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Article abstract

This study develops and tests a theoretical framework which suggests that the relationship between the level of multi-territory (or multi-point) contact and rivalry takes the form of an inverted U-shaped relationship. Drawing on a large sample of European airlines over the period 2001-2006, we provide empirical support for the inverted U-shaped relationship between multi-territory contact and rivalry as reflected by entries into and exits from the territory of a competitor. We conclude that competition between firms exhibits successive periods of rivalry and forbearance, possibly independently of time and institutional settings.

Rivalry and Forbearance in the European Airline Industry: Evidence of an Inverted U-Shaped Competitive Pattern[1]

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Résumé

Cet article propose et teste un modèle théorique qui suggère que la relation entre le niveau de contact multi-territoires (ou multipoints) et la rivalité entre compagnies aériennes européennes se caractérise par une forme en U inversé. Utilisant un échantillon important de compagnies aériennes sur la période 2002-2006, nous offrons une confirmation empirique de la relation en U inversé entre contacts multi-territoires et rivalité mesurés par les entrées et sorties des territoires d'un concurrent. Nous en concluons que la concurrence entre compagnies aériennes suit des périodes de rivalité et de retenue, peut-être indépendamment de la période et du contexte institutionnel.

Mots clés : Contacts multi-marchés, dynamique concurrentielle, industrie européenne du transport aérien.

Abstract

This study develops and tests a theoretical framework which suggests that the relationship between the level of multi-territory (or multi-point) contact and rivalry takes the form of an inverted U-shaped relationship. Drawing on a large sample of European airlines over the period 2001-2006, we provide empirical support for the inverted U-shaped relationship between multi-territory contact and rivalry as reflected by entries into and exits from the territory of a competitor. We conclude that competition between firms exhibits successive periods of rivalry and forbearance, possibly independently of time and institutional settings.

Keywords: Multimarket contacts, Competitive dynamics, European airline industry

Resumen

Este estudio desarrolla y prueba un modelo teórico que sugiere que la relación entre el nivel de contacto multiterritorial (o multipuntos) y la rivalidad entre compañías aéreas europeas adopta la forma de una U invertida. Basándose en una amplia muestra de las compañías aéreas europeas durante el período 2001-2006, se proporciona una confirmación empírica de la relación en forma de U invertida entre contacto multiterritorial y rivalidad, como se refleja en las entradas y salidas del territorio de un competidor. Se concluye que la competencia entre las empresas muestra períodos sucesivos de la rivalidad y de reserva, quizás independientemente del período y del contexto institucional.

Palabras claves: Contactos multimercados, contactos multi-mercados dinámica competitiva, aerolínea europea, transporte aéreo europeo.

Pure neo-classical Market competition is an ideal (Demsetz, 1967), in which price is the only competitive signal used by firms to produce the quantity of goods leading to a stable equilibrium at the margin. Rivalry between individual firms or pairs of firms is not identified and is not central to the neo-classical economics theory. The same holds for Industrial Organization theory which focuses primarily on Market structure (Bain, 1951), industry attractiveness (Porter, 1980) and economies of scale and scope (Chandler, 1990). Similarly, the New Institutional Economics research does not focus on rivalry between firms. Institutions of the Environment create the rules of the game and incentives for firms in general (North, 1990). The norm of transaction costs economizing is prescribed to strategists of firms for their choice between alternate and discrete Institutions of the Economy for transaction attributes identical for all firms (Williamson, 1985, 1991a and 1991b). Populations ecology theory (Hannan and Freeman, 1977) looks at firms as competing for an overall pool of resources in their quest for survival, not face to face rivalry. The resource-based view (Wernerfelt, 1984; Barney, 1991; Amit and Shoemaker, 1993) shares part of the focus of the Ecology of populations and adds the need for firms to benchmark the position of their resources and capabilities relative to competitors (Grant, 1998). All these theories look for a best or better solution. They are not interested in the complexity of strategic maneuvering for geographic territories, products, clients, technologies, resources, capabilities and allies. They do not focus on the attack/response pattern of face to face competition to gain and sustain a competitive advantage against individually identified rivals (Karnani and Wernerfelt, 1985).

Contrary to above theories, two different theoretical contributions emphasize the dynamics of competition between firms, from mutual forbearance to all out rivalry. One of the oldest comes from the German sociologist Simmel (1923, 1950). For Simmel, psychological characteristics are at the same time a precondition and a result of social and economic interactions. Individuals belonging to the same group tend towards similar behaviors revealing and reinforcing their group identity. Thus, Simmel expects non calculative tacit

1. We are grateful to EUROCONTROL for its financial support. We also thank Renaud Mouyrin for his valuable help in constructing the database.

cooperation between firm strategists, including forbearance, a form of mutual social restraint. To borrow an analogy with competition for survival in the world of animals: "wolf does not eat wolf" coincides with "the survival of the fittest". The second theoretical contribution owes to Edwards (1955) calculus based view that entrepreneurs have little interest in a prolonged overall rivalry because it would destroy the profit potential of their industry, while forbearance based upon deterrence is a positive sum game. Combining Simmel's and Edwards' theories, competition may, hence, be viewed as a mix of outright face to face rivalry and forbearance.

Building upon Edwards' (1955) and Baum and Korn (1996, 1999) theories depicting the effects of multi-point competition on rivalry and forbearance, this study examines the dynamics of multi-territory competition occurring in the European airline industry. More specifically, we investigate the inverted U shaped relationship between multi-territory and rivalry as reflected by entries into and exits from the territory (air routes between city pairs) of a competitor. We prefer the concept of territories to "Markets" used in most previous research because of the confusion created by the different meanings of the latter. Indeed, "Market" has quite distinct senses for neo-classical and Transaction Costs economists, but also for Strategic Management, Marketing and Geography scholars. Our findings provide evidence that the mix of rivalry and forbearance exists for European airlines and could be part of a universal form of competition between firms.

Our paper is structured in four main sections. First, we review the theoretical and empirical literature on multipoint competition and suggest a set of hypotheses linking multi-territory competition and rivalry in the context of the European airline industry. Second, we describe the research methodology employed in this paper. Third, we present the statistical models estimated as well as main findings relating to rivalry and forbearance between European airlines. Finally, we highlight the main limitations of our study and propose a research agenda relating to possible future comparisons of rivalry and forbearance between airlines of different countries.

Theory and Hypotheses

Theoretical models of multipoint competition are based upon the calculus assumptions of Edwards (1955). Firms are considered to be fully informed, with a long term survival and short term profit orientation and an ability to coordinate their actions between their operational units for attacks and/or responses. Most empirical work examining American airlines use the assumptions above. Edwards (1955) set the ground for the frequently tested hypothesis of the inverse relationship between the number of contacts between firms and the intensity of rivalry, predominantly called the forbearance hypothesis: the higher the number of multipoint contacts, the higher the propensity of forbearance.

Karnani and Wernerfelt (1985) provided the most detailed theory specifying characteristics of firms and industries as well as possible outcomes of tit for tat attacks and responses in conditions of multipoint competition between firms. Their model predicts attacks and responses according to four characteristics of the attacking firm and five for the incumbent. For the attacking firm, they consider: sales volume of the incumbent, industry entry barriers, synergies with existing territories and ability to retaliate by the incumbent. The incumbent can retaliate in function of the four criteria above plus the attractiveness of the attacker's territory. When attacked, the incumbent has four choices: 1. no response, 2. defense on his own territory, 3. retaliation on one or several territories of the attacker, 4. total war on all the attacker's territories. Karnani and Wernerfelt (1985) predict that responses 1 and 4 will be rare because they signal causes of potential disequilibria: weakness and invitation to further attacks for the first response and risks of destruction of the attractiveness of the industry, including bankruptcies for the competitors within the dyad and eventually outside for total war. Response 2 obtains when the incumbent is protected by high industry barriers, low sales volume and resources utilized (thus the amount of profits in jeopardy is low), the synergy with other territories is high. Response 3 (partial retaliation) is based upon the opposite reasons to response 2: low industry barriers, high profit stake (high sales and resource utilization) and low synergy with other territories. As partial retaliation has a higher potential to signal future retaliations by the incumbent in case of further attacks than response 2, they predict it will be the response most frequently chosen by competing firms.

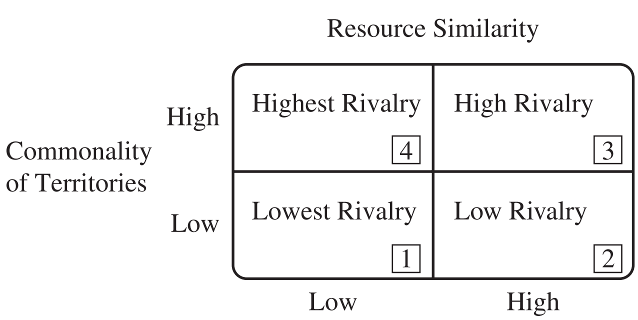
In the same year of publication of the Karnani and Wernerfelt article, Hamel and Prahalad (1985) extended the model to competition between firms on a global scale. As a result, Hamel and Prahalad (1985) suggest that multinational corporations set footprints in the home territories of their main global competitors as well as third territories to signal their ability to retaliate in case of an attack on their home base, where they usually have a combination of large market share, large investments in resources and thus a large share of their global profits. These proactive moves were instrumental in speeding up the spread of global competition with mutual forbearance concerning the home base spheres of influence of the leading competitors.

However, early empirical research testing Karnani and Wernerfelt theory in the American airline industry were disappointing. Indeed, Smith and Wilson (1995) found that 67% of the incumbents under attack did not respond, 9% went for total war, a total of 76% for the two least expected responses. Partial retaliation, the response most highly expected occurred in 15% of cases only and defense on the home territory 5%. These unsatisfactory results may come from the lack of validity and reliability of the manifest variable used to measure the concept of resources. They may also be explained by the fact that setting footprints in the airline industry is much harder to establish than other less regulated industries. This difficulty is even stronger in the context of the European airline industry. Indeed, obtaining a time slot, i.e. the right to fly on an air route between two airports at a scheduled time, requires the formal agreement of a committee staffed with national (as opposed to European) air transport bureaucrats and representatives of existing companies. They have an extremely slowly receding informal practice of favoring national carriers. Cabotage is practically unheard off. As it would require high up-front investments in airport supporting facilities, companies have little incentive to challenge the decisions of these committees in front of European courts.

To improve the understanding of the dynamic effects of multimarket competition on the pattern of rivalry, Chen (1996) added the similarity of resources to the commonality of territories covered. In the context of the airline industry, resources which grant valuable differentiation include attractive landing time slots, being a member of a global alliance network, airport hub domination and all costly to redeploy up-front investments such as hub facilities in the main airport(s) [2]. Even though aircrafts represent a kind of resources, they can however be redeployed at low cost for other routes or sold on a second hand market. Thus, they are not generally accounted for in the concept of similarity of resources in the airline industry. Combining the two dimensions (1) similarity of resources and (2) commonalities of territories, enriches the analysis of the unique characteristics of each firm and competitive interaction within a dyad. More specifically, juxtaposing the two dimensions Chen (1996) predicted four situations described in figure 1.

FIGURE 1

Commonality of territorries, resource similarity and rivalry



Adapted from Chen (1996, p.108)

First, low similarity of resources combined with low commonality of territories will result in the lowest level of rivalry: firms have neither incentive nor resources for face to face rivalry. Second, low common territory coverage combined with high similarity of resources increases the ability of response of the incumbent. However, provided that the attacker knows it, the latter is likely to forbear and bring the level of rivalry close to the first situation. The attacker's forbearance may not be complete if he wants to print a footstep signaling the presence of local resources for potential future retaliation. Third, when the number of common territories as well as similarity of resources is high, the probability of rapid response by the incumbent is the highest and thus the probability of forbearance by the potential attacker. Fourth, a high level of common territories combined with strong dissimilarity of resources provides an incentive for attack by the rival who believes he has superior resources and his opponent a low ability to retaliate. The last situation can provide the highest level of rivalry amongst the four situations specified by Chen (1996).

The four situations proposed by Chen (1996) have not been tested as such. Gimeno (1999) provided strong empirical support to the staking of spheres of influence from their hub relative to those of their main competitors by American airlines between 1984 and 1988. This extension of their territories and resources from their main base created credible and reciprocal threats between rivals and moved them to the third situation analyzed by Chen (1996) and leading to an increase in mutual forbearance. Their strategic moves follow the most likely response on one or several territories of the attacker predicted by Karnani and Wernerfelt (1985) and recommended by Hamel and Prahalad (1985). The concept of spheres of influence (Gimeno, 1999) proves to be a better predictor of rivalry and forbearance than industry characteristics (Smith and Wilson, 1995).

Undertaking tests of complex models such as those coined by Karnani and Wernerfelt (1985) or Chen (1996) is quite challenging, especially that initial attempts were disappointing (Smith and Wilson, 1995). Indeed, early testing of the linear effects of multimarket competition on rivalry and performance in the empirical settings of the US airline industry (Sandler, 1988) and the US financial services industry (Alexander, 1985; Rhoades & Haggestad, 1985; Mester, 1987) revealed that the magnitude of such effects are non-significant. In contrast, empirical support for the linear impact of multimarket competition on rivalry and performance has been recurrent in more recent studies, although not unanimous (see Jayachadran and al. 1999 for a review). For instance, in the context of the US airline industry, Baum and Korn (1996), Gimeno and Woo, (1996), Miller (2010), Prince and Simon (2009) and Singal (1996) found that multi-routes contacts reduce, in a linear fashion, the level of rivalry as reflected by increases in fares and decreases in the quality of service (e.g. delays, etc.). In contrast, Zhang and Round (2009) study indicates that increase in multimarket contact between Chinese airlines in the period 2002-2004 did not result in higher airfares in Chinese city-pair markets. Furthermore, Bilotkach, (2011) found that multimarket contact between US airlines has an effect on their flight frequency decisions, although this effect has diminished over time. Finally, other recent studies have shown that the consequences of

2. The authors thank an anonymous reviewer for raising and helping clarify this point.

multimarket contact on rivalry are observable in the context of industries other than the airlines, such as the US newspaper industry (Fu, 2003), the pharmaceutical industry (Guedri & McGuire, 2011) and the insurance industry (Greve, 2008).

In this paper, we suggest a more complex pattern than the linear relation between the level of multipoint contact and rivalry tested in most previous research. Indeed, unlike most previous studies, which measured rivalry through market share stability, price levels, performance or collusion, and building upon population ecology theory (Hannan and Freeman, 1977), we examine rivalry through the lenses of rates of entries to and exits from competitor territories. We view the interactions of contacts on multiple territories and forbearance behavior in the perspective of two distinct periods in the history of competitive interactions within a dyad (Baum & Korn, 1999; Haveman & Nonnemaker, 2000; Stephan et al., 2003 Fuentelsaz & Gomez, 2006). First, when territory overlap is low, attackers can be attracted by several new territories and incumbents willing to counterattack on third territories to signal their willingness to respond mildly and/or more aggressively on the home base of the initial attacker to create a position of mutual hostages. Once initiated, this pattern of attacks and responses can escalate as long as the potential for a complete territorial overlap is not exhausted. This process of increased rivalry helps competitors observe and understand each other's competitive behavior. Second, once territorial overlap and mutual learning are high, firms are prevented from further entries in each other territories by the prospect of benefits of future escalation becoming unworthy of the risks of mutual destruction. Forbearance obtains together with recognition of stable dominant/subordinate patterns. Such a historical modeling of the competitive relation within the competitive dyad leads to hypothesize an inverted U-shaped relation between a firm's rate of entry in competitors' territories and the level of multipoint contact.

Our rationale for exits is basically symmetrical. At the outset, when multipoint contact is low, exits signaling weaknesses or subordination are rare. When the number of attacks and multipoint contacts increases, so is defense through lower prices or counter-attacks. Increasing exits by losers or incumbents willing to signal a subordinate position on selected dyads follows, eventually to call for an exchange from subordinate to dominant position on other dyads. In the process, firms increase their learning of each other competitive behavior. When reaching a moderate level of multipoint contacts, exit rates attain their maximum. Afterwards, the increase in multipoint contact does not necessarily offer the possibility to find additional exits. Firms want to show the limits of their exiting behavior and their willingness to increase their level of subordination or domination. Thus, forbearance and competitive stability follow. Accordingly, we hypothesize an inverted U shaped relation between the rate of exit of a firm from the territories of competitors and their level of multipoint contact. Hence, we suggest the following hypotheses:

Hypothesis 1*. The relationship between the rate of entry of a European airline into a competitor's territories and the level of multi-territory contact with the competitor exhibits an inverted U-shape.*

Hypothesis 2*. The relationship between a European airline rate of exit from a competitor's territories and the level of multi-territory contact with the competitor exhibits an inverted U-shape.*

Methods

Sample

We tested the inverted U-shape effects of multimarket contact on firm rates of entry to and exit from a competitor's territories over the period 2001-2006 in the context of the European airline industry. More specifically, we collected data on airlines for 11 semesters ranging from winter 2001 to winter 2006. Taking as reference point the definition provided by the International Air Transport Association (IATA), summer semester spans from the last Saturday in March to the last Saturday in October while the remaining period delimits winter semester. Accordingly, the summer semester includes seven months whereas the winter semester includes only 5 months. As our study involves several variables measured with a time-lag (t-1 and t+1), our regression models include a total of 9 periods (winter 2001 and winter 2006 semesters used to measure time-lagged variables).

The geographical scope of our study encompasses routes connecting city-pairs located within the European Union as well as Norway and Switzerland. Routes connecting cities located within the ten countries which joined the European Union on the first of January 2004 are included in our sample since winter 2001 semester because these countries have encouraged the opening of their national territories and access to their main airports by other European airlines before their entry into the European Union. This also applies to Norway and Switzerland that share a common regulatory and institutional industry framework with countries of the European Union. Moreover, to be included in our sample, flights connecting city-pairs must satisfy two conditions. First, the capacity of a flight operated by an airline must exceed 20 seats, which allows elimination of cargo, helicopters and small jets operations. Second, flight distance must be greater than 280 km, which reduces substitution effects of land transportation modes. All airports in a city are grouped under the unique name of the city.

In total, our sample included 64 airlines engaged in regular and scheduled passenger flights satisfying the above-mentioned conditions. Airlines involved mainly in charter operations as well as those operating on a small number of city-pairs (less than four routes) are excluded from the sample. Airlines which changed name over the time period under study (e.g. Olympic Airways became Olympic Airlines on

2004) are considered as the same company. Similarly, subsidiaries operating in different territories (e.g. KLM Cityhopper, KLM exel, KLM fr) are consolidated under the single name of the parent airline (e.g. KLM Royal Dutch Airlines) because important strategic decisions such as entries to and exit from routes are likely to be established and coordinated at the level of the parent airline.

Variable Definitions

Dependent variables:

Rate of entry into a competitor's markets was measured using a count variable capturing the number of new entries undertaken by airline *i* into routes served by competitor *j* at period *t*+1. Similarly, r*ate of exit from a competitor's markets* was defined as the number of exits undertaken by airline *i* from routes served by competitor *j* at period *t*+1. Data on city pair routes served by airlines for all semesters were obtained from the Official Airlines Guides (OAG) database.

Over the period under study, a total of 4154 entries into a competitor's markets and 4139 exits from a competitor's markets were recorded. The distribution of entries and exits over the 9 semesters is presented in figure 2. Figure 2 indicates that beyond macro-environmental factors related to global economic downturn, terrorist attacks, increase in oil prices and epidemics such as SARS and avian flu, which have impacted industry demand and competitive dynamics throughout the 2002-2006 period, seasonality appears also as an important driver influencing the pattern of market entries and exits[3]. More specifically, the frequency of airlines' entry into a competitor's markets is significantly higher in winter semesters than in summer semesters. In contrast, the pattern of airlines' exit from a competitor's markets looks counter-cyclical to airlines' entry to markets as the frequency of exits is significantly higher in summer semesters than in winter semesters. Given this pattern of seasonality likely to be driven by demand fluctuations with respect to the semester of the year, we are confronted with a potential confound effect. We control for this effect in our statistical models by including a dummy variable capturing semesters of the year. Out of the 4139 exits from a competitor's markets observed over the period, only four resulted into a local duopoly and none into a local monopoly.

Independent variables

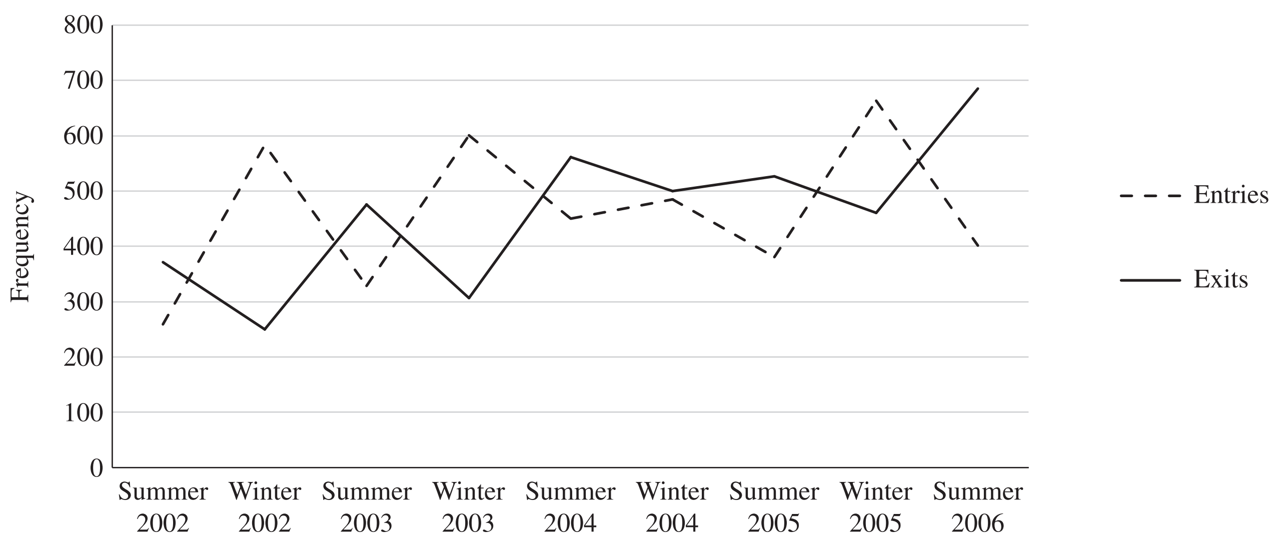
In line with previous studies measuring multimarket competition in the airline industry (Baum & Korn, 1999; Gimeno & Woo, 1996; Evans & Kessides, 1994; Bilotkach, 2011; Prince, & Simon, 2009), we adopted the following definition to operationalize the level of multimarket contact between airline *i* and competitor *j (MMCijt)*:

If airline *i* and competitor *j* compete in more than one route, then:

$$MMC_{ijt} = \frac{\sum_{m \in M_{it}} \left[C_{imt} \times \left(D_{imt} \times D_{jmt} \right) \right] + \sum_{m \in M_{jt}} \left[C_{jmt} \times \left(D_{imt} \times D_{jmt} \right) \right]}{\sum_{m \in M_{it}} D_{imt} + \sum_{m \in M_{jt}} D_{jmt}}$$

FIGURE 2

Distribution of entries to and exists from a competitor's markets over the period 2002-2006



3. The authors thank an anonymous reviewer for raising and helping clarify this point.

In contrast, if airline *i* and competitor *j* do not compete at all or compete in only one route (no multimarket competition), then $MMCijt=0$.

Where:

- *m* denotes a given route in the set of routes *Mit* and *Mjt* served by airline *i* and competitor *j* at period *t*.
- *Cimt* and *Cjmt* are the centralities of route *m* to the route networks of airlines *i* and competitor *j* at period *t*.
- D_{imt} and D_{jmt} are dummy variables equal to 1 if airlines *i* and competitor *j* compete in route m at period *t* and 0 otherwise.

Data on city-pair routes served by airline *i* and competitor *j* over the nine periods were obtained from the Official Airlines Guides (OAG) database.

Control variables

In total, we included in our regression models thirty three control variables. These variables have been shown in previous research (Baum & Korn, 1999; Gimeno & Woo, 1996; Evans & Kessides, 1994; Bilotkach, 2011; Prince, & Simon, 2009) to have intervening effects on the relationship between the two dependent variables and the level of multimarket contact between airline *i* and competitor *j*. These control variables may be clustered into eight groups.

The first group of variables controls for the impact of aggregate environmental munificence on the rate of entry to and exist from a competitor's markets. In particular, we controlled for the effects of domestic and intra-Europe demand conditions using two variables measuring domestic and intra-Europe passenger traffic (revenue passenger-kilometers in millions) undertaken by members of the Association of European Airlines (AEA) at the end of each period *t*. Data on monthly domestic and intra-Europe passenger traffic generated by members of the AEA were obtained from *Airline Business* magazine. Domestic traffic is defined in relation with the country where the airline is a registered corporation. For example, flights within Germany are domestic for Lufthansa, from Frankfort to Nice, they are intra-European. Moreover, we controlled for the effect of aggregate European airlines performance in both domestic and intra-Europe markets using load factor ratio. Load factor is defined as airline's revenue passenger miles (RPMs) expressed as a percentage of available seat miles (ASMs) offered. Data on monthly average domestic and intra-Europe load factors achieved by AEA members were obtained from *Airline Business* magazine.

The second group of variables controls for the effect of airlines' alliance agreements on the rate of their entry to and exist from contested routes. More specifically, we used two dummy variables to control for alliance effects. The first dummy variable takes a value of one if airlines *i* and *j* are both members of SkyTeam or OneWorld or Star alliance constellations at period *t* and zero otherwise. Joint membership in one of these alliance constellations indicates that airlines *i* and *j* are involved in a strong web of alliances pertaining to code sharing agreements, insurance and parts pooling, facilities sharing, joint ground handling, maintenance, joint marketing, schedule coordination, frequent flyer plans, computer reservation systems, management contracts and equity ownership. The second dummy variable equals one if airlines *i* and *j* have only a codeshare agreement on at least one route at period *t* and zero otherwise. Accordingly, this second variable captures the effect of weak ties as opposed to the first variable which proxies airlines' joint involvement in strong and comprehensive alliance agreements. Data on strategic alliances were obtained from annual surveys published by *Airline Business* magazine.

The third group of variables controls for some of airline's characteristics such as age, size, international focus, country of origin and number of rivals. The fourth group of variables takes into consideration past competitive behavior of airlines (entries and exits) in period t-1. The fifth group of variables measures relative size, relative routes dominance and relative multi-market contacts between airline *i* and competitor *j*. The sixth cluster of variables captures the extent of competition, size and density of routes served and not served by airline *i*. The seventh group of variables considers the competitive behavior of airline *i* (entries and exits) in other competitors' routes as well as the competitive behavior of other competitors' in airline *i* routes. Finally, we controlled for seasonality using a dummy variable taking a value of 1 if period *t* is summer semester and 0 if period *t* is winter semester. Definitions as well as correlations and descriptive statistics of all these variables are presented in table 1 and 2 respectively.

Analysis and Results

Given the nature of our two dependent variables (1) airline's rate of entry into a competitor's routes and (2) airline's rate of exit from a competitor's routes, we used negative binomial regression models to test our two hypotheses. This technique is suitable for estimating models predicting the number of discrete occurrences of some events, in this case, entries to and exits from focal routes. Negative binomial regressions were preferred over poisson regressions because they correct for overdispersion, that is, when data variance exceeds the mean (Barron, 1992). The examination of the distribution of count measures in our data revealed the presence of overdispersion (at $p < .05$), which justified the need to use binomial regression models. In addition we used White's (1980) heteroscedasticity adjusted standard errors (robust standard errors) to correct for heteroscedastic residuals. Data analysis is based on 4154 market entries (5454 competitor-dyad-semesters) and 4139 market exits (5464 competitor-dyad-semesters).

Tables 3 and 4 report unstandardized negative binomial regression coefficients, robust standard errors and incidence

TABLE 1

Definitions of all variables included in the empirical analysis

Variables	Definitions
Rate of entry into a competitor's markets	Number of entries undertaken by airline *i* into routes served by competitor *j* at period *t*+1
Rate of exit from a competitor's markets	Number of exits undertaken by airline *i* from routes served by competitor *j* at period *t*+1
Domestic passenger traffic (RPK)	Total domestic passenger traffic (revenue passenger-kilometres in millions) undertaken by members of the Association of European Airlines (AEA) at the end of period *t*.
Intra-Europe passenger traffic (RPK)	Total intra-Europe passenger traffic (revenue passenger-kilometres in millions) undertaken by members of the Association of European Airlines (AEA) at the end of period *t*.
Domestic load factors	Domestic revenue passenger miles (RPMs) expressed as a percentage of available domestic seat miles (ASMs) achieved by members of the Association of European Airlines (AEA) at the end of period *t*.
Intra-Europe load factors	Intra-Europe revenue passenger miles (RPMs) expressed as a percentage of available intra-Europe seat miles (ASMs) achieved by members of the Association of European Airlines (AEA) at the end of period *t*.
Constellation co-membership	Dummy variable equals one if airlines *i* and *j* are both members of SkyTeam or OneWorld or Star alliance constellations at period *t* and zero otherwise.
Codeshare agreement	Dummy variable equals one if airlines *i* and *j* have a codeshare agreement on at least one route at period *t* and zero otherwise.
Airline *i*'s age	The chronological age of airline *i* since its founding at period *t*
Competitor *j*'s age	Thechronological age of competitor *j* since its founding at period *t*
Log airline *i*'s size	Logged available seat miles flown by airline *i* during period *t*
Log competitor *j*'s size	Logged available seat miles flown by competitor *j* during period *t*
Airline *i*'s international focus	Number of routes serving a city outside of airlines *i* home country at period t / Total number of routesserved by airline *i* at period *t*
Competitor *j*'s international focus	Number of routes serving a city outside of competitor *j* home country at period t /number of routes served by competitor *j* at period *t*
Airlines *i* and *j* country of origin	Dummy variable taking a value of 1 if airline *i* and competitor *j* belong to the same country of origin and 0 otherwise
Airline *i*'s number of rivals	Total number of rival firms competing on routes served by airline *i* during period *t*
Competitor *j*'s number of rivals	Total number of rival firms competing on routes served by airline *j* during period *t*

Variables	Definitions
Airline *i*'s entries into *j's* markets	Total number of entries undertaken by airline *i* into routes served by competitor *j* during period *t*-1
Airline *i*'s exits from *j's* markets	Total number of exits undertaken by airline *i* from routes served by competitor *j* during period *t*-1
Competitor *j*'s entries into *i's* markets	Total number of entries undertaken by competitor *j* into routes served by airline *i* during period *t*-1
Competitor *j*'s exits from *i's* markets	Total number of exits undertaken by competitor *j* from routes served by airline *i* during period *t*-1
Airlines *i*'s route dominance over *j*	Percentage of routes on which airline *i* meets competitor *j* and in which airline *i* is dominant (has the largest share) during period *t*
(Size competitor *j* / Size airline *i*)	Available seat miles flown by airline *i* / available seat miles flown by competitor *j* during period *t*
Number of competitor *j*'s routes not served by *i*	Total number of routes served by competitor *j* that are not served by airline *i* during period *t*
Log Avg. capacity of *j*'s routes not served by *i*	Logged average available seat miles flown by competitor *j* in routes not served by airline *i* during period *t*
Avg. route density of *j*'s routes not served by *i*	Average number of rivals competing on routes served by competitor *j* and not served by airline *i* during period *t*
Number of competitor *j*'s routes served by *i*	Number of routes served by both airline *i and* competitor *j* during period *t*
Log Avg. capacity of *j*'s routes served by *i*	Logged average available seat miles flown by competitor *j* in routes served by airline *i* during period *t*
Avg. route density of *j*'s routes served by *i*	Average number of rivals competing on routes served by both competitor *j* and airline *i* during period *t*
i's entries into other competitor' markets	Number of entries undertaken by airline *i* into markets served by competitors other than *j* during period *t*
i's exits from other competitor' markets	Number of exits undertaken by airline *i* from markets served by competitors other than *j* during period *t*
Other competitor' entries into *i*'s markets	Number of entries undertaken by competitors other than *j* into markets served by airline *i* during period *t*
Other competitor' exits from *i*'s markets	Number of exits undertaken by competitors other than *j* from markets served by airline *i* during period *t*
Multimarket contact between airline *i* and competitor *j* (*MMCij)*	If airline *i* and competitor *j* compete in more than one route, $$MMC_{ij} = \frac{\sum_{Mit}\left[C_{imt}\times\left(D_{imt}\times D_{jmt}\right)\right]+\sum_{Mjt}\left[C_{jmt}\times\left(D_{imt}\times D_{jmt}\right)\right]}{M_{it}+M_{jt}}$$ Otherwise, $MMC_{ij} = 0$ Where: m denotes a given route in the set of routes M_{it} and M_{jt} served by airline *i* and competitor *j* during period *t* C_{im} and C_{jmt} are the centralities of route m to the route networks of airlines *i* and competitor *j* during period *t* D_{imt} and D_{jmt} are dummy variables equal to 1 if airlines *i* and competitor *j* compete in route m during period *t* and 0 otherwise
(MMC*ij)*²	(Multimarket contact between airline *i* and competitor *j*) squared
MMC*ij/* Avg. MMCi competitors other than *j*	Multimarket contact between airline *i* and competitor *j* / average multimarket contact airline *i* has with other competitors than *j* at period *t*
Seasonality	Dummy variable taking a value of 1 if period *t* is summer semester and 0 if period *t* is winter semester

TABLE 2

Descriptive statistics and correlations

Variables	Mean	S.D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Rate of entry into a competitor's markets	0.76	2.56	1.00																	
2. Rate of exit from a competitor's markets	0.76	2.57	0.34	1.00																
3. Domestic passenger traffic (RPK)	4590	275	-0.05	0.05	1.00															
4. Intra-Europe passenger traffic (RPK)	12685	1292	-0.05	0.05	0.92	1.00														
5. Domestic load factors	66.56	1.54	-0.04	0.03	0.59	0.65	1.00													
6. Intra-Europe load factors	67.24	3.00	-0.05	0.04	0.73	0.88	0.84	1.00												
7. Constellation co-membership	0.06	0.24	-0.06	-0.06	0.02	0.03	0.01	0.02	1.00											
8. Codeshare agreement	0.15	0.36	-0.11	-0.10	-0.02	-0.02	0.01	-0.01	0.60	1.00										
9. Airline *i*'s age	49.31	26.74	-0.14	-0.09	-0.01	0.00	-0.01	-0.01	0.18	0.23	1.00									
10. Competitor *j*'s age	49.31	26.74	0.00	-0.04	-0.01	0.00	-0.01	-0.01	0.18	0.23	-0.01	1.00								
11. Ln airline *i*'s size	15.30	1.33	-0.06	-0.05	0.16	0.16	0.15	0.15	0.12	0.06	0.52	-0.08	1.00							
12. Ln competitor *j*'s size	15.30	1.33	0.05	0.06	0.16	0.16	0.15	0.15	0.12	0.06	-0.08	0.52	-0.08	1.00						
13. Airline *i*'s international focus	0.78	0.25	0.01	0.00	0.04	0.05	0.01	0.04	0.01	0.08	0.15	0.09	-0.05	0.03	1.00					
14. Competitor *j*'s international focus	0.78	0.25	-0.05	0.00	0.04	0.05	0.00	0.04	0.01	0.08	0.09	0.15	0.03	-0.06	0.16	1.00				
15. Airlines *i* and *j* country of origin	0.19	0.39	0.36	0.34	-0.01	-0.02	0.00	-0.02	-0.12	-0.18	-0.24	-0.24	-0.16	-0.16	-0.25	-0.25	1.00			
16. Airline *i*'s number of rivals	22.48	11.75	-0.08	-0.08	0.10	0.12	-0.01	0.06	0.12	0.06	0.54	-0.07	0.86	-0.13	0.06	0.06	-0.19	1.00		
17. Competitor *j*'s number of rivals	22.48	11.75	0.04	0.01	0.10	0.12	-0.01	0.06	0.12	0.06	-0.07	0.54	-0.13	0.86	0.05	0.06	-0.19	-0.13	1.00	
18. Airlines *i*'s *entries into j's markets*	0.78	2.59	0.40	0.72	0.05	0.05	0.05	0.05	-0.06	-0.11	-0.15	0.00	-0.02	0.09	0.01	-0.03	0.35	-0.07	0.04	1.00

Variables	Mean	S.D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
19.Competitor *j*'s entries into *i*'s markets	0.78	2.59	0.24	0.47	0.05	0.05	0.05	0.05	-0.06	-0.10	0.00	-0.14	0.09	-0.02	-0.03	0.01	0.35	0.04	-0.07	0.37
20.Airlines *i*'s exits from *j's markets*	0.64	2.43	0.68	0.40	-0.03	-0.02	-0.03	-0.02	-0.05	-0.09	-0.07	-0.04	-0.09	0.03	-0.01	-0.04	0.33	-0.09	0.01	0.32
21.Competitor *j*'s exits from *i*'s markets	0.64	2.43	0.37	0.28	-0.03	-0.03	-0.04	-0.02	-0.05	-0.09	-0.04	-0.06	0.03	-0.07	-0.03	0.00	0.33	0.01	-0.08	0.25
22.Airlines *i*'s route dominance over *j*	49.71	44.37	-0.02	-0.03	0.00	0.00	0.00	0.00	0.00	-0.01	-0.09	0.09	-0.28	0.29	0.06	-0.07	0.00	-0.24	0.25	-0.04
23.(Size competitor *j* / Size airline *i*)	6.32	30.37	0.04	0.01	0.00	0.00	-0.02	-0.01	-0.02	-0.04	-0.19	0.09	-0.39	0.17	-0.08	-0.02	0.05	-0.24	0.18	-0.02
24.Nb of competitor *j*'s routes not served by *i*	163.89	128.38	0.07	0.09	0.14	0.15	0.07	0.11	0.09	0.00	-0.10	0.37	-0.10	0.81	0.01	0.05	-0.12	-0.12	0.78	0.09
25.Ln Avg. capacity of *j*'s routes not served by *i*	11.27	0.68	-0.04	-0.09	0.15	0.15	0.17	0.14	0.04	-0.01	-0.08	0.18	-0.09	0.63	-0.01	-0.24	-0.16	-0.14	0.54	-0.06
26.Av. route density of *j*'s routes not served by *i*	1.94	0.44	0.01	0.00	0.02	0.04	-0.05	0.00	-0.03	-0.09	-0.09	-0.08	-0.08	0.15	-0.08	-0.17	0.03	-0.09	0.24	0.00
27.Nb of competitor *j*'s routes served by *i*	8.96	17.75	0.44	0.70	0.04	0.04	0.04	0.04	-0.05	-0.11	-0.06	-0.06	0.09	0.09	-0.01	0.00	0.44	0.03	0.03	0.69
28.Ln Avg. capacity of *j*'s routes served by *i*	11.83	0.95	0.02	-0.03	0.14	0.13	0.17	0.14	0.01	-0.05	-0.03	-0.02	0.24	0.25	-0.18	-0.17	0.19	0.17	0.17	0.02
29.Av. route density of *j*'s routes served by *i*	3.11	0.98	0.11	0.10	0.03	0.04	0.01	0.02	-0.07	-0.14	-0.22	-0.21	-0.01	0.00	-0.18	-0.18	0.25	0.00	0.01	0.10
30.*i*'s entries into other competitor' markets	9.55	14.92	0.27	0.30	0.14	0.16	0.10	0.13	-0.05	-0.14	-0.16	-0.12	0.24	-0.03	0.09	-0.08	0.16	0.22	-0.06	0.36
31.*i*'s exits from other competitor' markets	9.39	16.84	0.29	0.28	0.04	0.03	-0.04	0.01	-0.03	-0.09	0.04	-0.11	0.08	-0.06	0.00	-0.07	0.17	0.11	-0.07	0.22
32.Other competitor' entries into *i*'s markets	13.17	17.27	0.06	0.13	0.10	0.11	0.07	0.09	0.09	-0.01	0.30	-0.09	0.53	-0.08	-0.01	0.00	0.02	0.54	-0.10	0.11
33.Other competitor' exits from *i*'s markets	12.35	15.01	0.14	0.10	0.04	0.05	-0.05	0.03	0.06	-0.05	0.16	-0.10	0.44	-0.08	-0.04	-0.01	0.04	0.46	-0.09	0.10
34.MMC*ij*/ Avg. MMCi competitors other than *j*	0.93	1.96	0.21	0.25	0.03	0.03	0.02	0.02	-0.05	-0.10	-0.08	-0.13	0.04	-0.04	-0.07	-0.10	0.42	0.01	-0.08	0.28
35.MMC*ij x* 100	1.84	3.62	0.26	0.27	-0.01	-0.01	-0.01	-0.01	-0.07	-0.10	-0.15	-0.15	-0.07	-0.07	-0.15	-0.15	0.50	-0.10	-0.10	0.31
36.$(MMC_{ij})^2 \times 100$	0.17	0.74	0.13	0.13	0.01	0.01	0.00	0.00	-0.05	-0.05	-0.12	-0.11	-0.09	-0.09	-0.10	-0.10	0.36	-0.11	-0.11	0.16
37. Seasonality	0.55	0.49	-0.07	0.05	0.71	0.68	0.78	0.70	0.01	0.00	-0.01	-0.01	0.18	0.19	0.01	0.02	0.01	0.02	0.02	0.06

Variables	**Mean**	**S.D**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**
19. Competitor *j*'s entries into *i's* markets	0.78	2.59	1.00																	
20. Airlines *i*'s exits from *j's* markets	0.64	2.43	0.25	1.00																
21. Competitor *j*'s exits from *i's* markets	0.64	2.43	0.33	0.45	1.00															
22. Airlines *i*'s route dominance over *j*	49.71	44.37	0.04	-0.01	0.01	1.00														
23. (Size competitor *j* / Size airline *i*)	6.32	30.37	-0.04	0.12	-0.04	0.14	1.00													
24. Nb of competitor *j*'s routes not served by *i*	163.89	128.38	0.04	0.05	0.00	0.36	0.17	1.00												
25. Ln Avg. capacity of *j*'s routes not served by *i*	11.27	0.68	-0.17	-0.05	-0.16	0.16	0.11	0.31	1.00											
26. Av. route density of *j*'s routes not served by *i*	1.94	0.44	0.03	0.02	0.06	0.11	0.03	0.04	0.59	1.00										
27. Nb of competitor *j*'s routes served by *i*	8.96	17.75	0.69	0.42	0.43	0.00	-0.05	0.10	-0.14	-0.03	1.00									
28. Ln Avg. capacity of *j*'s routes served by *i*	11.83	0.95	0.01	0.00	-0.01	0.01	0.02	0.14	0.31	0.10	0.04	1.00								
29. Av. route density of *j*'s routes served by *i*	3.11	0.98	0.10	0.11	0.10	0.01	0.02	0.02	0.16	0.29	0.08	0.63	1.00							
30. *i*'s entries into other competitor' markets	9.55	14.92	0.21	0.23	0.18	-0.24	-0.09	-0.03	-0.01	0.05	0.30	0.07	0.22	1.00						
31. *i*'s exits from other competitor' markets	9.39	16.84	0.14	0.43	0.23	-0.14	0.01	-0.04	-0.05	0.05	0.22	0.01	0.17	0.36	1.00					
32. Other competitor' entries into *i*'s markets	13.17	17.27	0.18	0.07	0.08	-0.30	-0.13	-0.08	-0.09	-0.03	0.17	0.03	0.04	0.44	0.26	1.00				
33. Other competitor' exits from i's markets	12.35	15.01	0.10	0.16	0.19	-0.26	-0.12	-0.08	-0.09	0.02	0.13	0.02	0.05	0.37	0.44	0.59	1.00			
34. MMCij/ Avg. MMCi competitors other than j	0.93	1.96	0.33	0.18	0.21	-0.02	-0.06	-0.13	-0.13	-0.04	0.50	0.09	0.01	0.06	0.03	0.01	0.04	1.00		
35. MMCij x 100	1.84	3.62	0.31	0.23	0.23	0.00	-0.05	-0.15	-0.11	-0.02	0.47	0.10	0.06	0.02	0.04	-0.05	-0.01	0.88	1.00	
36. $(MMCij)^2$ x 100	0.17	0.74	0.16	0.11	0.12	0.00	-0.03	-0.15	-0.11	-0.05	0.27	0.04	0.01	-0.03	-0.01	-0.08	-0.05	0.81	0.89	1.00
37. Seasonality	0.55	0.49	0.06	-0.04	-0.05	0.00	0.00	0.10	0.21	-0.04	0.05	0.20	0.01	0.11	-0.06	0.08	-0.04	0.02	-0.01	0.01

N= 5464

Due to the pooled nature of the sample, correlations tend to be overstated. Correlations greater than 0.03 are significant at $p < 0.05$.

rate ratios obtained by exponentiating regression coefficients. Models 1 and 3, the baselines, includes all controls variables pertaining to demand, load factors, alliances, airlines' age, size, international focus, country of origin, number of rivals, number of past entries and exits, route dominance, characteristics of routes served and available to be served, competitor's relative size, multimarket contact with other competitors and seasonality. Models 1 and 3 indicate that several control variables have statistically significant impacts on airline's rate of entry into and exit from a competitor's markets. In particular, airline *i* rates of entry into and exit from a competitor's *j* route are lower if both airlines *i* and *j* are partners in codeshare agreements (beta = -0.545; p<0.01 for entry; beta = -0.404; p<0.05 for exit). This result suggests that strategic alliances mitigate the extent of competitive entries and exits in the industry. Similarly, models 1 and 3 suggest that the older the airline *i* the lower its rates of entry into and exit from routes served by competitor *j* (beta = -0.017; p<0.001 for entry; beta = -0.005; p<0.05 for exit). This result suggests that airline aging is associated with some inertia in terms of rates of entries and exits. In contrast, airline size seems to have opposite effects on the rates of entry and exit. Indeed, the larger the airline *i* the higher its entry rate into routes served by competitor *j* (beta = 0.282; p<0.001). On the contrary, the larger the airline *i* the lower its exit rate from routes served by competitor *j* (beta = -0.333; p<0.001). This result indicate that large airlines, which have superior access to resources, are able to initiate an extended scope of attacks (more entries) and are better able to defend their positions (less exits). Models 1 and 2 also indicate that airlines' international focus has significant effects on entry and exit rates. More specifically, the larger competitor *j* international focus the lower airline *i* entry rate into routes served by competitor *j* (beta =-0.438; p<0.05). Furthermore, the larger airline *i* international focus the lower its exit rate from routes served by competitor *j* (beta = -0.921; p<0.001). Interestingly, models 1 and 2 suggest that rates of entry are higher if airlines *i* and *j* belong to the same country of origin (beta = 1.142; p<0.001) while co-nationality does not impact significantly rates of exit. Moreover, models 1 and 2 suggest that competitive attacks initiated at period *t*-1 trigger several counter-attacks at subsequent period *t*. For instance, the larger the number of entries undertaken by competitor *j* into routes served by airline *i* at period *t*-1*,* the larger airline *i* rate of entry into routes served by competitor *j* at period *t* (beta = 0.029; p<0.05). In addition, models 1 and 2 indicate that airline's route dominance mitigates the extent of subsequent entry and exit. Indeed, the higher the percentage of routes on which airline *i* meets competitor *j* and in which airline *i* is dominant (has the largest share) at period *t* the lower airline *i* rates of entry to and exit from routes served by competitor *j* (beta = -0.004; p<0.001 for entry; beta = -0.005; p<0.001 for exit). Moreover, the higher relative multimarket contact, defined as multimarket contact between airline *i* and

TABLE 3

Negative binomial regressions testing the inverted U relationship linking firm's rate of entry into a competitor's markets and the level of multimarket contact with the competitor.

	Dependent variable: airline's rate of entry into a competitor's routes					
Variables	**Model 1**			**Model 2**		
	Coeff.	**Robust S.E**	**IRR**	**Coeff.**	**Robust S.E**	**IRR**
Intercept	-10.966***	3.657	0.001	-11.233***	3.598	0.001
Domestic passenger traffic (RPK)	-0.001	0.001	0.999	-0.001	0.001	0.999
Intra-Europe passenger traffic (RPK)	0.001	0.001	1.000	0.001	0.001	1.000
Domestic load factors	0.118	0.068	1.125	0.113	0.068	1.120
Intra-Europe load factors	-0.043	0.053	0.958	-0.033	0.053	0.967
Constellation co-membership	-0.054	0.297	0.948	-0.111	0.297	0.895
Codeshare agreement	-0.545**	0.201	0.580	-0.486**	0.201	0.615
Airline *i*'s age	-0.017***	0.002	0.983	-0.017***	0.002	0.983
Competitor *j*'s age	0.001	0.002	1.000	0.001	0.002	1.001
Ln airline *i*'s size	0.282***	0.079	1.325	0.272***	0.081	1.313
Ln competitor *j*'s size	0.199	0.128	1.220	0.139	0.122	1.150

	Dependent variable: airline's rate of entry into a competitor's routes					
Variables	**Model 1**			**Model 2**		
	Coeff.	**Robust S.E**	**IRR**	**Coeff.**	**Robust S.E**	**IRR**
Airline *i*'s international focus	0.337	0.185	1.401	0.443*	0.186	1.558
Competitor *j*'s international focus	-0.438*	0.177	0.645	-0.435*	0.178	0.647
Airlines *i* and *j* country of origin	1.129***	0.122	3.094	1.003***	0.124	2.726
Airline *i*'s number of rivals	0.001	0.008	1.001	0.001	0.008	1.001
Competitor *j*'s number of rivals	0.014	0.008	1.014	0.010	0.008	1.010
Airlines *i*'s *entries into j's markets*	0.064***	0.014	1.066	0.048***	0.014	1.049
Competitor *j*'s *entries into i's markets*	0.029*	0.014	1.030	0.017	0.014	1.018
Airlines *i*'s exits from *j's markets*	0.216***	0.020	1.242	0.205***	0.020	1.228
Competitor *j*'s exits from *i's markets*	-0.017	0.015	0.983	-0.029*	0.014	0.972
Airlines *i*'s route dominance over *j*	-0.004***	0.001	0.996	-0.004***	0.001	0.996
(Size competitor *j* / Size airline *i*)	-0.001	0.001	0.999	0.001	0.001	1.000
Nb of competitor *j*'s routes not served by *i*	0.001	0.001	1.000	0.001	0.001	1.001
Ln Avg. capacity of *j*'s routes not served by *i*	0.027	0.144	1.028	0.053	0.140	1.055
Av. route density of *j*'s routes not served by *i*	-0.225	0.129	0.799	-0.210	0.128	0.811
i's entries into other competitor' markets	0.015***	0.004	1.015	0.015***	0.004	1.015
i's exits from other competitor' markets	0.003	0.003	1.003	0.004	0.003	1.004
Other competitor' entries into *i*'s markets	-0.005	0.003	0.995	-0.004	0.003	0.996
Other competitor' exits from *i*'s markets	0.002	0.004	1.002	0.002	0.004	1.002
MMC*ij*/ Avg. MMCi competitors other than *j*	0.106***	0.029	1.111	0.042	0.036	1.043
Seasonality	-0.810***	0.173	0.445	-0.797***	0.170	0.451
MMC*ij x* 100				0.174***	0.034	1.190
(MMC*ij)*² *x* 100				-0.670***	0.132	0.512
Pearson Chi²	1269.59***			1354.88***		
Log likelihood	-4048.13			-4031.14		
Sample size (N)	5454			5454		

Table 3 reports unstandardized negative binomial regression coefficients, robust standard errors and incidence rate ratios (IRR)
Significance levels: *** $p<0.001$; ** $p<0.01$; * $p<0.05$
The sample includes 4154 market entries and 5454 competitor-dyad-semesters.

TABLE 4

Negative binomial regressions testing the inverted U relationship linking firm's rate of exit from a competitor's markets and the level of multimarket contact with the competitor

Variables	Dependent variable: airline's rate of entry into a competitor's routes					
	Model 3			Model 4		
	Coeff.	Robust S.E	IRR	Coeff.	Robust S.E	IRR
Intercept	6.605*	3.059	738.588	6.221*	3.100	503.362
Domestic passenger traffic (RPK)	0.001	0.001	1.001	0.001	0.001	1.001
Intra-Europe passenger traffic (RPK)	0.001	0.001	1.000	0.001	0.001	1.000
Domestic load factors	-0.070	0.063	0.933	-0.071	0.063	0.932
Intra-Europe load factors	-0.035	0.049	0.966	-0.039	0.049	0.961
Constellation co-membership	0.090	0.282	1.094	0.045	0.281	1.047
Codeshare agreement	-0.404*	0.191	0.668	-0.353	0.191	0.703
Airline *i*'s age	-0.005*	0.002	0.995	-0.004*	0.002	0.996
Competitor *j*'s age	-0.006***	0.002	0.994	-0.006***	0.002	0.994
Ln airline *i*'s size	-0.333***	0.067	0.717	-0.300***	0.070	0.741
Ln competitor *j*'s size	0.252***	0.071	1.287	0.287***	0.077	1.332
Airline *i*'s international focus	-0.921***	0.155	0.398	-0.792***	0.159	0.453
Competitor *j*'s international focus	-0.069	0.158	0.933	0.100	0.171	1.105
Airlines *i* and *j* country of origin	0.210	0.112	1.234	0.186	0.112	1.204
Airline *i*'s number of rivals	0.030***	0.007	1.031	0.029***	0.007	1.030
Competitor *j*'s number of rivals	0.009	0.007	1.009	0.008	0.007	1.008
Airlines *i*'s *entries into j's markets*	0.168***	0.016	1.183	0.160***	0.015	1.173
Competitor *j*'s *entries into i's markets*	0.067***	0.017	1.070	0.063***	0.017	1.065
Airlines *i*'s exits from *j's markets*	0.037***	0.011	1.038	0.030**	0.010	1.031
Competitor *j*'s exits from *i's markets*	-0.008	0.014	0.992	-0.009	0.013	0.991
Airlines *i*'s route dominance over *j*	-0.005***	0.001	0.995	-0.005***	0.001	0.995
(Size competitor *j* / Size airline *i*)	-0.001	0.001	0.999	0.001	0.001	1.000
Nb of competitor *j*'s routes not served by *i*	0.007	0.004	1.007	-0.002	0.003	0.998
Ln Avg. capacity of *j*'s routes not served by *i*	-0.293***	0.066	0.746	-0.377***	0.069	0.686
Av. route density of *j*'s routes not served by *i*	0.270***	0.055	1.311	0.325***	0.056	1.384
i's entries into other competitor' markets	0.005*	0.003	1.005	0.006**	0.003	1.007
i's exits from other competitor' markets	0.009***	0.002	1.009	0.009***	0.002	1.009
Other competitor' entries into *i*'s markets	0.010***	0.003	1.010	0.011***	0.003	1.011
Other competitor' exits from *i*'s markets	-0.007*	0.003	0.993	-0.006**	0.003	0.994
MMC*ij*/ Avg. MMCi competitors other than *j*	0.177***	0.030	1.194	0.136***	0.037	1.146
Seasonality	0.215	0.150	1.240	0.259	0.153	1.296
MMC*ij x* 100				0.213***	0.026	1.237
(MMC*ij*)² *x* 100				-0.871***	0.103	0.418
Pearson Chi²	-4213.88***			-4181.00***		
Log likelihood	1473.05			1847.25		
Sample size (N)	5464			5654		

Table 4 reports unstandardized negative binomial regression coefficients, robust standard errors and incidence rate ratios (IRR)
Significance levels: *** p<0.001; ** p<0.01; * p<0.05
The sample includes 4139 market exits and 5464 competitor-dyad-semesters.

competitor *j* divided by average multimarket contact airline *i* has with other competitors than *j*, the higher airline *i* rates of entry to and exit from routes served by competitor *j* (beta = 0.106; $p<0.001$ for entry; beta = 0.177; $p<0.001$ for exit). Finally, rates of entry into routes served by competitors are significantly lower in summer semesters than in winter semesters (beta = -0.810; $p<0.001$).

Model 2 provides a test for the U-inverted shape relationship between the level of multi-market contact and airline's rate of entry into a competitor's routes. This test is accomplished by including in the model the variable measuring the level of multi-market contact between airlines *i* and *j* (MMC*ij x* 100) and the squared value of this variable. Results presented in model 2 do provide support for such a curvilinear relationship since the coefficient for the squared term is statistically significant at $p<0.001$. Indeed, the coefficient for variable "MMC*ij x* 100" is positive (beta= 0.174) and statistically significant at $p<0.001$ while the coefficient for the squared term "$(MMCij)^2$ x 100" is negative (beta= -0.670) and statistically significant at $p<0.001$. Moreover, the two goodness of fit indicators Pearson Chi² and Log Likelihood improved significantly after including the linear and quadratic forms of the variable "MMC*ij x* 100". Thus, hypothesis 1 is supported.

Model 4 illustrates the results of negative binomial regression testing the U-inverted shape relationship between airline's rate of exit from a competitor's routes and the level of multi-market contact with the competitor. Again, our findings do provide support for the U inverted shape relationship as the coefficient for variable "MMC*ij x* 100" is positive (beta =0.213) and statistically significant at $p<0.001$ while the coefficient for the squared term "$(MMCij)^2$ *x* 100" is negative (beta= -0.871) and statistically significant at $p<0.001$. Moreover, the two goodness of fit indicators Pearson Chi² and Log Likelihood were enhanced significantly after including the linear and quadratic forms of the variable "MMC*ij x* 100". Hence, hypothesis 2 is supported.

Figure 3 presents graphically the relationships between multimarket contact and rates of entry to and exit from competitor's markets suggested in hypotheses 1 and 2. The two curves indicate that inflection points for both entry and exit occur at relatively low levels of multimarket contact (MMC*ijt* = 0.129 for entry and MMC*ijt* = 0.122 for exit) [4]. That is, the effect of multimarket contact on airline *i*'s rates of entry to a competitor's *j* market is positive when multimarket contact between airlines *i* and *j* ranges from 0 to 0.129. Beyond this level, any increases in multimarket contact reduce the rates of market entry. Similarly, any increases in multimarket contact further than 0.122 reverse the sign of the effect and decrease the rates of exit from a competitor's market. This finding suggesting that mutual forbearance behavior, which results from multimarket contact in the European airline industry, is triggered at low levels of multimarket contacts is interesting. Several industry-specific characteristics may explain this finding. For instance, the gradual saturation of major European airports and the unavailability of timeslots reduce the scope of competitive dynamics in the industry, which in turn may lead to rapid establishment of mutual forbearance behavior[5]. Moreover, as the airline industry is capital intensive, there is little incentive for airlines to relocate operations in competitor's hub airport. The resulting "hold up effect" as well as airline hub domination may provide an additional explanation for the occurrence of mutual forbearance behavior at low levels of multimarket contact. Finally, familiarity between European airlines ensuing from long history of competitive interactions (i.e. average airline age in our sample is 49.31 years) increases mutual dependence recognition, and as a result, may triggers mutual forbearance dynamics at low levels of multimarket contact.

Discussion & Conclusion

The empirical findings presented in our study provide support for the inverted u-shaped relation between the degree of multi-territory contact and the level of rivalry and forbearance in the context of the European airline industry. Our study also points to significant seasonal and alliance mitigating effects. These results are in line with previous studies, most notably, Baum and Korn (1996, 1999) studies. However, it does not follow that such conclusions can be generalized to other areas of the world, across time or industries. Further research with a wider scope would be required in order to draw such conclusions. Comparing our results with previous empirical work on non-European airlines such as Baum and Korn (1996; 1999), Gimeno and Woo, (1996), Miller (2010), Prince and Simon (2009), Zhang and Round (2009), Bilotkach, (2011) and Singal (1996) naturally raises difficult obstacles. Indeed, beyond the fact that only Baum and Korn (1999) and our study theorized and tested a curvilinear relationship between multimarket contact and rivalry in the airline industry, other obstacles to generalization relate primarily to (1) the choice of time periods studied and differences in institutional environments, (2) stages in the competitive life cycle (3), maturity of strategic groups (4) differences in propensities to enter into alliances and (5) Competition for timeslots. We assess each of these five dimensions in the following sections.

1. Choice of periods and differences in institutional environments:

Replicating other studies during the same period as the one considered in this paper may seem to be the right choice at first glance. For instance, Baum and Korn (1996, 1999) reported empirical findings in the context of California

4. The authors thank an anonymous reviewer for raising and helping clarify this point.

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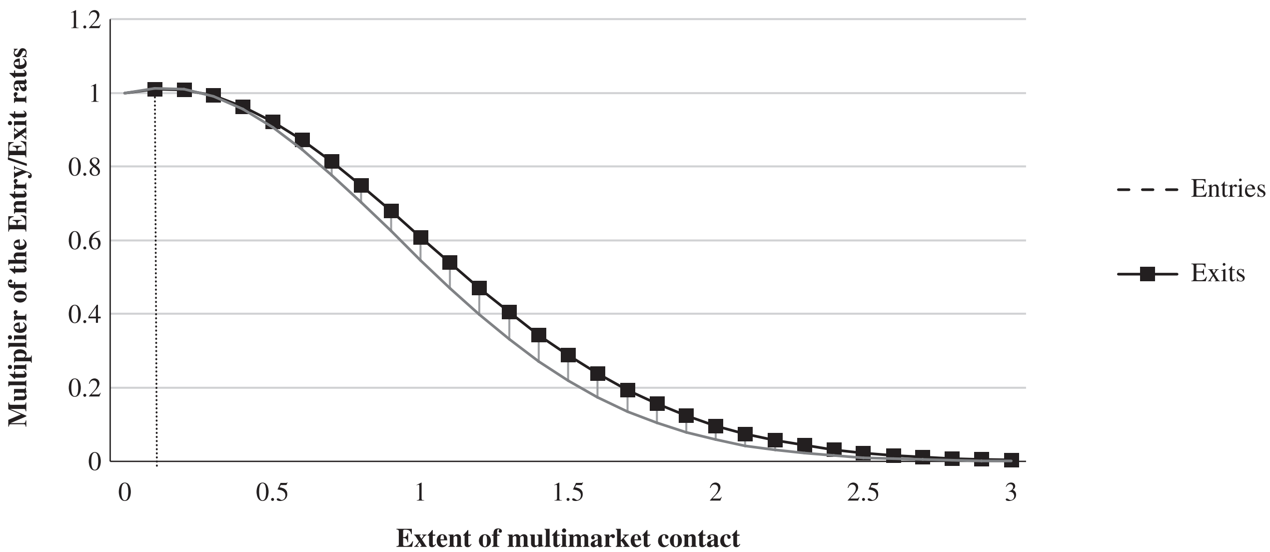
FIGURE 3

The effects of multimarket contact on airline i's rates of entry to and exit from a competitor's market



commuter airlines for the period 1979-1984. Unfortunately, a quantitative comparison between empirical findings is not possible because the OAG data base for Europe is not available for the same period in other regions of the world, Asia, Africa, Latin America and the Middle East in particular. Even if the data for both sets of airlines were collected during the same period, it would not provide identical rules of the game (North, 1990) on both sides because informal and formal Institutions were and are still quite different. Liberalization started in Europe in 1987 instead of 1978 in the USA. Selecting the period 1988-1993 for Europe could pick up similar initial influences of deregulation on increased rivalry under the condition that institutional changes had identical impacts on both sides. Such is not the case as European changes were slower, took much longer and were never identical to American ones. The time lags and institutional differences are such that selecting periods with identical conditions of institutional changes and their corresponding implications for territorial overlaps is hardly possible.

An explanation of a possibly higher magnitude of forbearance between European airlines compared to American carriers based on Institutional differences requires extra caution. The distinction between the influence of formal and informal Institutions needs a thorough explanation. Most of the theory of multipoint competition rests on the initial assumptions of rationality made by Edwards (1955). The outcome of calculus involving the positioning on competitors territories for deterrence purposes will not be the same with different formal rules of the game. A comparison of the "Baby-sitting" rule on both sides of the Atlantic provides a good example. Once awarded, the timeslot on an air route between two cities has to be used by the benefiting airline, at least a minimum of the time. Otherwise, it could take advantage of the timeslot to keep competitors away without providing service to customers. The legal minimum, as measured by the percentage of the number of potential yearly flights required is called "baby sitting". At 25% of the time in the U.S. of America, it is less costly and difficult to defend them than for 75% of the time in Europe. The defending airline would be more likely to retaliate in the latter case due to higher sunk and operating costs. Aware of such a situation the potential attacker of the territory of a Baby-sitting incumbent would have lower incentives to do so in case of the 75% rule and ceteris paribus his level of forbearance would be higher. The difference above may explain why airlines have higher incentives to trade slots in the US of America than in Europe. They have more to trade than in Europe. Thus the "grey" Market in Europe is likely to be much smaller than in North America. By definition, however grey markets publish no statistics.

Grandfather rights may also be implemented differently on both sides of the Atlantic as well as between different European countries. Sociological (i.e. non calculus based) explanations of forbearance (Simmel, 1923, 1950) could shed light on whether or not grandfather rights are implemented impartially in the USA and with a nationalistic bias in some European countries. The 2007 open skies Treaty between Europe and the U.S. of America is another formal institution to be included for research using post 2007 data. Future research would also benefit from considering the influence of informal institutions (North, 1990; Williamson, 1998) as their impact on competition can be direct on firms or indirect via formal institutions (Williamson, 1998).

2. Competitive life cycles:

Different results in the magnitudes of forbearance across airlines in geographical areas varying in their institutional environments and their periods can be explained by several other independent variables than the extent of territorial overlap. The results in Baum and Korn (1999) could reflect the initial stages of increased rivalry due to deregulation while the results in this paper for a period starting fifteen years after the beginning of European deregulation could reflect more mature competitive conditions, i.e. a higher level of territorial overlap resulting in higher forbearance intensity. In sum, if the magnitude of European forbearance were higher than the American one, the difference could be interpreted by a later stage of observation in the competitive life cycle as theorized in this paper instead of institutional differences.

3. Strategic groups:

Different stages of maturity in the strategies of groups of competitors could lead to analogous influence on the magnitude of forbearance. Low cost airlines were starting in the USA during the period 1979-1984 analyzed in Baum and Korn (1999) while they started in Europe more than ten years later and were beginning to mature at the end of the period 2002 to 2006 analyzed in this paper. Entering territories of historical carriers by low cost airlines and thus rising rivalry would be expected with the Baum and Korn data as opposed to increasing territory saturation and increasing forbearance with the data in this paper. As low cost players represent a relatively small share of competitors, their suggested influence would favor lower forbearance by California carriers between 1979 and 1984 than for European airlines between 2002 and 2006 and would probably be small. However, they would add up to lower forbearance explained by a later stage of observation in the competitive life cycle in the European case. Untangling the influence of strategic group membership and stage in the competitive life cycle is likely to be difficult but could lead to worthwhile discussions.

4. Alliances:

Other competing explanations of differences in the magnitude of forbearance may come from a higher propensity of European airlines to enter into alliances and for these alliances to have a moderating influence on their competitive behavior in Europe, namely increased forbearance. Baum and Korn studied California commuter airlines on a territory where international alliances have a lower influence on forbearance than within Europe and furthermore because they had not yet really started.

5. Competition for the allocation of landing time slots:

One additional suggestion for further research is that competition on air slots occurs before as well as after they are granted to airlines by regulatory authorities, the FAA in North America and a complex web of authorities in Europe. Existing research on multipoint competition starts once individual airlines attack another one on a particular air slot or slightly before if they decide not to do so because of forbearance calculus or traditions. However, they cannot start operations on an air slot without the approval of the corresponding regulating agency. It looks like the importance of regulating agencies implementing the rules of the game for competition designed by the legislator is assumed away in the existing empirical literature. Deregulation in the airline industry does not mean that rules were abolished. They still exist, with more market-oriented incentives and they differ between geographical areas. For an improved understanding of competition in the airline industry, it would be quite interesting to assess the relative importance of competition for air slots compared to competition once they are allocated. Forbearance on the latter kind could possibly be largely offset by fierce competition on the former. It is also possible that forbearance obtains in both instances.

In sum, this study provides empirical evidence for the inverted U-shaped relation between the level of multi-territory contact and the level of forbearance as measured by entries and exits into and from the territory of a competitor in the context of the European airline industry between 2002 and 2006. Combined with previous empirical findings reported in our review of the literature, our results open the path towards the universality of the U-shaped form of competition in the airline industry. An ambitious agenda for future research is derived from the proposed comparison of the magnitudes of forbearance between airlines of different regions of the world.

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