The Performance Implications of Membership in Competing Firm Constellations: Evidence from the Global Airline Industry

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Abstract

Constellations are alliances among multiple autonomous firms, such that these groups compete against each other in the same or similar industries for both clients and members. In this study I outline sources of benefits associated with membership in firm constellations and offer novel hypotheses about how group organization—i.e., whether the constellation is explicit (based on formal, multilateral agreements) or implicit (informal clusters based on the structure of bilateral ties among firms)—affects those sources. The global airline industry, which has witnessed the formation of both implicit and explicit constellations, provides an appropriate empirical setting. Results suggest that group organization moderates the relative impact of constellation-specific variables, which determine membership benefits available to all members, and member-specific variables, which determine how membership benefits are distributed within the group.

INTRODUCTION

Many industries are witnessing the formation of firm "constellations" competing against each other for the attraction of new members and for the penetration of their products or services in customer markets (Gomes-Casseres, 1994, 1996). In the case of global airlines, for instance, a traveler wishing to fly from Kansas City, US, to Gothenburg, Sweden, can use alternative airline groupings offering connections through distinct intermediate hubs. The traveler can use the services of the "Star Alliance"—e.g., United Airlines through Chicago and then Lufthansa through Frankfurt—or, alternatively, the services of the "Oneworld" group—e.g., American Airlines through Dallas and then British Airways through London (Hanlon, 1999; ter Kuile, 1997). All these constellations share similar features: they represent alliances with multiple, rather than simply two firms; their members have a considerable degree of autonomy, in some cases actively switching between groups; and their markets usually reach global dimensions.

Competing constellations have received sparse attention in the literature on interorganizational collaboration. Although there has been a growing interest in interorganizational networks as sources of competitive advantage (Dyer & Singh, 1998; Gulati, Nohria, & Zaheer, 2000), empirical studies have not paid enough attention to the dynamics of competition in settings involving multiple networks (Gulati, 1998: 310). In other words, empirical research has focused on individual networks in isolation—in general, "ego" networks or the web of alliances surrounding firms (e.g. Dyer & Nobeoka, 2000; Gulati, 1999; McEvily & Zaheer, 1999; Uzzi, 1996)—rather than *competing* networks. Yet, in instances where competition is shifting from firms to constellations, strategic implications can be profound, as a firm's performance may crucially depend on which group it chooses to join (Gomes-Casseres, 1996; Gulati, 1998). Even though past research has empirically analyzed constellations in several industry contexts (Nohria & Garcia-Pont, 1991; Vanhaverbeke & Noorderhaven, 2001; Walker, 1988), the performance implications of constellation membership have not been examined in detail.

In this study, I fill this void by examining how membership in competing constellations affects the performance of firms in the global airline industry. To do this, I proceed as follows. In the second section, I present hypotheses about the performance implications of membership in firm constellations. In the third section, I provide background information on the airline industry and the formation of airline constellations. In the fourth section, data and methods are presented. In the fifth session, I discuss the empirical results. Concluding remarks follow.

CONSTELLATION MEMBERSHIP AND FIRM PERFORMANCE

Constellations are alliances among multiple autonomous firms, such that these groups compete against each other in the same or similar industries for both clients and members. In this section, I distinguish between explicit and implicit constellations, and then present the theoretical framework linking constellation membership to firm performance.

Explicit and implicit constellations. Constellations can be either explicit or implicit. *Explicit* constellations are coalitions involving formal agreements in a *multilateral* fashion: such agreements tend to be general (i.e., applied to all members) and include a broad range of activities. In addition, explicit constellations are publicly known; in most cases, they are even associated with brand names, and their members constitute separate entities and committees to manage the affairs of the group. Examples of explicit constellations are the groupings of global airlines emerging especially in the mid 1990s (Hanlon, 1999), which I study in this paper.

Implicit constellations, in turn, are informal firm groupings "implied" from the structure of *bilateral* ties between firms. More precisely, an implicit constellation is a cluster of firms showing relatively more ties to one another than to firms outside the group (Nohria *et al.*, 1991: 109). Previous research has defined constellations implicitly based on the structure of bilateral ties between firms, and empirically examined their boundaries using clustering algorithms (Nohria *et al.*, 1991; Vanhaverbeke *et al.*, 2001; Walker, 1988). In some cases, implicit constellations may also be "expanded" versions of explicit constellations in that they may include firms tied to key (though not all) members of the latter.

Constellations and firm performance. Following Gomes-Casseres (1994), I assume that constellation benefits are influenced by two factors: generic attributes of the group and individual (member-specific) attributes relative to other constellation members (see also Gulati, 1998: 310). I call these characteristics *constellation-specific* and *member-specific* attributes respectively. While constellation-specific attributes (e.g., the size of its aggregated customer base) determine the total value generated by the group, member-specific attributes (e.g., a firm's relative size) determine how that value is distributed among members. Thus, one should expect two sources of interfirm performance differences in the presence of constellations. First, in situations where groups are heterogeneous, distinct constellations with distinct constellation-specific attributes will yield differential membership benefits. Second, in situations where members are heterogeneous, member-specific attributes will induce differential performance for firms belonging to the *same* constellation. In other words, some firms may attain higher membership benefits even if they belong to the same group.

Constellation-specific attributes. A firm can benefit from joining a constellation when it can capture *positive externalities* emanating from the presence of other firms in the group. Positive externalities can be *scale-driven*. The benefits that customers attain by consuming the products of the constellation may increase with the expected numbers of users, thus characterizing a situation of network externalities (Economides, 1996; Katz & Shapiro, 1985, 1994). For instance, the attractiveness of a technological standard depends on the extent to which other customers adopt that standard (Arthur, 1989; Axelrod, Mitchell, Thomas, Bennett, & Bruderer, 1995; David, 1985). This is particularly important when customers face switching costs to pursue alternative products supplied by other firms (such as in the case of frequent flyer programs), thus implying that the attraction of new customers to a particular constellation requires, to a large extent, that their individual suppliers become members. In addition, unit costs may decrease and services may improve due to jointly orchestrated operations. The presence of such increasing returns to scale, although different, is functionally similar to the case of positive network externalities (Tirole, 1988: 409) since it implies that the benefits of a constellation's product increase with the extent of its demand. This discussion implies that the *size of the aggregated customer base* of the group is an important constellation-specific attribute in the presence of scale-driven externalities. Thus:

Hypothesis 1. In contexts involving scale-driven externalities, members of a constellation with a large aggregated customer base will outperform members of a constellation with a small aggregated customer base.

Membership benefits can also be due to *resource-driven* externalities. Some argue that value-enhancing interorganizational relationships are based on the exploitation of resource complementarities, in the sense that the benefits to use a resource increase when it is jointly used with other resources (Grandori & Soda, 1995; Teece, 1992). This suggests that the *resource diversity* of the group may be an important constellation-specific attribute in the presence of resource-driven externalities, for three main reasons. Thus, a firm may be able to improve the development or introduction of its own products by capturing spillovers from constellation members assuming specialized and diverse roles (Feldman & Audretsch, 1999; Kogut, 2000). For instance, a foreign firm can use local firms' knowledge of domestic markets in several countries to introduce its products. Also, resource diversity implies that intra-group competition will not be strong (Axelrod et al., 1995; Gomes-Casseres, 1994; Lawless & Anderson, 1996). By contrast, firms holding similar resources tend to engage in direct competition since they are able to offer substitute products and thus undercut one another (Gimeno & Woo, 1996). This discussion implies:

Hypothesis 2. In contexts involving resource-driven externalities, members of a constellation with high resource diversity will outperform members of a constellation with low resource diversity.

But the existence of positive externalities will not, by itself, guarantee that firms will be able and even willing to share resources and markets. Although allying firms in constellations preserve their autonomy, arm's-length exchanges will not suffice for the internalization of interfirm externalities (Arrow, 1974). Coordination failure may induce the collective adoption of inferior options (Schelling, 1978). Lack of enough cooperation may also result if members act opportunistically, for instance by free riding on collective investments (Olson, 1965) or expropriating other firms' proprietary resources in activities outside the constellation (Teece, 1992; Williamson, 1985). A *dense* web of bilateral ties among firms—i.e., when they are extensively connected with one another—will help to mitigate such failures. Several authors propose that dense networks promote the emergence of shared norms and informal sanctioning mechanisms that enhance cooperation (Coleman, 1988; Granovetter, 1985). By enhancing group cohesion, network density also tends to facilitate joint action and improve communication, consequently reducing the likelihood of coordination failure (Jones, Hesterly, Fladmoe-Lindquist, & Borgatti, 1998). Therefore:

Hypothesis 3. Members of a constellation with high density of bilateral ties among firms will outperform members of a constellation with low density of bilateral ties.

Member-specific attributes. While constellation-specific attributes determine the total value generated by the group, member-specific attributes define how that value is divided among members. If firms agree to articulate their resources and pool their customer bases, they will need to define possible ways to do so, and arrange schemes to compensate for the access to resources and markets. Such compensation schemes do not need to be pecuniary, such as in the form of prices for each resource; firms may, for instance, negotiate on the access to certain resources or markets. Using Hirschman's (1970) terminology, I discuss two mechanisms that members can use to articulate resources and markets within the group, and to define the underlying compensation schemes: exit and voice. While *exit* is a bargaining mechanism based on threats to terminate the ongoing interorganizational association, *voice* "involves dialog, persuasion, and sustained organizational effort" (Williamson, 1985: 257).

Exit. In the presence of scale-driven externalities, the *relative size* of a member's customer base will be an important member-specific attribute influencing intra-constellation bargaining, since a member with relatively large customer base will bring relatively larger benefits to other members in the form of network externalities or gains of scale. Thus, large members can threaten to leave the group to partner with larger firms or simply go alone (Economides & Flyer, 1997; Katz et al., 1985), which would cause a substantial reduction in the level of scale-driven externalities to small members. This asymmetry will grant large members an ability to negotiate better deals within the group. Thus:

Hypothesis 4. In contexts involving scale-driven externalities, a member with a large customer base relative to the aggregated customer base of its constellation will outperform another constellation member with a relatively small customer base.

In the presence of resource-driven externalities, in turn, an important member-specific attribute will be the extent to which a member controls *critical resources* within its constellation. Resources are critical when their withdrawal from the set of resources available to the group substantially reduces the benefits from the articulation of the remaining resources. Similarly to a large customer base in the presence of network externalities, members controlling critical resources will have a privileged position in bargaining processes (Harrigan, 1988; Pfeffer & Salancik, 1978). This is because the departure of a member controlling a critical resource will, by definition, sharply reduce the level of interfirm externalities within the group. Consequently:

Hypothesis 5. In contexts involving resource-driven externalities, a member controlling critical resources within its constellation will outperform another constellation member without control of such critical resources.

Members holding ties to several other firms *outside* the constellation will also be able to benefit from internal bargaining processes. This is because there are sunk costs to form linkages among firms (Kranton & Minehart, 2000), for instance in the form of search costs and investments in exchange interfaces. Thus, it will be relatively less costly for a member to depart from its current constellation and form a new group when that member has existing linkages with alternative firms. In other words, outside ties tend to grant members salient exit options, thereby increasing the credibility of exit threats. Additionally, outside ties tend to be less redundant (Burt, 1992) than ties to existing constellation members. Consequently, holding such ties tends to increase a member's relative contribution to the constellation, as they represent avenues to obtain external resources and lure new firms to the group. These arguments lead to:

Hypothesis 6. A member with bilateral ties to several firms outside its constellation will outperform another constellation member holding no or few bilateral ties to outside firms.

Voice. While exit tactics are based on the relative value that firms add to alternative constellations, voice is based on deliberate actions to obtain group resources and to influence collective decisions. The establishment of extensive bilateral ties to constellation members is likely to be a key mechanism to exercise voice in the group. An obvious reason is that bilateral ties represent direct ways to get access to the resources and markets of particular members. But it is also reasonable to suppose that those ties represent conduits of information and influence beyond their own particular terms (Powell, Koput, & Smith-Doerr, 1996: 120). Notice that, differently from firms, constellations do not have strict hierarchical relations where certain agents are responsible for most decisions. Thus, members that are "more centrally located than others, in the sense that they are directly connected to many members" (Gomes-Casseres, 1996: 56) will have an improved ability to exercise voice. Such members will be more able to control the flow of information within the constellation, lead joint efforts, and influence collective strategies in their favor (Barley, Freeman, & Hybels, 1992; Gnyawali & Madhavan, 2001). This discussion implies:

Hypothesis 7. A member holding bilateral ties to several firms belonging to its constellation will outperform another constellation member holding no or few bilateral ties to other members.

Group organization: implicit vs. explicit constellations. I propose that the constellation's organizational form, namely whether it is implicit or explicit, will moderate the effect of constellation- and member-specific attributes on firm performance. Consider first the effect of constellation-specific attributes. The general nature of agreements involving explicit constellations increases the access of firms to the markets and resources of the whole group, which in implicit constellations is defined solely on a bilateral basis. This process is facilitated by the adoption of common, standardized exchange procedures in explicit groups. Standardization creates compatibility across members' production and marketing systems, thereby expanding the possibility to exploit complementarities (Schilling & Steensma, 2001; Thompson, 1967). In addition, the process of creating and managing formal, general agreements also represents an opportunity for multilateral communication and negotiation, which reduces the likelihood that the group will be trapped into inferior collective strategies (Farrell & Saloner, 1988; Schelling, 1978). Explicit constellations may be associated with formal boards and committees, which not only act as control devices, but also enhance the achievement of collective agreements. Once established, formal agreements can also curb opportunistic behavior by establishing clauses specifying the role and obligations of members (Poppo & Zenger, 2002). Therefore, by facilitating coordination and cooperation, explicit constellations tend to augment the internalization of interfirm externalities borne by constellation-specific attributes.

Furthermore, the fact that explicit constellations are publicly known can influence expectations about the prospects of the group. Thus, the market penetration of a constellation's products in the presence of network externalities is largely dependent on whether customers expect the constellation to thrive or not (Economides, 1996; Katz *et al.*, 1985). Promotion tactics and even brand names attached to the constellation are helpful precisely because they can help to influence such expectations (Katz *et al.*, 1994: 107). This tends to increase the level of externalities that firms can internalize by collaborating. Collectively, the arguments above suggest that the effect of constellation-attributes will be more pronounced in explicit than implicit constellations. Thus:

Hypothesis 8. Constellation-specific attributes will contribute more to explaining interfirm performance differences in explicit constellations than in implicit ones.

In the case of member-specific attributes, this effect is reversed. The benefits that a firm can attain by being part of an implicit constellation will be largely dependent on its position in the group. Since in implicit constellations there are no general terms guiding joint action, there is more room for exit and voice tactics to define collective strategies and compensation schemes. For instance, large and central firms tend to assume leading roles in implicit constellations, since they are likely to have a higher ability to form and manage multiple ties. In addition, the absence of general agreements in implicit constellations implies that a firm must establish direct ties to other members to increase its access to their resources and markets. Otherwise, that firm will only attain indirect membership benefits through its ties to central members, which will act as "intermediaries" in the transfer of interfirm externalities.

By contrast, in explicit constellations the action shifts, albeit partially, from bilateral to multilateral negotiations. As agreements become more comprehensive and general, bilateral agreements become less instrumental in delivering direct access to the resources and markets of the whole group. Increased participation in the process of decision making—for instance, through committees or boards—tend to increase members' voice over collective strategies and redistribution rules. In addition, since the formalization of interfirm alliances demands idiosyncratic expenses to multilaterally negotiate agreements and create common exchange procedures, the efficacy of exit tactics diminishes. Other things being equal, firms will lose more value if they defect from an explicit than an implicit constellation. This discussion suggests that in explicit constellations the effect of member-specific attributes will tend to be attenuated relative to implicit constellations, thereby leading to:

Hypothesis 9. Member-specific attributes will contribute more to explaining interfirm performance differences in implicit constellations than in explicit ones.

DATA AND METHODS

Since the deregulation of the U.S. industry and the increasing privatization of carriers in Europe and East Asia, competition between airline companies has reached a global status due to the desire to expand route networks internationally (Morrison & Winston, 1995; Pustay, 1992). However, existing regulatory policies that constrain the acquisition and use of foreign resources pose major challenges to international air travel. Although there are instances of companies holding equity stakes in international carriers, most governments disallow complete foreign ownership of domestic airlines and airport facilities (Hanlon, 1999; Pustay, 1992). In this context, alliances become a fundamental recourse for airlines to expand internationally.

The first airline alliances were purely *bilateral*, involving agreements between two carriers only. The most common type of bilateral alliance is the so-called *codesharing* agreement, by which two carriers combine routes as a single composite product to customers. Usually one firm (the "marketing carrier") sets the price and sells the flight, while the other firm (the "operating carrier") becomes responsible for the connecting routes (Bamberger, Carlton, & Neumann, 2001). Carriers also engage in *marketing* agreements such as the establishment of joint frequent flyer programs (FFP) and combined promotion efforts. *Explicit* airline constellations, moving beyond purely bilateral deals, have emerged especially in the 1990s. Most explicit constellations involve full marketing cooperation with respect to FFPs and promotions, besides joint access to airport facilities (such as lounges) controlled by individual members. Some groups also offer comprehensive codesharing agreements involving several routes instead of bilateral agreements comprising few routes (Oum & Yu, 1998). Thus, agreements tend to have a multilateral fashion, in that they are applicable to all members and broad in nature. Estimates indicate that the five existing explicit airline constellations in 2001 contributed to almost 60% of the global air traffic, representing 203.3 billion dollars in revenues (Baker, 2001). But there is evidence of the existence of *implicit* constellations prior to the emergence of most explicit airline groupings, corresponding to firm clusters based on extensive bilateral agreements (Whitaker, 1996). As I discuss next, some implicit constellations also appear to be expanded coalitions with key (though not all) members of explicit constellations as their core group.

Data. This study uses information on the operations of 75 global airlines as well as their alliances and patterns of membership in constellations between 1995 and 2000. The carriers in the sample represent about 81% of the total world passenger traffic in 2000, and 54 distinct countries.[1] (The complete list of carriers is available from the author upon request.) The data come from multiple sources. Carriers' operational information, such as traffic and capacity, is obtained from the *World Air Transport Statistics* compiled by the International Air Transport Association (IATA). Data on airline alliances and the evolution of constellations are taken from several issues of the magazine *Airline Business*, which conducts annual surveys on the alliance activity of the industry. Since it is based on annual surveys, an advantage of this alliance database is that it provides a picture of alliances that were actually in place in a particular year.[2] I also obtain information on equity stakes among carriers from several issues of *Airline Business*. Finally, I collect information on international routes serviced by carriers from the International Civil Aviation Organization's (ICAO) digest of statistics *Traffic by Flight Stage*. The database involves information on individual carriers observed through time; thus, the data have a panel structure.

Constellation membership: implicit vs. explicit groups. Following previous work (Nohria *et al.*, 1991; Vanhaverbeke *et al.*, 2001; Walker, 1988), I adopt a clustering approach to demarcating the boundaries of implicit constellations, based on the matrix of bilateral ties among carriers in the sample. I employ a clustering algorithm based on *tabu search* optimization (Glover, 1989), which is available in the software *UCINET 5.0* (Borgatti, Everett, & Freeman, 1999). An advantage of this algorithm is that it finds groups given a certain pre-specified number of partitions, independent of the clustering configurations found with fewer partitions (which is the case, for example, of hierarchical clustering algorithms). Basically, the clustering algorithm maximizes a "fit" function based on the average "proximity" of group members defined in terms of the existence of bilateral ties to one another, given a pre-specified number of groups or partitions. Thus, the algorithm has a clear rule for optimizing the composition of groups, which is somewhat obscure in other clustering methods (Lawless *et al.*, 1996). To create a matrix of interfirm linkages, I simply consider that there is a linkage between two firms (coded 1) when they have either a bilateral alliance or an ownership relation (i.e., when at least one of the carriers has an equity stake in the other carrier). Otherwise, I consider that there is no linkage (coded 0). Such a matrix is constructed for every year in the sample. Although tabu search greatly increases the likelihood that a global maximum will be found (Lawless *et al.*, 1996), the procedure may in some cases get trapped into a local maximum or stop before superior solutions are found. In an attempt to avoid this, I run the algorithm five times and choose the clustering configuration that yields the highest value of the "fit" function.

Any clustering algorithm, however, has an important drawback: there is a lot of subjectivity in choosing the "ideal" number of partitions. In the present study, I choose 5 partitions for two main reasons. First, in the last year of the sample (2000), there were 5 explicit constellations in place. Thus, if I follow the conjecture, discussed earlier, that implicit constellations may be either precursors of explicit groups or "expanded" versions of such groups when they are in place, then it makes sense to find a clustering pattern that has some correspondence to the eventual configuration of explicit constellations. Second, transatlantic routes between Europe and the United States are considered to be a key target for global airline alliances.[3] Thus, it is natural to assume that key competing U.S. carriers will be central players in each group. In my sample, four U.S. carriers can be considered key international players: American Airlines, Delta, Northwest Airlines, and United Airlines, thus suggesting at least 4 constellations. Adding an apparent cluster of European carriers led by Swissair results in 5 groupings.

The demarcation of the boundaries of explicit constellations, by contrast, is straightforward: it is simply based on public announcements of carriers' membership in constellations, as well as (if this is the case) their departure from those groups, as published in the magazine *Airline Business* and other sources obtained through Nexis-Lexis. In 2000, there were five existing explicit airline constellations—Star Alliance (including United Airlines, Lufthansa and SAS), Oneworld (including American Airlines and British Airways), SkyTeam (including Delta and Air France), Northwest/KLM (unofficially labeled "Wings"), and Qualiflyer (including Swissair and other European carriers).

The detailed composition of the implicit constellations (resulting from the cluster analysis), as well as the membership profile of the explicit constellations, is available from the author upon request.

Dependent variable. I employ carriers' passenger *load factor* as a performance measure, which serves as the dependent variable in this study. The load factor is a measure of aircraft capacity utilization. More precisely, it is the ratio of carrier i's total traffic, measured in revenue passenger kilometers (RPK), to its overall traffic capacity, measured in available seat kilometers (ASK), at year t (%). This corresponds to the variable $LoadFactor_{it}$. The main advantage of this measure is that it is a simple and standard way in the industry to compare the performance of airlines. Its main disadvantage is that it ignores the role of non-passenger sources of revenue and operational inputs besides aircraft capacity, such as labor (Schefczyk, 1993). Previous research has found, however, that a carrier's load factor is significantly related to its financial performance (e.g. Behn & Riley Jr., 1999; Morrison et al., 1995).

Constellation-specific attributes

Size. Scale-driven externalities in the airline industry result mainly from demand aggregation and gains from scale generated by joint operations and marketing activities. Thus, I measure the size of the aggregated customer base of the constellation using the variable $TotTraffic_t(C_j)$, which corresponds to the total scheduled passenger traffic (sum of individual billion RPKs) of constellation C_j at year t. To avoid a spurious correlation between this variable and the size of a carrier's *individual* customer base, for each carrier I exclude from this variable the carrier's total passenger traffic.

Resource diversity. An important resource in the airline industry is the infrastructure in foreign cities, since there are regulatory barriers for carriers to establish international hubs. Thus, the constellation will exhibit diversity regarding this resource when members are positioned in distant cities/hubs, which expands the possibilities for connections and the creation of complementary routes. By contrast, similar or proximate hubs will more likely be substitutes than complements. Based on this idea, I define the variable d_{ik} as the distance (in 1,000 kilometers) between the cities where the main hubs of carriers i and $k \in C_j$, are located. The main hub of a carrier is defined as the city which, for that particular carrier, shows the highest number of departing connections to other cities as evidenced by the *Traffic by Flight Stage* database. The measure of diversity within constellation C_j with respect to the availability of distinct cities/hubs at year t, labeled $DiversCity_t(C_j)$, is equal to $[\sum_i\sum_{k<i} d_{ik}]/[\frac{1}{2}m_t(C_j)(m_t(C_j) - 1)]$, where $m_t(C_j)$ is the number of members of constellation C_j at year t. This measure gives the average distance between the main hubs of all carrier-pairs within the constellation. If all carriers belong to different but close countries, the value of $DiversCity_t(C_j)$ is likely to be small. Its value is largest when carriers belong to different and distant countries, i.e., when their headquarters are "scattered" around the globe.

Resource diversity in airline constellations may also depend on whether some members specialize in small, domestic markets, while other members specialize in large markets with a broad range of international routes. Based on this idea, I also assess diversity based on the *international positioning* of constellation members defined as the percentage of their total passenger traffic (RPK) at year t coming from international traffic. Thus, the variable $DiversIntPosit(C_j)$ measures the standard deviation of individual carriers' international positioning for members of constellation C_j at year t. A high value of this variable indicates that the constellation has a mix of carriers specializing in international and domestic routes.

Density of bilateral ties. The variable $Density_t(C_j)$ measures the density of the network of bilateral ties within constellation j at year t, which is simply the observed number of existing ties relative to the total possible number of ties between members.

Member-specific attributes

Relative size. A carrier's relative size within its constellation is measured by the variable $RelCapacity_{it}(C_j)$, which refers to the ratio of carrier i's passenger available seat capacity (ASK) to the total capacity of its constellation, C_j, at year t.

Dominance of critical resources. As previously discussed, foreign hubs are fundamental resources in global airline constellations, and they will be relatively more critical when they are "in between" other cities and thus are expected to receive a large fraction of the overall flow of passengers coming from and going to other hubs and spokes. This suggests the use of the standardized *betweenness centrality* measure in network analysis (Freeman, 1979; Wasserman & Faust, 1994) to indicate the importance of each city in receiving traffic from the constellation's route network.[4] Cities with large betweenness centrality scores are likely to be central hubs in the international route network, whereas cities with low scores are likely to be either local hubs or spokes. Within this perspective, using information from the *Traffic by Flight Stage* database, for each year I first construct a matrix of global city-pairs where each entry is coded 1 if there is a flight departing from a city (row) to another city (column) offered by at least one member of a particular constellation C_j at year t. Based on this matrix, I use the software *UCINET 5.0* (Borgatti *et al.*, 1999) to compute the standardized betweenness centrality score of each city k, denoted $w_{kt}(C_j)$. The next step is to measure how carriers dominate such critical hubs. Still using ICAO's *On-Flight Origin and Destination* statistics, I compute for each city-pair k the number of carrier-routes departing from that city and offered by all carriers in the industry, belonging or not to the constellation, at year t.[5] I then define p_{ikt} as the proportion of all carrier-routes from city k serviced by carrier i at year t. This provides an indication of the extent to which a carrier dominates the traffic involving a particular city. The final measure, denoted as $DomHub_{it}(C_j)$, is equal to the sum $\sum_k w_{kt}(C_j)p_{ikt}$, where k indexes all cities belonging to the route network of the constellation. Intuitively, this measure indicates a carrier's dominance of the traffic (in terms of route counts) involving cities in the network of the constellation weighted by the relative importance or criticality of those cities in terms of traffic aggregation.[6]

Bilateral ties to firms outside the constellation. The variable $OutsideTie_{it}(C_j)$ is the proportion of carrier i's total bilateral ties (i.e., to any firm in the sample) that are to carriers *not* belonging to its constellation, C_j, at year t. Thus, it measures the extent to which carrier i has external options in terms of relationships with firms outside its constellation.

Bilateral ties to other constellation members. The variable $InsideTie_{it}(C_j)$ is the proportion of members of constellation C_j to which carrier $i \in C_j$ has bilateral ties at t.

Control variables. I employ several controls in this study: $Capacity_{it}$, $Employees_{it}$, and $Routes_{it}$ measure respectively carrier i's passenger seat capacity (billion ASK), number of employees (in thousands), and number of serviced international routes (in thousands, according to the *Traffic by Flight Stage* database) at year t; $Cargo_{it}$, measures the ratio of carrier i's cargo flights (measured in billion RTK, revenue tonne kilometers) to its number of employees (in thousands) at year t; Age_{it}, which indicates the time elapsed, at t, since the carrier's founding; $EgoTies_{it}$ and $EgoTraffic_{it}$, measure respectively carrier i's total number of bilateral ties to other firms in the sample, and the sum of the individual traffic (billion RPKs) of those firms to which carrier i is *directly* tied at year t;[7] $Contact_{it}(C_j)$, represents the average number of international route contacts between carrier i and other members of its constellation—i.e., the number of international routes jointly serviced by those carriers; $Contact_t(C_j)$ is simply the mean of $Contact_{it}(C_j)$ for all $i \in C_j$, i.e., the average number of international route contacts among *all* group members;[8] $GDPCap_{it}$, $GDPGrow_{it}$, and Pop_{it} represent respectively the carrier country's per capita GDP (1,000 US$), GDP percent growth, and population (billion inhabitants); and finally, $Year(t)$ is a set of year-specific dummy variables.

Method. To assess the impact of membership in a constellation C_j on the performance of a firm i, I estimate the following equation:

(1) $y_{it} = \boldsymbol{x}_t(C_j)\boldsymbol{\beta} + z_{it}(C_j)\boldsymbol{\gamma} + \boldsymbol{w}_{it}\boldsymbol{\delta} + \tau_t + \lambda y_{it-1} + e_{it}$,

where y_{it} is the performance measure used (load factor); $\boldsymbol{x}(C_j)$ is a vector of constellation-specific attributes; $\boldsymbol{z}_i(C_j)$ is a vector of member-specific attributes; $\boldsymbol{w}_{it}$ is a vector of firm-specific control variables; τ_t denotes year-specific effects; y_{it-1} is the lagged value of the dependent variable (to control for adjustment processes); and e_{it} is an error term. This equation is estimated twice: in the first regression, C_j corresponds to carrier i's *implicit* group; in the second, it corresponds to carrier i's explicit group (if any). With respect to the error term e_{it}, I initially employ a standard random-effects specification by assuming that $e_{it} = \alpha_i + \varepsilon_{it}$ where α_i is a time-invariant, firm-specific term, and ε_{it} is a time-varying error term, and that both terms are normally distributed and uncorrelated with the independent variables. The model is estimated via generalized least squares (GLS).

A problem with this random-effects specification, however, is that constellation- ($\boldsymbol{x}(C_j)$) and member-specific attributes ($\boldsymbol{z}_i(C_j)$) may be endogenous. Namely, unobserved firm-specific attributes may be correlated with both performance and those explanatory variables. For instance, some firms may have superior competence not only to manage airline operations but also to select partners, which may in turn influence group attributes (e.g., total traffic). In an attempt to assess the robustness of the results, I employ alternatively a standard fixed-effects specification by removing within-carrier means, which satisfactorily removes fixed carrier-specific unobserved heterogeneity (α_i). However, estimating a dynamic model like (1) with fixed effects may generate inconsistent estimates due to the use of the lagged dependent variable as an explanatory term, as discussed by Nickell (1981). To avoid this effect, I drop the lagged dependent variable when using fixed effects.[9]

RESULTS AND DISCUSSION

Table 1 shows the results of the regressions relating constellation membership to firm performance. Models (1) and (2) refer to the sample of firms belonging to explicit constellations; all models are significant ($p < 0.001$). The random-effects model (1), estimated via GLS, provides support for Hypothesis 1: an increase in the aggregated customer base of the constellation ($TotTraffic_t(C_j)$) significantly increase members' performance ($p = 0.049$).[10] A carrier is expected to have an increase in its load factor by almost 1 percentage point if the traffic brought by other constellation members increases by 100 billion RPKs. The other constellation-specific attributes are insignificant, thus providing no support for Hypotheses 2 and 3: the resource diversity and the density of bilateral ties within explicit constellations do not have a significant effect on performance. Likewise, all member-specific attributes are insignificant, thus providing no support for Hypotheses 4 to 7: the relative position of firms within explicit constellations, at least with respect to the attributes employed in this study, does not explain interfirm performance differences.

Model (2) is the fixed-effects version of model (1). Support for Hypothesis 1 is robust to the fixed effects specification: $TotTraffic_t(C_j)$ remains significantly related to performance ($p = 0.0365$). Although the variable measuring hub diversity ($DiversHub_t(C_j)$) is significant ($p = 0.002$), it has a sign that is the opposite of what is predicted in Hypothesis 2: diversity appears to reduce, rather than increase performance. A 1,000 km increase in the average distance between members' main hubs decreases load factors by 0.73 percentage points. It is possible that $TotTraffic_t(C_j)$ may be picking part of the effect of increased hub diversity. Thus, even though hub diversity has a direct negative effect on performance, it may have an indirect positive effect by increasing the aggregated traffic of the constellation due to the possibility to exploit complementarities. Some support for this conjecture is found by noting in Table 1 that $DiversHub_t(C_j)$ and $TotTraffic_t(C_j)$ have a significant and positive correlation, around 0.66 ($p < 0.001$). Other constellation-specific variables and all member-specific variables remain insignificant in the fixed-effects specification.

Table 1 also presents the results of regressions including variables related to implicit constellations; all models, (3) and (4), are significant ($p < 0.001$). Model (3) corresponds to random-effects estimates. No constellation-specific attribute is significant, thus providing no support for Hypotheses 1 to 3: general attributes of implicit constellations apparently do not explain interfirm performance differences. However, several member-specific attributes are significant. $RelCapacity_{it}(C_j)$, which measures a carrier's capacity relative to the total capacity of its group, is marginally significant ($p = 0.088$), thus providing moderate support for Hypothesis 4: larger members appear to outperform smaller members. Hypothesis 5 is not supported: the measure of hub dominance adopted in this study, which is a proxy for the control of critical resources, is unrelated to firm performance. The remaining member-specific attributes, related to the structure of a carrier's bilateral ties, are strongly significant. A 10 percent increase in the proportion of a member's bilateral ties that are to firms outside its constellation ($OutsideTie_{it}(C_j)$) enhances its load factor by 0.33 percentage points ($p < 0.001$), thereby lending support to Hypothesis 6. Also, a 10 percentage point increase in the proportion of members to which a certain firm holds bilateral ties ($InsideTie_{it}(C_j)$) increases that firm's load factor by around 0.62 percentage points ($p = 0.003$), thus supporting Hypothesis 7. Notice that the effect of a firm's *total* number of bilateral ties ($EgoTies_{it}$), which is used as a control variable, is significant but negative ($p = 0.001$). These results suggest that superior performance in the context of implicit constellations is not brought by an increase in bilateral ties per se. Rather, it is driven by a balance between within-group ties—which possibly grant a member enhanced influence and access to group resources—and ties to firms outside the group—which possibly yield that member external options.

However, as model (4) shows, these results are not robust to a fixed-effects specification. No constellation- or member-specific variable is significant in this case. This may be due to two causes. First, it may be a consequence of fixed-effects estimation, which is likely to reduce within-firm heterogeneity—more critical in the case of member-specific variables—and magnify the problem of attenuation bias due to measurement error (Johnston & DiNardo, 1997). Notice that variables related to implicit constellations are inherently measured with error due to the rather subjective boundaries of those groups. The second possible cause may be due to the fact that the lagged dependent variable, $LoadFactor_{it\text{-}1}$, is not included in the fixed-effects models. Indeed, across all random-effects models this variable is always strongly significant ($p < 0.001$), thus suggesting that adjustment processes do matter in the case of load factors. If I include the lagged dependent variable in the fixed-effects model, then $InsideTie_{it}(C_j)$ regains statistical significance ($p = 0.038$), although both $RelCapacity_{it}(C_j)$ and $OutsideTie_{it}(C_j)$ remain insignificant.

The final set of hypotheses, 8 and 9, assert that the effects of constellation- and member-specific variables are contingent on group organization. The results of the random-effects models (1) and (3) unambiguously support those hypotheses. Namely, constellation-specific attributes are only significant and hence explain interfirm performance differences when they are related to explicit constellations, which is aligned with Hypothesis 8. Member-specific attributes, by contrast, are only significant in the regression for implicit constellations, thereby supporting Hypothesis 9. Thus, while explicit constellations appear to augment the effect of constellation-specific attributes on firm performance, in implicit constellations the effect of member-specific attributes appears to be more pronounced. Support for the impact of group organization on the role of constellation-specific attributes (Hypothesis 8) is robust to the fixed-effects specification. But member-specific attributes are insignificant in both models (2) and (4), thereby failing to provide robust support for Hypothesis 9. However, the fact that $InsideTie_{it}(C_j)$ becomes significant in the fixed-effects model when that lagged dependent variable is introduced does not allow for a decisive rejection of Hypothesis 9.

CONCLUSION

This study moves beyond research focusing on isolated networks or the web of alliances surrounding particular firms and shows that there is value in examining the impact of membership in competing constellations. Although past research has studied competing constellations, the performance implications of membership in those groups remain a rather unexplored topic. I find that membership in constellations has positive performance implications in a way that is influenced by the extent to which the group is explicit (formalized, involving multilateral deals) or implicit (informal, based on the structure of bilateral ties among firms).

It is important to note, however, that the results presented here are confined to a single industry and thus may not be generalizable to other contexts. Many variables under analysis here are industry-specific, although they relate to general theoretical concepts. Moreover, the international traffic in the airline industry is also heavily regulated, which makes the use of alliances the only way for global airlines to benefit from foreign resources. In other industry contexts, firms may expand their networks and develop their own resources *internally*, i.e., by increasing the size and scope of their operations. I believe, however, that the theoretical framework and the results presented here have applicability in other contexts for several reasons. Even in situations where firms are free to acquire foreign resources, the internalization of large networks within a single firm is either unfeasible or excessively costly (Richardson, 1972). For this reason, Nohria and Garcia-Pont (1991) claim that constellations are crucial in *global* contexts precisely because firms cannot hope to fully control and have access to local resources. Thus, there are circumstances where the expansion of networks internally is difficult, and thus membership in constellations becomes an important organizational decision. However, an assessment of the benefits of constellation membership in other industries, particularly in contexts where firms have more freedom to choose alternative organizational modes, is certainly needed.

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Table 1. Constellation membership and performance: regression results

	Explicit constellations		Implicit constellations	
	Random effects (1) $LoadFactor_{it}$	Fixed effects (2) $LoadFactor_{it}$	Random effects (3) $LoadFactor_{it}$	Fixed effects (4) $LoadFactor_{it}$
<u>*Constellation-specific*</u>				
$TotTraffic_t(C_j)$	0.009**	0.009**	0.003	0.001
	(0.006)	(0.005)	(0.002)	(0.002)
$DiversHub_t(C_j)$	-0.075	-0.730*	0.043	0.134
	(0.251)	(0.221)	(0.109)	(0.113)
$DiversIntPos_t(C_j)$	11.915	5.778	-4.524	-4.943
	(9.990)	(7.505)	(4.032)	(3.857)
$Density_t(C_j)$	1.394	-0.563	1.771	-0.408
	(4.262)	(4.185)	(3.894)	(3.898)
<u>*Member-specific*</u>				
$RelCapacity_{it}(C_j)$	6.488	10.919	6.009†	4.035
	(6.869)	(9.383)	(4.427)	(4.714)
$DomHub_{it}(C_j)$	-0.053	-0.082	-0.032	-0.017
	(0.103)	(0.082)	(0.068)	(0.077)
$OutsideTie_{it}(C_j)$	0.719	-0.339	3.262*	-0.287
	(2.518)	(2.253)	(0.994)	(1.002)
$InsideTie_{it}(C_j)$	2.243	-2.785	6.212*	2.012
	(2.793)	(2.895)	(2.244)	(2.219)
<u>*Controls*</u>				
$Capacity_{it}$	-0.006	-0.018	-0.008	0.071**
	(0.039)	(0.105)	(0.014)	(0.036)
$Employees_{it}$	0.025	-0.442**	0.005	-0.098
	(0.093)	(0.152)	(0.040)	(0.087)
$Routes_{it}$	0.941	18.402†	0.830	-1.841
	(4.557)	(9.865)	(2.664)	(4.400)
$Cargo_{it}$	7.802	-10.980	5.698	-1.997
	(11.482)	(25.742)	(4.054)	(12.566)
Age_{it}	0.005	-0.632	0.019	0.004
	(0.029)	(0.655)	(0.011)	(0.158)
$EgoTies_{it}$	-0.020	-0.131	-0.256*	-0.098
	(0.151)	(0.189)	(0.100)	(0.125)
$EgoTraffic_{it}$	-0.001	0.004	0.002	0.004
	(0.004)	(0.003)	(0.002)	(0.002)
$Contact_{it}(C_j)$	0.024	-0.152	-0.140	-0.220
	(0.102)	(0.080)	(0.159)	(0.150)
$GrContact_t(C_j)$	0.004	-0.087†	0.003	-0.013
	(0.070)	(0.090)	(0.075)	(0.080)
$GDPCap_{it}$,	-0.023	-0.345	0.043**	-0.156†
	(0.058)	(0.238)	(0.021)	(0.085)
$GDPGrow_{it}$	0.176	0.259*	0.173*	0.225*
	(0.125)	(0.085)	(0.048)	(0.047)
Pop_{it}	-7.244	661.279*	0.165	81.196*
	(10.809)	(228.194)	(1.047)	(26.455)
$LoadFactor_{it-1}$	0.717*	-	0.792*	-
	(0.086)		(0.033)	
N	86	86	401	401
χ^2	31,992.47*	-	1,103.81*	-
F	-	7.82*	-	5.08*

* $p < 0.01$; ** $p < 0.05$; † $p < 0.10$ (one-tailed tests for hypothesized effects). The table shows parameter estimates and standard errors in parenthesis. All models include year-specific dummy variables.

NOTES

[1] The estimate of world passenger traffic used here is taken from Baker (2001). Individually, these databases contain information on more than 75 carriers, but I still had to reduce the sample size due to missing data on certain variables of interest for certain carriers. Whenever feasible, I supplemented missing data with information obtained through Nexis-Lexis.

[2] I disregard agreements that were pending in a given year, and focus on passenger agreements only (i.e., exclusive cargo agreements are not included in the sample.) Sometimes, a survey at year *t* indicates that an alliance resumed in year $t - n$, but there is no reference to that alliance in the $t - n$ survey. Unless the latter indicates that the alliance is pending at $t - n$, I consider that the alliance was already in place in that period.

[3] As mentioned by an airline executive, "some 80 per cent of the benefits from any of the global alliances come on the transatlantic" (quoted in Odell & Spiegel, 2002).

[4] Suppose g_{uv} is the number of geodesics (shortest paths) linking two cites *u* and *v*, and $g_{uv}(k)$ the number of geodesics linking the two cities that contain city *k*. Then the betweenness centrality measure of city *k* is defined by $\sum_{v<u} g_{uv}(k) g_{uv}$ where $k \neq u, v$. The *standardized* measure corresponds to this value divided by the number of all possible city-pairs not including city *k*, i.e., $\frac{1}{2}(c-1)(c-2)$, where *c* is the total number of cities.

[5] For instance, if a city is connected to only one city in the route network, and the connection is serviced by two carriers, then the number of carrier-routes involving that city is 2.

[6] Ideally, one should use information on the individual *traffic* of city-pair routes to compute this measure. However, the *Traffic by Flight Stage* database does not contain traffic information for all routes surveyed. Instead of disregarding routes for which data on traffic are missing, which would for some carriers discard information on their entire route networks, I opt to use instead a rough assessment of carriers' relative traffic based on route counts, as described before.

[7] Notice that constellation-based associations may be *indirect*.

[8] In the present study, controlling for multimarket contact is important because, as shown by Gimeno and Woo (1996), it may be correlated with resource similarity. Multimarket contact facilitates tacit collusion because a particular firm can retaliate against another firm's competitive hostility in a certain market through an escalation of competition in other shared markets. Thus, failure to control for multimarket contact may bias the analysis of the impact on a firm's resource profile and performance.

[9] Since firms *self-select* whether they will join an explicit constellation or not, another possible problem is that unobserved firm-specific factors may cause systematic performance differences conditional on a firm having chosen a particular explicit constellation, and bias the estimates as a result. I employ the now-standard Heckman (1979) two-stage approach to test for this possibility (using a Probit equation in the first stage to describe the choice of an explicit constellation), but the test shows no evidence of self-selection bias. (Results not reported here, but available from the author upon request.)

[10] Tests for hypothesized effects are one-tailed.