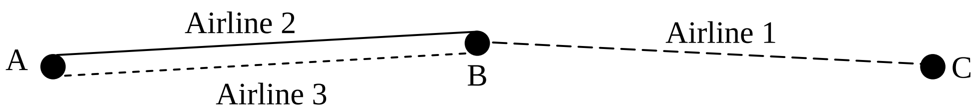


Figure 1: Network with Choice of Alliance Partner

Within the route network structure shown in Figure 1, let us assume that Airport A is located in the United States while Airport B is located in Europe. Airport C is also located in Europe; however, the airport does not offer direct transatlantic connections. As a consequence, customers travelling from C to A would need to travel on an intra-European beyond-the-gateway route, provided on a monopoly basis by Airline 1. The transatlantic route is served by two competing airlines. For simplicity, we assume further that Airline 1 does not offer transatlantic flights. Without antitrust immunity, Airline 1 would have incentives to enter into interline or codeshare agreements with both Airline 2 and Airline 3 aiming to increase traffic on its B-C route. This situation changes if Airlines 1 and 2 become members of the same alliance, and are granted antitrust immunity. In that case, Airlines 1 and 2 are jointly maximizing their profit, and therefore basically behave as one airline. This change in the incentive structure of the two carriers opens possibilities for foreclosure, as it would increase revenue and lower the costs of those two airlines if A-C customers switch from Airline 3 to Airline 2 for their transatlantic flight. In fact, in the simple network structure shown in Figure 1, A-C customers of Airline 3 might be forced to switch to Airline 2 (or alternatively not to fly at all) in the event that airline 1 refuses to accept passengers from Airline 3. The above-stated immediately suggests a simple hypothesis that is consistent with foreclosure following an airline partnership with antitrust immunity. Specifically, non-alliance carriers will lower their traffic from/into an alliance hub (as they are unable to channel passengers beyond the European hub); while alliance members will increase this traffic. We do admit, however, that foreclosure is not the only strategy that can produce such evidence: we will consider possible alternative explanations when discussing the findings of our data analysis in Section 5.2 below.

Market foreclosure, as discussed above, will affect competition on the AB route. As interline AC customers switch from Airline 3 to Airline 2; Airline 3's cost increases, and that of Airline 2 falls, due to economies of traffic density. Airline 2 will thus gain market power on AB route, which can translate into higher prices charged to the passengers. Thus, market foreclosure in this example leads to a potentially anti-competitive outcome.

Before we continue with the construction of an extended alliance network and the assessment of possible foreclosure strategies, it is important for our further reasoning to connect the general categories of foreclosure discussed in the preceding section to airline networks. In this respect, the discussion of Figure 1 reveals that a foreclosure strategy in an airline network technically includes both types of foreclosure: input foreclosure and customer foreclosure. If we focus on a flight from Europe to the United States, the bottleneck input good is the connecting flight from Airport C to the transatlantic Hub B, while the competitively supplied downstream product is the transatlantic flight. However, if we start the journey in the US, we have a competitively supplied upstream product (the transatlantic flight), and a bottleneck downstream product (the intra-EU beyond-the-gateway flight). Although this finding as such is interesting by itself, its relevance for the remainder of the paper is limited for basically two reasons. First, flights are usually sold in bundles consisting of outbound and inbound flights. Second, the general investigatory steps from an antitrust perspective are identical for both types of foreclosure. In both cases, it must be shown that the foreclosing firm has the *ability to foreclose*, the *incentive to foreclose*, and that such a foreclosure strategy would have a significant *detrimental effect on competition* downstream.

With respect to the *ability to foreclose*, one possibility for Airline 1 would be an outright refusal to accept the interline passengers from anyone except the alliance partner. If there are no alternative airlines operating on the route (i.e., market power is maximized), applying such a foreclosure strategy would leave the A-C passengers with the choice to travel with Airline 2 or not to travel at all.[9] A similar but more subtle foreclosure option would be to increase the interlining fee for outside airlines – i.e. to raise rival's costs – in order to reduce or even eliminate the profitability of interlining for the outside airline. Whatever the exact mechanism, the end result will be higher traffic by the partner airlines with antitrust immunity, and lower traffic by the outside airlines on routes to/from the partner airlines' hub airports.

Concerning the *incentive to foreclose*, foreclosing on the outside carriers can be a rational strategy for the alliance members, as it not only increases their revenue (the passenger spends all his/her money 'within' the alliance), but also lowers their cost via economies of traffic density (and increases the rivals' cost for the same reason)[10]. However, the incentives to foreclose are not equally present in all situations. For example, as raised by Reitzes and Moss (2008), foreclosure will, on the one hand, be more successful the higher the gateway's reliance on connecting traffic (basically because the monopoly beyond-the-gateway flights create the possibilities for foreclosure). On the other hand, the possibilities for foreclosure depend on the options for channelling passengers via alternative hub airports. If passengers in city C have no alternative connection on the European side of the Atlantic, the foreclosure possibilities are larger compared to situations in which such alternative routes would exist. The dominance of European flag carriers in serving their respective home countries at least suggests that the ability and the incentives to foreclose these markets are present. This conclusion holds if possible counterstrategies of Airline 3 are taken into account. For example, if market entry in the C-B route would be possible relatively easily, a foreclosure strategy would not be implementable for the alliance. However, given the dominance of European flag carriers at their hub airports together with substantial infrastructure congestion problems, it is reasonable to assume that entry into the main hubs is not an easy undertaking. Furthermore, entry into a few intra-European routes (e.g. through a code-sharing agreement with another carrier), would certainly be insufficient for Airline 3 to operate profitably. They would need a European carrier of significant size who would be able to distribute

[9] In should be noted here that it might still be possible for Airline 3 to offer flights on the A-B route as long as direct demand for travel between A and B is strong enough to profitably operate such a service. However, the overall demand level will certainly be lower compared to a world without antitrust immunity (and market foreclosure).

[10] On the margin, if a connecting passenger comes from within your alliance rather than from the outside, your load factor increases, and that of your rival falls, which (due to economies of traffic density) increases the difference between your per passenger cost and your rival's. However, this effect has to be traded off with the loss of revenue from accepting interlining passengers from outside alliances.

incoming traffic to many European cities without a direct connection to the United States.

Finally, it must be shown that a foreclosure strategy could have a significant *detrimental effect* on competition (*not* just competitors). An answer to such a question is not necessarily straightforward. Take the AB market discussed above. On this route, foreclosure leads to higher cost for Airline 3. It is true that a raising rival's cost strategy may hurt competitors; however, that does not automatically lead to the conclusion that final consumers are also hurt (by prices set above the competitive level). In particular, it is beyond dispute that the granting of antitrust immunity leads to the complete removal of double marginalization thereby creating a pro-competitive cost advantage of the alliance carriers compared to the outside airline.

However, despite the fact that it is unclear to what extent such efficiencies are immunity-specific[11] (and cannot be realized by lower degrees of airline cooperation such as code-sharing), the existence of efficiencies as such does not rule out the possibility of (larger) anti-competitive effects, especially if the efficiencies come at the cost of increased market power and therefore an enlarged ability and incentive to use that power in an anti-competitive fashion. In other words, although it is typically true that foreclosing on the outside of the partnership carriers enhances efficiency gains of cooperation, it also reduces competition, leaving the sign of the net effect of such a practice ambiguous. Typically, the social optimum is not reached in a monopolistic market structure, as at some point, the loss of competition overtops the gains in efficiencies. Furthermore, it is an open question to what extent a dominant firm has incentives to pass-on realized efficiencies to its customers in the form of lower prices.

3.2.2 Market foreclosure in an extended airline network

Let us now apply our general reasoning to an extended network context to further discuss which markets can be affected by foreclosure at hub airports of the immunized alliance members. Figure 2 depicts such an extended but still simple network with two competing airline alliances. Airports S1, H1, and H2 are located across the Atlantic Ocean from H3, H4, and S2. Let us call the partnership between the airlines operating hubs H1 and H3 Alliance 1; while Alliance 2 members will operate hubs H2 and H4. Then, we can define the following types of international markets:

- Markets between the hubs within an Alliance: H1-H3 and H2-H4 routes;
- Markets between the hubs of competing Alliances: H1-H4 and H2-H3;

[11] See Bilotkach and Hüschelrath (2012) for a detailed discussion of this issue.

- Spoke-overseas hub routes: S1-H3, S1-H4, S2-H1, and S2-H2; note that in addition to one-stop flight possibilities, we may also have non-stop flights on these markets (not singled out here to keep Figure 2 as simple as possible).
- Spoke-spoke routes: S1-S2.
- Routes between alliance hubs and 'non-hub' markets, such as H3-X route in Figure 2. Note that the notion of 'non-hub' market is relative to the alliances with antitrust immunity. In fact, X could be a hub airport of an airline that does not belong to any of the alliances with immunity (e.g., X could denote Philadelphia airport, which is a hub for US Airways – a Star Alliance member left out of the antitrust immunity deals).

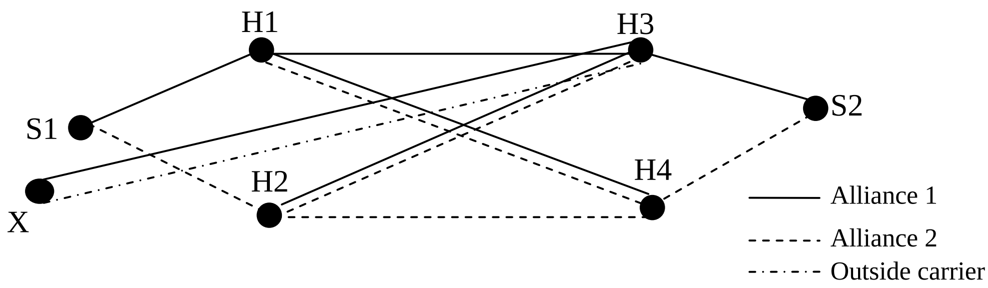


Figure 2: Simple Network with Two Alliances

Let us analyze the possibility of market foreclosure on the above-defined routes due to antitrust immunity.

– Markets between hubs of the same alliance (H1-H3 and H2-H4 routes) will see traffic gain by the corresponding alliance members. Removal of double marginalization and a consequent drop in the interline fares within the immunized alliance will lead to more passengers using hub-to-hub route as a segment in their journey.
– Markets between the hubs of competing Alliances (H1-H4 and H2-H3) could experience a drop in non-stop traffic by airlines from both alliances, as antitrust immunity will lead to a reduction in interlining across alliances (inter-alliance itineraries, such as S1-H2-H3-S2 will be replaced by trips within alliances, resulting in fewer passengers in the H2-H3 segment). This may or may not be detrimental to competition and consumer welfare on those markets. While we can expect higher cost for non-stop passengers on those routes through economies of density; the airlines can respond by scheduling fewer flights and/or using smaller aircraft, mitigating the potentially adverse outcomes.

- Spoke-overseas hub routes: S1-H3, S1-H4, S2-H1, and S2-H2. Consider the S1-H3 market. We have established above that Alliance 2's traffic on H2-H3 route may decrease, while Alliance 1's traffic on H1-H3 route will increase. This may create cost disparity between services of the two competing alliances: per passenger cost on H1-H3 segment will be lower than on H2-H3 segment. Also, to the extent changes in traffic volumes are complemented with changes in frequency of service, Alliance 1 will obtain a competitive advantage over Alliance 2 on this market in non-price product characteristics. In the most extreme case, Alliance 2 may end up closing down the H2-H3 segment of its network (as it might be unable to operate this market profitably without passengers connecting to S2 via H3). Thus, we see the potential for decreased competition on these markets. At the same time, we cannot say that antitrust immunity leads to foreclosure on those markets. Indeed, Alliance 2 airlines are still able to carry passengers on the S1-H3 route internally.
- Spoke-to-spoke markets (S1-S2) are not affected much by foreclosure, as competition between the airlines is simply replaced by the competition between alliances. It is however true that the S1-S2 passengers will now have fewer options, as routings S1-H1-H4-S2 and S1-H2-H3-S2 are no longer available to them.
- H3-X route (where an alliance member competes with an airline that is not a member of an alliance with immunity) is the most important one for our purposes (and is essentially the A-B market depicted in Figure 1, placed into the enlarged network context). On this route, formation of alliance with immunity can foreclose the X-S2 market to the carrier that remains outside of an alliance, as it is no longer able to channel its traffic via H3.

The net effect of competition between the alliances is increased specialization of individual alliance members on channelling the passenger traffic via the alliance partners' hubs, and reduction in traffic to the competing alliance's hub airports. While over the entire network the effect of this network reorganization could be to increase the number of markets served, and competition between the alliances may intensify (especially on the spoke-to-spoke markets), we have identified some markets where competition will decrease. Specifically, those markets include *all* routes originating and terminating at the hub airport of an immunized alliance member. Our conclusion is actually quite different from the approach regulators have up to now applied to antitrust immunity, where only routes between alliance members' hubs have been considered susceptible to reduced competition with antitrust immunity. Last but not least, not all airlines are alliance members and the formation of airline alliances puts those carriers into a clearly disadvantageous position, also decreasing competition on the affected markets. As an example, if we suppose that the H3-S2 route is also served by a non-alliance carrier, the formation of the alliance will decrease competition in this market.

In the end, we can formulate the following testable hypotheses.

Hypothesis 1: airlines without antitrust immunity will serve fewer flights and carry fewer passengers (as compared to what they offer elsewhere on their network) on markets involving hub airports of members of alliances that enjoy antitrust immunity.

Hypothesis 2: antitrust immunity is expected to yield lower traffic between the hub airports of members of competing alliances.

Hypothesis 3: antitrust immunity is expected to increase the corresponding airlines' services between their hubs

Hypothesis 4: antitrust immunity is expected to increase the corresponding airlines' services from their hubs to airports that are not hubs of competing alliances.

Of the four hypotheses we formulated, only the first one is related to market foreclosure. Hypothesis 2 reflects re-routing of passengers on hub-spoke markets as a result of antitrust immunity. Hypotheses 3 and 4 reflect expansion of the alliance with immunity due to removal of double marginalization and consolidation of traffic within the joint alliance network.

4. Data

4.1 Sample and Key Variables

Our main data source is the T-100 dataset for international airline services, provided by the US Department of Transportation. This dataset includes monthly information on all non-stop services between the US and the rest of the world. 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. Natural logarithm of monthly departures and passenger volumes, at the airline-route level, will be our main dependent variables.

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 US and all current EU members, plus Switzerland and Norway, for the years 1992 to 2008. We have retained only passenger services, yet eliminated services with fewer than ten monthly departures.[12] Overall, we ended up with 51,896 observations, spanning

[12] Since we defined markets as non-directional, ten departures actually correspond to five flights each way, or about one

377 non-directional[13] airport-pair markets and 796 airline-market combinations between 38 US and 57 European airports.

Our key independent variables will 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. Specifically, we differentiate between:

- Immunized alliance members' services between their respective hub airports (e.g., KLM service from Amsterdam to Detroit, or Delta Air Lines and Air France flights between Paris and Atlanta, after the carriers obtained immunity for their partnership); 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 (e.g., KLM service from Amsterdam to Chicago O'Hare after Star Alliance obtained antitrust immunity, or Delta Air Lines services from this carrier's hub to Frankfurt when both Delta and Lufthansa are in an alliance with immunity); 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 (e.g., KLM service from Amsterdam to Boston, or Lufthansa flights from Frankfurt to such airports as Phoenix, Boston, Dallas-Ft. Worth, 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 (e.g., British Airways services to airports such as Chicago O'Hare, Denver, Washington Dulles, or Continental Airlines or US 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 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. Such services include many of the flights to/from UK (e.g.,

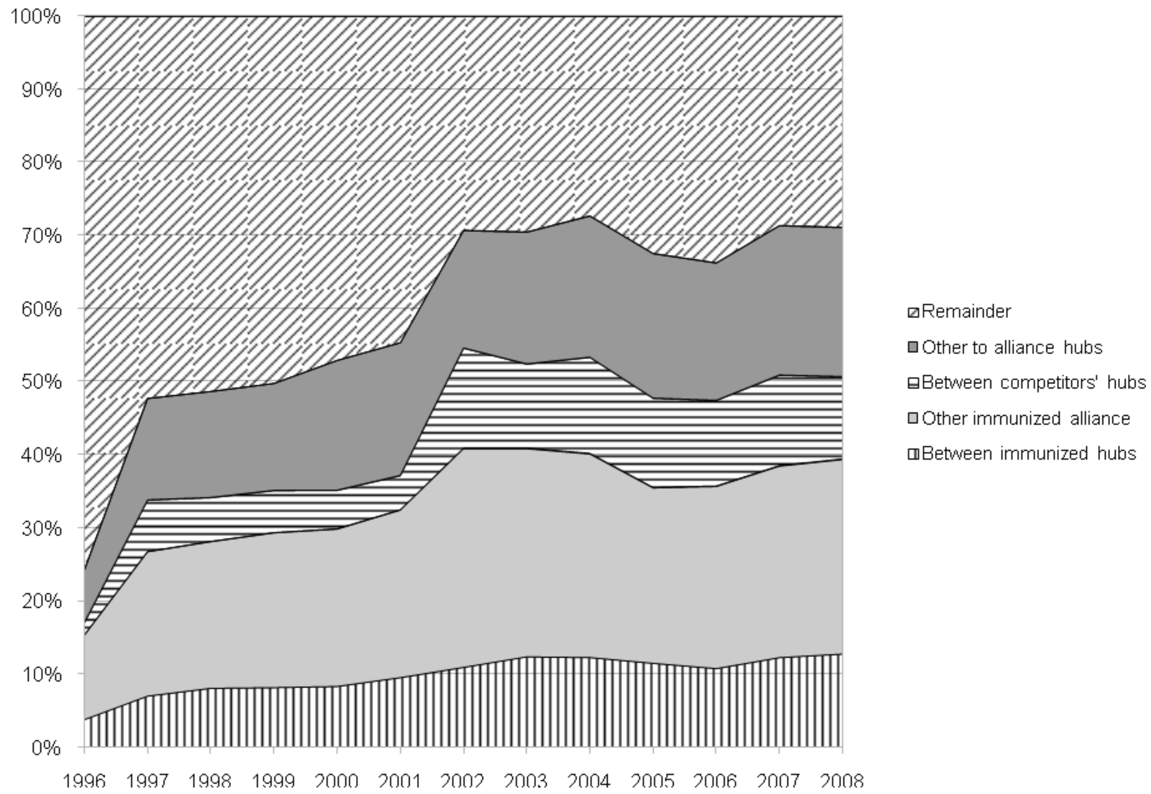
scheduled flight per week.

[13] This means that JFK-Heathrow traffic is lumped together with Heathrow-JFK passengers.

British Airways' flights to Philadelphia, Seattle, Los Angeles, Phoenix; American Airlines' flights to London from Los Angeles, Miami, Dallas-Ft. Worth, St. Louis; United Airlines' flights to London from New York), and a lot of the flights by the airlines that do not participate in partnerships with antitrust immunity, such as Continental Airlines and US Airways.

These four categories combined encompass (in 2008) up to 70 percent of all non-stop services in the dataset, as evident from Figure 3. That figure starts from 1996 rather than 1992, as 1996 is the first full year when we observe several competing alliances with antitrust immunity (KLM-Northwest partnership; Delta–Swissair–Sabena–Austrian Airlines partnership[14]; as well as Lufthansa-United and Lufthansa-SAS immunity within Star Alliance).

[14] This partnership was subsequently dissolved (see Appendix). Delta has become a founding member of SkyTeam; Sabena and Swissair went bankrupt. Following reorganization, Sabena is now called Brussels Airlines, and Swissair's new name is Swiss International Airlines. All three carriers are owned by Lufthansa, and are members of Star Alliance.



Note: Market shares are based on frequency of service; shares based on number of passengers carried and seats offered are similar.

Figure 3: Market Share of Services Involving Hubs of Alliances with Immunity

It can be observed that between 1996 and 2002 there has been a steady growth in the share of services involving hubs of alliance partnerships with antitrust immunity; since then this share has stabilized at about 70 percent. This implies that seven out of ten flights on the transatlantic markets (US-EU plus Norway and Switzerland) involve either one or two airports used as hubs by the airlines participating in partnerships with antitrust immunity[15].

To correctly classify the services in line with the above categories, we need information on both the airlines' hub airports and the timeline of antitrust immunity decisions. In addition, we know that some of the airline partnerships which had been granted antitrust immunity were eventually dissolved; therefore it was necessary to determine the corresponding timeline as well. US DOT's decisions on

[15] After 2010, with the Continental-United merger, and the granting of antitrust immunity to the American Airlines – British Airways partnership, the total share of services involving at least one airport of an alliance member with immunity exceeds 85 percent.

granting of antitrust immunity are publicly available on the Department's webpage; we used them to construct the timeline presented in the Appendix. Internet research on the airline's and alliance's webpages revealed the dates of dissolution of partnerships. For the purpose of data analysis, we considered immunized alliances as operational starting from the month following the granting of antitrust immunity until either the month in which the partnership was dissolved or (for currently active alliances) the end of 2008.

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; and SAS, operating hubs at Copenhagen, Stockholm, and Oslo). For the US 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,[16] New York JFK

4.2 Control Variables

In the data analysis that follows, we will use the following control variables. At the country level, we include data on the volume of trade between the USA and each of the European countries. This information is obtained from the IMF; regressions will include natural logarithm of trade volume as an independent variable. The following two country-specific dummy variables are also included. First, the Visa Waiver Program[17] indicator variable will be used where such a program is in effect for a given European country (the corresponding information was obtained from the US Department of State). Second, the Open Skies Agreement[18] indicator variable will take value of one where such a treaty is in place (this information is available from the US Department of Transportation). All three variables – higher trade volume, Visa Waiver Program and Open Skies Agreement – are expected to yield higher

[16] There were no transatlantic services out of Salt Lake City until early 2008.

[17] The Visa Waiver Program was introduced in 1986 and allows citizens of certain countries to visit the US for tourism or business purposes for up to 90 days without a visa. Of the current EU members, only Poland, Greece, Bulgaria, Romania, and Cyprus are not participating in this program.

[18] Prior to the installation of the Open Aviation Area between the US and the EU (covering Switzerland and Norway as well) in 2010, the US signed Open Skies Agreements with individual countries. An Open Skies Agreement removes all barriers to entry with non-stop services between the US and a foreign country, except for the 'nationality clause' (i.e., airlines operating such services had to be owned and effectively controlled by nationals of either of the two countries).

travel volumes between the US and a foreign country. However, the effect of each of these variables at the individual route level is unclear, as airlines may open up new routes to a country in response to each of these factors; and the travel volume on some ‘older’ routes may decline (e.g., if an airline starts serving Stuttgart in addition to Frankfurt, some passengers which used to fly to Frankfurt will now go to Stuttgart, so the passenger volume on flights to Frankfurt may decrease).

The market-level control variables include geometric averages of endpoints’ per capita real income and population[19]; as well as the airport-pair market level Herfindahl-Hirschman index (HHI), which we calculated directly from the T-100 dataset (we will use the index based on passenger volumes). Using geometric averages for demographic variables appears to be standard practice in the literature. We use HHI rather than its logarithm, also following a previous empirical study of determinants of route frequency (Bilotkach, 2011).

Time-specific heterogeneity will be controlled for by year and month indicator variables[20]. Table 1 shows the descriptive statistics of our variables.

As shown in Table 1, our dataset covers very heterogeneous transatlantic services: some involve mere hundreds of passengers per month, while the largest players carry up to 3,400 passengers daily on a single airport-pair market (equivalent to four roundtrips using a fully loaded Boeing-747 aircraft in a conventional two-class configuration). On average, an airline in our sample performs one roundtrip per day, with the maximum of about six daily roundtrip services. An average service involves about 570 seats offered per day (roughly equivalent to a Boeing-777 or an Airbus A-330 flying roundtrip), with about 75 percent load factor. Individual markets are rather concentrated, as far as non-stop services are concerned. About half of all the services are to countries, with which USA has an Open Skies Agreement. For the entire sample, half of the observations fall into one of the four categories we have defined previously. That is, overall half of the services involve at least one hub airport of a member of an alliance with antitrust immunity. Notably, the category of services for which we expect that antitrust immunity can lead to evidence consistent with foreclosure (“Other services to alliance hubs” category) represents 17 percent of all observations – clearly a non-trivial share.

[19] For EU countries, only country-level data on per capita income was available from EUROSTAT. For US endpoints, data on the level of the metropolitan statistical areas (MSA) provided by the U.S. Census Bureau was used.

[20] Use of period (i.e., year-month) indicator variables yields nearly identical estimation results.

5. Data Analysis and Results

5.1 Methodology

Our data analysis methodology is based on estimation of the following regression specification:

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

Where:

- Y_{ij} is either flight frequency or number of passengers carried by airline *i* on market *j*;
- *X* is the vector of various control variables, as discussed in the previous section of the paper;
- Indicator variables $I_{HubHub}^{Immunity}$; $I_{HubOtherHub}^{Immunity}$; $I_{HubOther}^{Immunity}$; and $I_{ToImmuneHub}^{NoImmunity}$ represent the four key categories of services, defined in Section 4.1.

As we discussed previously, foreclosure will imply lower frequency of service and passenger volumes, offered by the outside carriers to hub airports of members of an alliance with antitrust immunity. In terms of the specification above, the research hypothesis is that $\alpha_4 < 0$. *This will be the main contention tested in our data analysis.*

Other hypotheses consistent with removal of double marginalization by antitrust immunity – and corresponding increase in traffic – would be $\alpha_1 > 0$ and $\alpha_3 > 0$. We also discussed that routes between the competing alliance members' hubs might be affected by antitrust immunity, which may manifest itself in reduced traffic; however, we also noted that it is not entirely correct to attribute any such traffic reduction to vertical market foreclosure. A priori, however, we expect $\alpha_2 < 0$.

One methodological challenge we face is market, airline, and airline-market specific heterogeneity, compounded by the fact that many carriers in our sample operate hub-and-spoke networks. This network structure 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), and estimate an airline-airport-pair-market fixed-effects model.

In the airline-market fixed effects model, the effects we are interested in will be identified by the variation in the relevant variable *within* a given airline-market cross-section. As an example, consider Delta Air Lines' service from Atlanta to Vienna. This service will be classified in the outside category before antitrust immunity was granted to the Delta – Austrian partnership (from January 1992 till June 1996); as well as after the partnership ended and before the Austrian – United pair obtained antitrust immunity within Star Alliance (April 2000 to January 2001). After Delta – Austrian obtained antitrust immunity and before their partnership ended (July 1996 to March 2000), this service will be classified as *service between immunized hubs*. In the period from February 2001 until January 2002, Austrian was a member of a partnership with antitrust immunity, while Delta was not: this implies that Delta service from Atlanta to Vienna will be in the *other services to alliance hubs* category during this period. In January 2002 Delta Air Lines itself became a part of an alliance with antitrust immunity. From February 2002 until the end of 2008 (as far as our dataset spans) Delta's Atlanta – Vienna service will be in the *services between competitors' hubs* category. Overall, about one third of all airline-market combinations in our sample move between the above-described categories at least once (the share is higher if we restrict our sample to services of 'legacy' carriers – see below for a description).

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 employ the following specifications. In all cases, first and second lags of the respective dependent variable are used. These are instrumented with third and fourth lags in regressions for the entire sample; and third to sixth lags in all other sub-samples. These specifications were chosen as they satisfy both of the fundamental conditions for the system GMM estimator: no correlation between the instruments and the residuals (Hansen J test), and no autocorrelation in the residuals (Arellano-Bond test for serial correlation).

Our measure of concentration, HHI, is also endogenous, and we deal with this issue by instrumenting the Herfindahl-Hirschman Index with the market level passenger volume, lagged six months. Generally, the literature offers two classes of instruments for HHI: lagged market concentration measures, and measures of market size. We opted not to use the former due to extremely strong correlation between HHI and its lags – over 0.9 for any lags from the first to the twelfth. We lagged the market-level passenger volume because current month's passenger volume will clearly be correlated with the current unobservable shocks affecting either frequency or passenger volume at the airline-market level. We chose to lag our instrumental variable six months because autocorrelation present in the data may lead to correlation between the current unobservable shock and the market-level passenger volume lagged only one or two months. The correlation between HHI and our instrument of choice is -0.6, which means that our instrument is neither too weak nor too strong.

In addition to running regressions on the entire sample; we perform a series of robustness checks for our results. First, we restrict our sample to services performed by the 'legacy' carriers; these include EU countries' traditional flag carriers and major US 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[21]. This restriction decreased the number of observations by about twelve percent. Second, we exclude services to/from the United Kingdom – by far the largest transatlantic market (at the country level). This country's flag carrier (British Airways) has faced a number of obstacles in trying to obtain antitrust immunity for its partnership with American Airlines, and travel between the US and the UK has been subject to some idiosyncratic rules, most notably entry restrictions at London Heathrow airport[22]. Third, to make sure the airlines' potentially non-random entry and exit decisions do not bias our results, we restrict our sample to services observed in at least 190 out of 204 possible months. This restriction constrains us to work with 93 airline-market combinations.

5.2 Results

Results of our data analysis exercise are presented in Tables 2 through 4. Table 2 presents results for the airline-market fixed effects two stage least squares model, with HHI treated as an endogenous variable as discussed above. Table 3 reports results for the sub-sample including 'steady' services (i.e., those observed in at least 190 out of 204 possible months). Table 4 reports the Arellano – Bover dynamic panel GMM estimation results – this model accounts for endogeneity arising from both lagged dependent variables, and the measure of concentration. Note also that the values of the Durbin – Watson statistic included in Tables 2 and 3 clearly indicate the presence of autocorrelation in fixed effects estimation, further justifying the use of system GMM.

Our estimation results are consistent with the market foreclosure hypothesis, and are robust to excluding non-legacy carrier services, services to/from the United Kingdom, and 'sporadic' services. Fixed effects estimation suggests antitrust immunity leads to a 4.2 to 5.4 percent decrease in the frequency of service by the outside carriers serving the newly immunized hub. Specifically, the size of

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21 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).

22 Up to May 2008, two US (American and United) and two UK (British Airways and Virgin Atlantic) airlines were allowed to perform direct transatlantic services out of London Heathrow airport.

the effect for the entire sample is 4.2 percent, and up to 5.4 percent when UK services are excluded (see Table 2). When only steady services are taken into account, the effect of market foreclosure on frequency of service increases to 5.3-7.8 percent (see Table 3). The effect on the passenger volumes is generally 1.5 to 2 times the effect on frequency (roughly 6.7-9 percent in Table 2, and 9-11.5 percent in Table 3) suggesting excluded airlines switch to a smaller aircraft and/or end up with lower load factors on their services to the newly immunized hubs.

GMM estimation results, reported in Table 4, indicate an effect of a smaller magnitude (1.1 to 1.7 percent for frequency, and 4.1 to 5.4 percent for passenger volume), with the ratio between the frequency and passenger volume effects of around 3. GMM estimation thus finds that the suspected effects of market foreclosure on passenger volumes are much more pronounced than the same on frequency of service.

Our results for the entire sample imply the following mean effects. Results in Table 2 suggest that after granting of antitrust immunity, airlines flying to the hub of the respective alliance member will operate about 3 fewer monthly flights, and carry about 880 fewer passengers per month. The corresponding magnitudes implied by system GMM estimates are much smaller: 0.8 fewer flights and 495 fewer passengers. Interestingly, our results also suggest that traffic lost by the carrier outside of the partnership with antitrust immunity is in part replaced by the hub operator with antitrust immunity (one can see this by comparing the magnitudes of the coefficients on “other services to immunized hubs“ and “other immunized alliance services” variables). Overall, however, on routes involving a hub of an alliance member with antitrust immunity, where such a carrier competes with an airline from outside of an immunized alliance (e.g., Amsterdam – Philadelphia market, where services over the span of our sample have been offered by KLM and US Airways, the latter carrier staying outside of the alliances with immunity), immunity leads to unchanged or slightly reduced total passenger volume.

Results for the effect of antitrust immunity on services by the corresponding partner airlines out of their hub airports to hub airports of their own alliance partners and to non-hub airports are well in accordance with our expectations. Antitrust immunity leads to a large increase in passenger traffic between the partner airlines' hub airports (from nearly 12 percent in GMM estimation to over 20 percent in fixed effects regressions). Obtaining antitrust immunity also helps the corresponding carriers to add passengers on flights to other airports from their hubs. Size of this effect varies between around 3 percent (system GMM) and about 4-7 percent (fixed effects).

We also expected antitrust immunity to lead to lower traffic between competing alliances' hub airports. In this dimension, results have not been consistent across specifications. The expected effect is robust only in Table 3 (results for 'steady' services); elsewhere, the corresponding coefficient is either positive or not statistically significant. However, as already argued above, the expected decrease in traffic between hubs of competing alliances with antitrust immunity should not really be interpreted as consistent with foreclosure.

The results reported in Table 5 indicate that antitrust immunity leads to the outside airlines both reducing their load factors and using smaller aircraft. The carriers not covered by antitrust immunity, when planning their flights to hubs of immunized alliance members, chose to use smaller airplanes in response to falling passenger numbers; at the same time, it appears that the load factors still drop, even with smaller aircraft being used. This can be explained by the fact that the carriers effectively face a lower bound on the size of aircraft which can be used for transatlantic services – one cannot fly those routes using aircraft smaller than Boeing-757 or 767, seating about 200 –250 passengers.

Control variables by and large behave as expected. The relationship between market concentration and frequency/passenger volumes is negative, which is consistent with the findings of other recent studies (e.g., Pai, 2010; Bilotkach et al., 2010). Open skies agreements sometimes imply a negligible or even a negative effect on frequency; but the effect of market liberalization on the passenger volumes is clearly positive.

In addition to the data analysis exercise for the transatlantic airline market presented here, we have evaluated whether antitrust immunity could yield evidence consistent with market foreclosure in the domestic US airline industry. That is, we investigated whether we would observe a reduction in traffic by the US major carriers into hub airports of the airlines that obtained antitrust immunity for their international partnerships. A priori, we did not expect to find such evidence in the domestic US airline industry. With about 650 million passengers traveling domestically per year, and only 50 million transatlantic customers annually, it is unlikely that any refusal to accept interline passengers from domestic segments would make a sizeable dent on outside of alliance airlines' traffic to hub airports of carriers enjoying antitrust immunity. This is indeed what we discovered empirically.

Summing up our findings, our data analysis shows that airlines excluded from the partnerships with antitrust immunity end up decreasing their frequency of service, and experience lower passenger traffic volumes (mostly due to a lower load factor rather than the use of smaller aircraft) for their services to the immunized alliance members' hub airports. This is consistent with the market foreclosure hypothesis we postulated.

Traffic on routes between the alliance members' hub airports increases substantially following the granting of antitrust immunity. Routes between hubs of competing alliances experience some decline in traffic, but this effect is not as robust, and mainly reflects rerouting of passengers, as discussed earlier. Taken together, the two effects suggest that antitrust immunity strengthens the competitive position of the respective alliance members on transatlantic markets from their hub airports to non-hub gateways.

Overall, our results suggest that bringing the possibility of market foreclosure as a result of antitrust immunity into consideration allows us to point to potential anti-competitive effects on markets which have generally been considered immune to lower competition as a result of increased airline cooperation. Specifically, review of antitrust immunity cases has been mostly concerned with the potential for declining competition on markets between hub airports of the partner airlines. It has been believed that airline alliances should not affect competition on routes from alliance members' hub airports to non-hub gateways. We show that this might not be true, and suggest that *competition on all markets involving a hub airport of a member of an alliance with antitrust immunity might decrease* through potential market foreclosure.

Despite the strong evidence that is consistent with foreclosure; it is important to put our results into perspective of existing research and alternative interpretations. As discussed in Section 3.1 above, theory and empirical evidence suggest that vertical cooperation and integration can result in both market foreclosure and efficiency gains. While the former is likely to reduce output and increase prices, the latter typically has inverted effects. Due to the lack of price and cost data we face in this study, our results therefore do not allow a definite conclusion on the question whether the granting of antitrust immunity leads to anti-competitive market foreclosure (in the sense that the identified effects overtop possible efficiency gains of antitrust immunity). Furthermore, the evidence we found can be subject to alternative interpretations relating to neoclassical or transaction cost theories. Most notably, antitrust immunity and resulting closer cooperation between the airlines can enable cost savings, which may be passed along to the passenger, making interline services by the respective alliance members more attractive to the travelers. The passengers will then substitute to those services, reducing traffic by the airlines which are not part of the alliance with antitrust immunity. Also, antitrust immunity can increase the cost of interlining with the outside airlines for the alliance member with immunity (but not necessarily for the outside carrier), which could also lead to the outcome we observe. Future studies could shed further light on these alternative explanations for our empirical findings.

Despite this inconclusiveness of our analysis, several industry specifics suggest that antitrust authorities are well advised to consider possibilities of market foreclosure in their examination of the competitive effects of antitrust immunity of airline alliances (see generally Section 3.2.1 for a detailed discussion). First, market power effects of especially European flag carriers are substantial with respect to both their home market and their main hubs. This finding not only suggests a substantial power of these alliances over price but might also imply reduced incentives to pass-on possible efficiencies downstream to the final consumer. Second, lower degrees of cooperation – such as, e.g., code-sharing agreements – already allow reaping a substantial fraction of the benefits of international airline cooperation (see Brueckner et al., 2011, for the most recent evidence on this effect). As a consequence, the incremental efficiencies realized after the granting of antitrust immunity are likely to be substantially smaller than the entire benefits of airline cooperation. In addition, it is important to remind that even the identification of anti-competitive foreclosure would not allow the immediate conclusion that antitrust immunity should not be granted. Such a decision has to be based on a comparison of all incremental costs and benefits triggered by such agreements (see Bilotkach and Hüschelrath, 2011).

6. Conclusion

Theoretical research and practical antitrust investigations have both suggested that members of international airline partnerships might have the ability and the incentive to foreclose the beyond-the-gateway markets to the airlines excluded from the respective alliance. It has also been argued that such foreclosure will likely be most effective when alliance partners have the right to jointly set fares for the interline services, and engage in revenue sharing arrangements – a privilege otherwise known as antitrust immunity. This paper assesses whether the evidence from the transatlantic airline market can be considered consistent with such market foreclosure, and quantifies the corresponding effects.

We conduct an extensive analysis of the data on non-stop services on the transatlantic scheduled commercial passenger airline market. Merging the data with the information on the structure of the airlines' networks and the dynamics of the airline partnerships on the same market over the time period from 1992 to 2008, we are able to analyze whether the airlines enjoying antitrust immunity take steps to keep interline traffic within their alliance. We find that antitrust immunity leads to a 4.2–5.4 percent (0.7–1.5 percent in dynamic panel data GMM estimation) decrease in frequency of service by the non-alliance carriers serving a newly immunized hub. The effect on the passenger volumes is even greater

(6.7 to 9 percent drop in fixed effects, 4.1 to 5.4 percent in GMM; and generally 1.5 to 2 times the effect on frequency). This implies that excluded airlines switch to smaller aircraft and/or end up with lower load factors on their services to the newly immunized hubs.

Our empirical results suggest that antitrust immunity may lead to reduced competition on all markets (whether non-stop or one-stop) involving alliance members' hub airport(s). In particular, in cases where an immunized alliance member competes with a non-alliance carrier, antitrust immunity results in increased market share inequality and potentially lower total traffic. Note that the literature has up to now only considered markets for travel between alliance members' hub airports as candidates for lower competition following antitrust immunity. We effectively expand the set of markets where antitrust immunity may yield losses to the traveling public.

More generally, our study presents evidence which is somewhat contrary to what is found in the general empirical literature on market foreclosure. Most studies suggest that foreclosure either appears to be pro-competitive or neutral in terms of its welfare effects. Our results suggest that foreclosure may have anti-competitive effects, depending on characteristics of the market(s) in question. Admittedly, we are unable to analyze the price effects of potential market foreclosure. Moreover, evidence we report here is subject to alternative interpretations, such as antitrust immunity bringing about cost efficiencies, which are passed along to travelers in the form of lower airfares, resulting in passengers switching away from the non-alliance product. However, an antitrust authority that simply ignores possible foreclosure strategies when investigating the competitive effects of antitrust immunity for airline alliances is likely to miss out an opportunity to further increase the benefits of its activities for the consumers, e.g., by imposing remedies to heal anti-competitive foreclosure concerns.

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Table 1: Descriptive Statistics of Variables

	Mean	Std. Dev.	Minimum	Maximum
Dependent variables				
Monthly frequency	66.59	44.02	11.00	494.00
Monthly passengers	13,304.17	10,121.67	101.00	107,457.00
Market level controls				
HHI	0.71	0.28	0.18	1.00
Geometric average population	3,661,752	2,315,145	169,565	11,675,551
Geometric average per capita income	37,001	9,527	6,650	67,565
Country level controls				
Trade volume (million US$)	53,539.63	35,645.67	399.6	152,001.00
Visa waiver	0.96	0.20	0.00	1.00
Open skies agreement	0.46	0.50	0.00	1.00
Key variables – route classification dummies				
Between immunized hubs	0.07	0.26	0.00	1.00
Other immunized alliance services	0.18	0.38	0.00	1.00
Between competitors' hubs	0.08	0.27	0.00	1.00
Other services to immunized hubs	0.17	0.37	0.00	1.00

Table 2: Fixed Effects Results

Independent Variable	Logarithm of frequency is dependent variable				Logarithm of total passengers is dependent variable			
	Entire sample	Legacy carriers only	Excluding UK	Excluding UK, legacy only	Entire sample	Legacy carriers only	Excluding UK	Excluding UK, legacy only
Constant	2.9707** (0.1602)	3.2937** (0.1770)	3.6684** (0.2187)	4.0090** (0.2304)	6.5072** (0.2146)	6.6731** (0.2381)	7.6483** (0.2680)	7.8384** (0.2792)
Market level controls								
HHI	-0.4150** (0.0658)	-0.5859** (0.0693)	-0.4361** (0.0633)	-0.4860** (0.0621)	-0.5332** (0.0956)	-0.6996** (0.0974)	-0.5171** (0.0938)	-0.5291** (0.0941)
Geometric average population	1.55E-07** (1.07E-08)	1.72E-07** (1.30E-08)	-1.15E-07** (2.57E-08)	-1.25E-07** (2.65E-08)	1.09E-07** (1.26E-08)	1.22E-07** (1.56E-08)	-1.07E-07** (2.47E-08)	-1.34E-07** (2.63E-08)
Geometric average per capita income	1.38E-05** (1.36E-06)	1.17E-05** (1.36E-06)	6.46E-06** (1.55E-06)	4.23E-06** (1.61E-06)	2.35E-05** (1.35E-06)	2.31E-05** (1.33E-06)	1.54E-05** (1.49E-06)	1.48E-05** (1.50E-06)
Country level controls								
Logarithm of trade volume	0.0180 (0.0130)	0.0064 (0.0141)	0.0458** (0.0166)	0.0317* (0.0171)	0.1634** (0.0188)	0.1624** (0.0199)	0.1235** (0.0232)	0.1205** (0.0233)
Visa waiver	0.1587** (0.0237)	0.1326** (0.0253)	0.1396** (0.0240)	0.1269** (0.0241)	0.1459** (0.0317)	0.1192** (0.0329)	0.1225** (0.0313)	0.1126** (0.0306)
Open skies agreement	-0.0077 (0.0056)	7.86E-05 (0.0060)	0.0057 (0.0067)	0.0173** (0.0068)	0.0399** (0.0068)	0.0450** (0.0071)	0.0667** (0.0073)	0.0712** (0.0074)
Key variables								
Between immunized hubs	0.1134** (0.0108)	0.1042** (0.0116)	0.1244** (0.0111)	0.1225** (0.0113)	0.2136** (0.0097)	0.1929** (0.0095)	0.2158** (0.0101)	0.2017** (0.0102)
Other immunized alliance services	0.0225** (0.0049)	0.0173** (0.0054)	0.0493** (0.0056)	0.0510** (0.0060)	0.0572** (0.0064)	0.0425** (0.0069)	0.0746** (0.0071)	0.0640** (0.0075)
Between competitors' hubs	0.0092 (0.0095)	-0.0002 (0.0103)	0.0317** (0.0099)	0.0309** (0.0101)	0.0090 (0.0111)	-0.0161 (0.0114)	0.0118 (0.0118)	-0.0064 (0.0117)
Other services to immunized hubs	-0.0421** (0.0079)	-0.0505** (0.0102)	-0.0509** (0.0079)	-0.0542** (0.0098)	-0.0665** (0.0099)	-0.0812** (0.0113)	-0.0830** (0.0100)	-0.0914** (0.0111)
Included observations	47610	42838	34354	30954	47610	42838	34354	30954
Adjusted R-squared	0.7995	0.7308	0.7407	0.6398	0.8259	0.7893	0.7897	0.7430
Durbin – Watson statistic	0.5520	0.5232	0.5711	0.5596	0.7222	0.6779	0.7133	0.6884

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 3: Fixed Effects Results for 'Steady' Services

Independent Variable	Logarithm of frequency is dependent variable				Logarithm of total passengers is dependent variable			
	Entire sample	Legacy carriers only	Excluding UK	Excluding UK, legacy only	Entire sample	Legacy carriers only	Excluding UK	Excluding UK, legacy only
Constant	1.9424** (0.2579)	1.7282** (0.2608)	0.0267 (0.3546)	0.3778 (0.3668)	5.0483** (0.2620)	4.6042** (0.2759)	3.8522** (0.3668)	4.0510** (0.3686)
Market level controls								
HHI	-0.3638** (0.0698)	-0.5129** (0.0718)	-0.5443** (0.0747)	-0.6031** (0.0749)	-0.4238** (0.0933)	-0.6236** (0.0936)	-0.6405** (0.1037)	-0.6967** (0.1037)
Geometric average population	3.42E-07** (1.14E-08)	3.88E-07** (1.24E-08)	4.21E-07** (2.56E-08)	4.07E-07** (2.71E-08)	2.99E-07** (1.50E-08)	3.59E-07** (1.63E-08)	4.50E-07** (2.50E-08)	4.43E-07** (2.59E-08)
Geometric average per capita income	2.67E-05** (1.04E-06)	2.73E-05** (1.05E-06)	3.02E-05** (1.71E-06)	2.78E-05** (1.82E-06)	3.33E-05** (1.22E-06)	3.51E-05** (1.26E-06)	3.61E-05** (1.72E-06)	3.47E-05** (1.71E-06)
Country level controls								
Logarithm of trade volume	0.0189 (0.0246)	0.0380 (0.0246)	0.2198** (0.0311)	0.2033** (0.0313)	0.2151** (0.0243)	0.2526** (0.0247)	0.3218** (0.0349)	0.3152** (0.0346)
Visa waiver	0.1593** (0.0367)	0.1150** (0.0378)	0.1211** (0.0397)	0.1010** (0.0414)	0.1712** (0.0465)	0.1085** (0.0493)	0.1112** (0.0549)	0.0918 (0.0562)
Open skies agreement	0.0230** (0.0069)	0.0217** (0.0071)	0.0397** (0.0103)	0.0358** (0.0103)	0.0590** (0.0086)	0.0598** (0.0090)	0.0684** (0.0107)	0.0650** (0.0107)
Key variables								
Between immunized hubs	0.1764** (0.0120)	0.1868** (0.0127)	0.2023** (0.0150)	0.2153** (0.0161)	0.2225** (0.0132)	0.2293** (0.0143)	0.2437** (0.0163)	0.2503** (0.0175)
Other immunized alliance services	0.0104* (0.0062)	0.0104 (0.0064)	0.0499** (0.0090)	0.0602** (0.0096)	0.0477** (0.0072)	0.0440** (0.0074)	0.0815** (0.0103)	0.0867** (0.0113)
Between competitors' hubs	-0.0799** (0.0103)	-0.0824** (0.0108)	-0.0436** (0.0117)	-0.0355** (0.0121)	-0.0736** (0.0119)	-0.0841** (0.0121)	-0.0607** (0.0120)	-0.0601** (0.0126)
Other services to immunized hubs	-0.0569** (0.0092)	-0.0779** (0.0104)	-0.0530** (0.0115)	-0.0655** (0.0118)	-0.0893** (0.0098)	-0.1159** (0.0109)	-0.0922** (0.0124)	-0.1088** (0.0134)
Included observations	18488	18099	11443	11251	18488	18099	11443	11251
Adjusted R-squared	0.7950	0.7742	0.6113	0.5984	0.8396	0.8257	0.7496	0.7465
Durbin – Watson statistic	0.4365	0.4339	0.4428	0.4414	0.6220	0.6030	0.5803	0.5712

Notes: 1. Sample includes only those airline-market cross-sections, which appear in the data at least for 190 months (out of 204 maximum possible); 2. Number of cross-sections: entire sample – 93; legacy carriers only – 91; exclude UK – 58; legacy carriers and excluding UK – 57; 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%

Table 4: Dynamic Panel Data GMM Model Results

Independent Variable	Logarithm of frequency is dependent variable				Logarithm of total passengers is dependent variable			
	Entire sample	Legacy carriers only	Excluding UK	Excluding UK, legacy only	Entire sample	Legacy carriers only	Excluding UK	Excluding UK, legacy only
Lagged dependent	0.3814** (0.0008)	0.3995** (0.0004)	0.3915** (0.0008)	0.3981** (0.0007)	0.2997** (0.0007)	0.3086** (0.0005)	0.3068** (0.0009)	0.3217** (0.0018)
Twice lagged dependent	0.1552** (0.0003)	0.1614** (0.0002)	0.1480** (0.0005)	0.1513** (0.0008)	0.0870** (0.0003)	0.0927** (0.0002)	0.0887** (0.0006)	0.0898** (0.0007)
Market level controls								
HHI	-0.1115** (0.0027)	-0.1799** (0.0016)	-0.1437** (0.0030)	-0.1717** (0.0026)	-0.3037** (0.0039)	-0.3723** (0.0021)	-0.3235** (0.0056)	-0.3042** (0.0053)
Geometric average population	7.04E-08** (2.13E-09)	7.38E-08** (1.14E-09)	-5.22E-08** (5.21E-09)	-5.12E-08** (3.66E-09)	7.01E-08** (3.62E-09)	7.22E-08** (1.63E-09)	-6.75E-08** (7.55E-09)	-5.15E-08** (8.56E-09)
Geometric average per capita income	6.42E-06** (3.04E-07)	5.06E-06** (1.77E-07)	3.15E-06** (2.64E-07)	2.08E-06** (2.70E-07)	1.50E-05** (4.87E-07)	1.38E-05** (2.73E-07)	9.18E-06** (4.05E-07)	9.91E-06** (5.26E-07)
Country level controls								
Logarithm of trade volume	0.0066** (0.0024)	0.0019 (0.0012)	0.0250** (0.0026)	0.0174** (0.0023)	0.1033** (0.0049)	0.0997** (0.0023)	0.0808** (0.0051)	0.0834** (0.0047)
Visa waiver	0.0742** (0.0034)	0.0587** (0.0021)	0.0649** (0.0034)	0.0600** (0.0033)	0.0924** (0.0061)	0.0779** (0.0037)	0.0792** (0.0078)	0.0706** (0.0061)
Open skies agreement	-0.0038** (0.0007)	0.0008 (0.0005)	0.0027** (0.0012)	0.0098** (0.0008)	0.0260** (0.0014)	0.0284** (0.0009)	0.0408** (0.0017)	0.0442** (0.0019)
Key variables								
Between immunized hubs	0.0588** (0.0029)	0.0521** (0.0016)	0.0636** (0.0025)	0.0592** (0.0024)	0.1282** (0.0044)	0.1181** (0.0026)	0.1344** (0.0044)	0.1186** (0.0032)
Other immunized alliance services	0.0125** (0.0010)	0.0091** (0.0005)	0.0250** (0.0010)	0.0247** (0.0012)	0.0352** (0.0017)	0.0275** (0.0009)	0.0518** (0.0022)	0.0393** (0.0015)
Between competitors' hubs	0.0102** (0.0017)	0.0052** (0.0009)	0.0202** (0.0017)	0.0183** (0.0017)	0.0089** (0.0032)	-0.0059** (0.0016)	0.0133** (0.0027)	-0.0018 (0.0031)
Other services to immunized hubs	-0.0119** (0.0012)	-0.0146** (0.0008)	-0.0162** (0.0011)	-0.0176** (0.0011)	-0.0413** (0.0020)	-0.0472** (0.0013)	-0.0493** (0.0018)	-0.0547** (0.0029)
Included observations	46975	42340	33892	30585	46975	42340	33892	30585
P-value of Hansen J statistic	0.65	0.83	0.79	0.89	0.42	0.61	0.53	0.72
P-value of Arellano-Bond test for serial correlation	0.36	0.57	0.45	0.47	0.34	0.56	0.64	0.57

Notes: 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. Year and month fixed effects included in all regressions, but not reported. Heteroscedasticity consistent White standard errors reported in parentheses. Significance: ** - 5%; * - 10%

Table 5: Effects on Aircraft Size and Load Factors

(a) Airline-Market Fixed Effects

Specification		Between immunized hubs	Other immunized alliance services	Between competitors' hubs	Other services to immunized hubs
Dependent variable – logarithm of aircraft size	Entire sample	0.1001** (0.0106)	0.0346** (0.0042)	-0.0002 (0.0068)	-0.0243** (0.0053)
	Legacy carriers only	0.0886** (0.0107)	0.0252** (0.0042)	-0.0159** (0.0067)	-0.0307** (0.0051)
	Excluding UK	0.0914** (0.0106)	0.0253** (0.0049)	-0.0198** (0.0070)	-0.0320** (0.0056)
	Excluding UK, legacy only	0.0792** (0.0108)	0.0130** (0.0050)	-0.0373** (0.0070)	-0.0371** (0.0056)
Dependent variable – logarithm of load factor	Entire sample	0.1052** (0.0094)	0.1052** (0.0094)	0.0417** (0.0056)	-0.0025 (0.0051)
	Legacy carriers only	0.0946** (0.0092)	0.0079** (0.0031)	0.0274** (0.0054)	-0.0104** (0.0046)
	Excluding UK	0.0916** (0.0084)	0.0166** (0.0041)	0.0241** (0.0063)	-0.0201** (0.0059)
	Excluding UK, legacy only	0.0828** (0.0087)	0.0084** (0.0041)	0.0114* (0.0061)	-0.0265** (0.0055)

Notes:
1. All dependent variables, specifications, and sample sizes are identical to those reported in Table 2
2. Adjusted R-squared and coefficients on control variables are similar to those reported in Table 2
3. Heteroscedasticity consistent White standard errors reported in parentheses
4. Significance: ** - 5%; * - 10%

(b) Dynamic Panel Data GMM

Specification		Between immunized hubs	Other immunized alliance services	Between competitors' hubs	Other services to immunized hubs
Dependent variable – logarithm of aircraft size	Entire sample	0.0989** (0.0032)	0.0344** (0.0013)	0.0006 (0.0019)	-0.0254** (0.0010)
	Legacy carriers only	0.0856** (0.0023)	0.0249** (0.0006)	-0.0141** (0.0011)	-0.0291** (0.0006)
	Excluding UK	0.0884** (0.0024)	0.0251** (0.0012)	-0.0196** (0.0021)	-0.0309** (0.0015)
	Excluding UK, legacy only	0.0760** (0.0018)	0.0116** (0.0008)	-0.0374** (0.0010)	-0.0342** (0.0010)
Dependent variable – logarithm of load factor	Entire sample	0.1040** (0.0037)	0.0174** (0.0013)	0.0388** (0.0022)	-0.0069** (0.0013)
	Legacy carriers only	0.0929** (0.0020)	0.0089** (0.0006)	0.0248** (0.0012)	-0.0152** (0.0005)
	Excluding UK	0.0932** (0.0028)	0.0176** (0.0011)	0.0221** (0.0021)	-0.0224** (0.0011)
	Excluding UK, legacy only	0.0824** (0.0022)	0.0096** (0.0006)	0.0103** (0.0014)	-0.0280** (0.0008)

Notes:
5. All dependent variables, specifications, and sample sizes are identical to those reported in Table 4
6. P-values of Hansen statistic and coefficients on control variables are similar to those reported in Table 4
7. Heteroscedasticity consistent White standard errors reported in parentheses
8. Significance: ** - 5%; * - 10%

Appendix

Timeline of Antitrust Immunity Granting Decisions on the Transatlantic Market:

January 13, 1993, Antitrust immunity involving KLM Royal Dutch Airlines and Northwest Airlines

May 20, 1996, United Airlines – Lufthansa pair granted antitrust immunity

June 14, 1996, Antitrust immunity granted to the following three pairs:

- Delta Air Lines – Swissair (ended on August 5, 2000)
- Delta Air Lines – Sabena (ended on August 5, 2000)
- Delta Air Lines – Austrian Airlines (the partnership ended on March 25, 2000)

Carve-outs: ATL-BRU, ATL-ZRH, CVG-ZRH

November 1, 1996, United – SAS receives antitrust immunity

December 3, 1999, Northwest – Alitalia granted immunity. The partnership ended in 2000

May 11, 2000, Antitrust immunity granted to the following pairs:

- American Airlines – Swissair (ended following Swissair bankruptcy on March 31, 2002)
- American Airlines – Sabena (ended following Sabena bankruptcy on November 7, 2001)

January 26, 2001, United – Austrian, and United – Lauda granted antitrust immunity

January 18, 2002, Antitrust immunity granted to the following pairs of carriers:

- Delta Air Lines – Air France
- Delta Air Lines – Alitalia
- Delta Air Lines – Czech Airlines

April 4, 2002, Antitrust immunity granted to United Airlines – British Midland (BMI), conditional on open-skies agreement between US and UK within the next six months

July 30, 2002, Antitrust immunity granted to American Airlines – Finnair

November 22, 2002, Antitrust immunity granted to American Airlines – Swiss International Airlines (ended in 2005)

April 15, 2004, Antitrust immunity granted to American Airlines – SN Brussels Airlines

February 13, 2007, First multi-airline antitrust immunity granted to the alliance consisting of United Airlines and the following EU partners: Austrian, BMI, LOT Polish Airlines, Lufthansa, SAS, Swiss, and TAP Air Portugal (all members of Star Alliance)

May 22, 2008, Six-way antitrust immunity granted to the following members of SkyTeam Alliance: Delta, Northwest, Alitalia, Czech, KLM, Air France. Note that same airlines' first application for six-way immunity was denied on February 6, 2006