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The role of cooperation in productivity: Alliance portfolio and network resources

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ABSTRACT

This study analyses the direct and indirect effect, through network resources, that the size of the alliance portfolio has on the company's performance, measured through productivity. In addition, two antecedents of the formation of alliance portfolios are studied: the firms' resource endowments and the participation of the focal firm in inter-organisational networks. One of the main contributions lies in the use of the network resources variable. The use of this variable gives empirical content to a concept widely analysed in the literature to explain the performance of interconnected companies. The study is carried out in the airline industry, a context in which firms display an intense cooperative activity establishing numerous exploiting alliances. The results show that the company's resource endowment and the participation in inter-organisational networks constitute a relevant factor in explaining the size of the alliance portfolio. Additionally, the results show a positive effect, but mediated by network resources, of the size of the alliance portfolio on the company's productivity. Finally, network resources are largely determined by the size of the alliance portfolio and significantly affect the company's productivity.

1. Introduction

The use and formation of alliance portfolios has become an increasingly widespread business practice, being especially developed in industries such as air transport, biotechnology and pharmaceuticals (Duysters, de Man, & Wildman, 1999; Wassmer, 2010; Wassmer, Li, & Madhok, 2017). An alliance portfolio is defined as "a firm's collection of direct alliances with partners" (Lavie, 2007, p. 1188) and can be a means to improve the competitive position, the exploitation of resources, the knowledge generation and the internationalisation of the focal firm (Ahuja, 2000a, 2000b; García-Canal, López Duarte, Rialp Criado, & Valdés Llaneza, 2002; Lavie, 2007). The associative behaviour that is manifested through the alliance portfolio generates network resources for the company (Gulati, 1999) that can improve its performance (De Martino, Errichiello, Marasco, & Morvillo, 2013; Gulati, Lavie, & Madhavan, 2011; Lavie, 2006).

Numerous works have studied the effect of alliance portfolios on performance. This literature has been developed around certain common characteristics regarding the dependent and independent variables. First, most studies have used financial results (Baum, Calabrese, & Silverman, 2000; Hoehn-Weiss, Karim, & Lee, 2017; Mouri, Sarkar, & Frye, 2012) or innovation (Rothaermel & Deeds, 2006; Shan, Walker, & Kogut, 1994) as a measure of performance, without considering other possible indicators, such as the company's productivity (de Leeuw, Lokshin, & Duysters, 2014; Faems, de Visser, Andries, & van Looy, 2010; Terjesen, Patel, & Covin, 2011). Second, most studies focus on certain characteristics of the alliance portfolio and their impact on performance (Faems, Janssens, & Neyens, 2012; Kim & Choi, 2014), but there are few works that analyse how an alliance portfolio allows generating network resources and how these resources affect the company's performance. Third, when analysing the impact of certain features of the portfolio on performance, the studies start from given characteristics of the portfolio, without analysing the possible antecedents of the configuration of that portfolio.

These characteristics are relevant when studying the relationship between the alliance portfolio and performance. Financial results could be determined by numerous variables, while the effect of exploitation alliances is much more visible on operational performance variables, such as the company's productivity. Similarly, the consideration of network resources implies deepening the understanding of the relationship between the alliance portfolio and the performance (Lavie, 2006). Finally, there is still a need to study the evolution and antecedents of alliance portfolios (Ahuja, Soda, & Zaheer, 2012; Wassmer, 2010), since

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without understanding these processes it is difficult to elucidate their impact on performance.

Given these characteristics of the literature, the present study pursues three related objectives. First, it analyses two possible antecedents of the alliance portfolio of alliances, such as the endowment of resources of the focal company and the participation of the company in inter-organisational networks. Second, it determines how alliance portfolios generate network resources, which implies theoretically and empirically defining these resources in a given context. Third, it establishes the impact that portfolio size and network resources have on the company's performance, defined from a productivity indicator. Due to the use of this measure, the study focuses on exploitation alliances, since this type of alliances has a more evident and predictable effect on the productivity than exploration alliances, especially in the medium and short term (Rowley, Behrens, & Krackhardt, 2000).

The industrial context of the study is the airline industry, which has been used in numerous studies on alliance portfolios (Cobeña, Gallego, & Casanueva, 2017; Hoehn-Weiss et al., 2017; Lazzarini, 2007; Wassmer et al., 2017) due to its intense cooperative activity. Additionally, this industry is characterised by the use of horizontal exploitation alliances (Rossmannek & Rank, 2019) and by the presence of formal inter-organisational networks, specifically airline constellations (Lazzarini, 2007).

The results show that the company's resources endowment and its participation in inter-organisational networks affect the size of the alliance portfolio, which in turn determines, through the ties established with partners, the network resources that the company can access and mobilise. Further, the size of the alliance portfolio has a positive and significant effect, but fully mediated by network resources, on firm productivity.

The article contributes to the alliance portfolio literature by advancing the knowledge of the antecedents of the characteristics of the portfolio and analysing the role of network resources in the complex relationship between the alliance portfolio and the performance. Moreover, this study represents one of the first attempts to empirically analyse the effects of network resources on the company's results. Additionally, this article increases the knowledge and understanding of the functioning of the airline industry. This industry is characterised by the use of horizontal alliances whose purpose, among others, is to increase the use of the airlines' production factors. The results of this article can be generalised to those industries that follow the same logic, such as many service industries.

2. Theoretical background and hypotheses

2.1. Firm's resource endowments

The literature has paid little attention to how the resource endowment of the focal company can affect the formation, size and composition of an alliance portfolio. These resources can be thought of as "strengths, advantages, or assets of the firm" (Eisenhardt & Schoonhoven, 1996 p. 138) and can be either tangible or intangible (Wernerfelt, 1984).

The literature has shown that the formation of alliances does not depend exclusively on the will of the company (Ahuja, 2000b; Casanueva, Gallego, & Sancho, 2013) but on its ability to offer some resource that is attractive and of interest to a potential partner (Bae & Gargiulo, 2004; Hoehn-Weiss & Karim, 2014). Consequently, the resource endowment summarises a focal firm's ability to attract partners and is one of the factors that cause the selection of a company as a strategic partner (Gulati & Gargiulo, 1999). Another reason which explains the forming of alliances is the need to access resources which are not present in the market and cannot be generated by the focal firm (Ahuja, 2000b; Bae & Gargiulo, 2004; Gulati, 1995; Huang, 2017; Kim & Choi, 2014; Lee, 2007; Mitsuhashi & Greve, 2009).

The greater possibilities that a company has to form strategic alliances thanks to its resource endowment should be reflected in the size of its portfolio of alliances, defined as the sum of all the alliances of a firm (Castiglioni & Galán González, 2020). However, this definition and approach have been criticised by different authors for the lack of a coherent overview, which can be dangerous and myopic (Chiambaretto & Fernandez, 2018; Wassmer & Dussauge, 2011, 2012). Nevertheless, it can be affirmed that companies which have a greater endowment of resources will have a greater number of alliances, thus increasing their alliance portfolio.

Based on the above, the following hypothesis is proposed:

H1: The resource endowment of a firm has a positive effect on the size of its alliance portfolio.

2.2. Inter-organisational networks

In multiple industries a paradigm shift is taking place in the competitive dynamics, from competition between companies to competition between groups (Gomes-Casseres, 2003). Unlike the business groups subject to a hierarchy, these groups are based on business networks or inter-organisational networks that assume different forms and types, such as the so-called alliance networks, clusters, constellations or multilateral alliances. These new forms of organization, more or less explicit and more or less formalised (Lazzarini, 2007), are characterised by the search for a joint objective through cooperation among its members. This cooperation can be both direct and indirect as not all firms have to have direct relationships between them (Wincent, 2008). As a result, this complex network of relationships between the partners of an alliance network can produce a highly complex reciprocity structure (Doz & Hamel, 1998; Human & Provan, 2000).

Companies therefore participate in company networks in order to share assets and gain competitive advantages that lead to increased performance (Casanueva, Gallego, Castro, & Sancho, 2014; Lavie, 2006, 2007). Such competitive advantages may be focused on harnessing the capacity to produce resources, producing economies of scale or saving on costs (Chen & Chen, 2003; Inoue, 2018; Yamakawa, Yang, & Lin, 2011).

Additionally, participation in these networks can be especially beneficial for a company, since these constellations provide the opportunity to establish links with possible partners with which the focal company might not have come into contact (Human & Provan, 2000). Therefore, these networks represent platforms that favour the formation of alliances between their members (Castiglioni, Castro, & Galán, 2015) because they increase trust among partners and reduce the risk of opportunistic behaviours (Das, 2006; Gulati, 1999). Also, these collective organisations can affect the formation of the future alliances of their members, because they can establish limits when they want to ally with external partners (Corbo & Shi, 2015). This limitation occurs especially in industries with different constellations that compete with each other, as in the airline industry (Gimeno, 2004). However, when the constellation or the network is sufficiently broad the possibilities of establishing alliances increase, as the search for partners and the formation of the agreement are simpler (Gomes-Casseres, 2003). Therefore, we state that:

H2: The participation of a company in an inter-organisational network has a positive effect on the size of its alliance portfolio.

Similarly, participation in a network of firms should affect both the amount of resources that a company makes available to its partners and the amount of network resources that the focal company can obtain or mobilise from them. Participation in these collective organisations implies a greater commitment than the formation of bilateral alliances as these constellations evaluate and select potential new members based on a series of requirements such as, for example, compatibility with the existing network and potential growth (Castiglioni, Gallego, & Galán, 2018; Corbo & Shi, 2015). In addition, for a company the participation

in inter-organisational networks can determine market benefits since it becomes part of an extensive network of routes and destinations, being able to offer a better service to its customer base (Subramanian, 2017; Wang, 2014).

Consequently, an inter-organisational network receives the extensive resources of its members, increasing the collective social capital (Lin, 1999) and this, in turn, increases the network resources that partner companies can mobilise from the network (Gulati et al., 2011). Based on the above, we propose the following hypothesis:

H3: The participation in an inter-organisational network has a positive effect on the amount of network resources that the focal company mobilises.

2.3. Alliance portfolio, network resources and productivity

From its origins, the literature on alliance portfolios has highlighted the size as one of the main management parameters (Shan et al., 1994), with an effect on the results (Baum et al., 2000; Mouri et al., 2012) and innovation (Ahuja, 2000a; Kim, Park, & Kang, 2015; Rothaermel & Deeds, 2006; Shan et al., 1994). Other studies suggest an inverted U-shaped relationship between the size of the alliance portfolio and results (Hoehn-Weiss & Karim, 2014; Karamanos, 2012; Rothaermel & Deeds, 2006), indicating the existence of an optimal portfolio size that maximises the company's performance. However, much research indicates that the impact of the portfolio size on performance may vary depending on the particular conditions of each company, its previous experience in partnerships (Rothaermel & Deeds, 2006) or the use of portfolio management tools (Heimeriks, Klijn, & Reuer, 2009).

Even though most studies use measures of financial performance or innovation indicators, little research has been done on the effect of portfolio size on the productivity of the company (de Leeuw et al., 2014; Faems et al., 2010; Terjesen et al., 2011). This small branch of research has used personnel costs (de Leeuw et al., 2014; Faems et al., 2010) or the manufacturing capabilities of the company (Terjesen et al., 2011) as a dependent variable.

Based on the ideas of March (1991) and Tushman and O'Reilly III (1996), the literature on alliance portfolios has differentiated between exploration alliances and exploitation alliances (Yamakawa et al., 2011). The formers are primarily focused on the creation of new knowledge and innovation for the company, while exploitation alliances are centred on the efficient use and transfer of resources (March, 1991).

From the point of view of productivity, the exploitation alliances that make up a portfolio of alliances should not produce the saturation effect highlighted by the literature and that determines an inverted U-shaped relationship (Hoehn-Weiss et al., 2017; Karamanos, 2012; Rothaermel & Deeds, 2006). This saturation effect is due, on the one hand, to the company's inability to integrate, assimilate and absorb the knowledge provided by its alliances (Duysters, Heimeriks, Lokshin, Meijer, & Sabidussi, 2012) and, on the other hand, to management limitations that entail a very high volume of alliances. Since exploitation alliances are not focused on the assimilation and absorption of the knowledge of the company's partners and that companies can have mechanisms to address the management of a high number of alliances, such as the creation of a unit dedicated to this function (Kale, Dyer, & Singh, 2002), we consider that:

H4: The size of the alliance portfolio has a positive effect on the productivity of the company.

Similarly, the size of the alliance portfolio, reflecting the associative behaviour of the company, should have a positive effect on the volume of network resources that a company can mobilise (Casanueva et al., 2014). Network resources are a type of resource, that is generated by the relationships that make up an inter-organisational network, and can be combined with the internal resources of a company to improve its performance (De Martino et al., 2013; Lavie, 2006). In inter-organisational networks, the social embeddedness created by the ties that a company establishes with its partners also generates value in the form of social capital (Lin, 1999). This value can be increased by the use of three different mechanisms - reach, richness and receptivity (Gulati et al., 2011). Of these three mechanisms, the increase in the size of the portfolio has a more evident effect on the reach; that is, the connection of the company with distant, different and diverse partners. This increase in reach in turn determines a greater richness of the network resources that the company can access. The network resources that a company can access and mobilise are determined by the number of partners with which it is related, or can be related, and with the resources that those partners possess (Lin, 1999). As a result, the larger the portfolio of alliances of a company, the greater the network resources it can have and use. Therefore, we state:

H5: The size of the portfolio has a positive effect on the amount of network resources of the company.

The third mechanism through which network resources create value - receptivity - is defined as the ability of the focal company to leverage the resources it obtains from its network and combine them with its own resources (Gulati et al., 2011). In a context of cooperation, the combination of the resources of the focal company with those of its partners results in pooling or complementary alliances depending on the similarity between the resources (Lavie, 2006). The internal resources of the focal company are therefore combined with the network resources that it obtains from its partners, determining the formation of a relational rents (Dyer & Singh, 1998), that will be distributed among the partners of the alliance according to different power dynamics (Lavie, 2009). The recombination of the internal resources of the company with the network resources should have a positive effect on productivity, since a leverage of the resources of the focal company occurs.

These mechanisms for obtaining network resources can determine for the focal company two possible ways of generating a competitive advantage. The first is based on the scope and quality of the mobilised network resources (reach-based advantage), while the second is based on the company's ability to recombine the network resources with its own resources (richness-based advantage) (Gulati et al., 2011). Based on the above, we propose the following hypothesis:

H6: Network resources have a positive effect on the productivity of the company.

The following figure (Fig. 1) shows the empirical model that has been analysed.

3. Data and methodology

The present work uses the global airline industry to verify the proposed hypotheses. The selection of this industry is based on the following reasons. First, it is an industry characterised by the proliferation of cooperative agreements and the presence of constellations of firms that operate globally (Lazzarini, 2007). The proliferation of all these relationships gives rise to alliance portfolios (Wassmer, 2010). Second, this industry allows a clear identification of the key resources; that is, the routes and destinations that each company operates (Wassmer & Dussauge, 2012). The destinations that connect these routes can be considered the markets of the companies (Wassmer & Dussauge, 2012) and are directly linked to the performance obtained by the company. Finally, this industry has been used in previous studies on networks and strategic alliances (Casanueva et al., 2014; Cobeña et al., 2017; Cobeña, Gallego, & Casanueva, 2019; Gimeno, 2004; Hoehn-Weiss et al., 2017; Wassmer et al., 2017).

3.1. Sample

The sample was determined from the list of the 200 largest airlines ranked by traffic level in 2011. This list was published by the specialised magazine Airline Business in August 2012. From that list, we determined, thanks to the use of the OAG (Official Airline Guide) database (2016), the alliance portfolios of the airlines in the sample. We

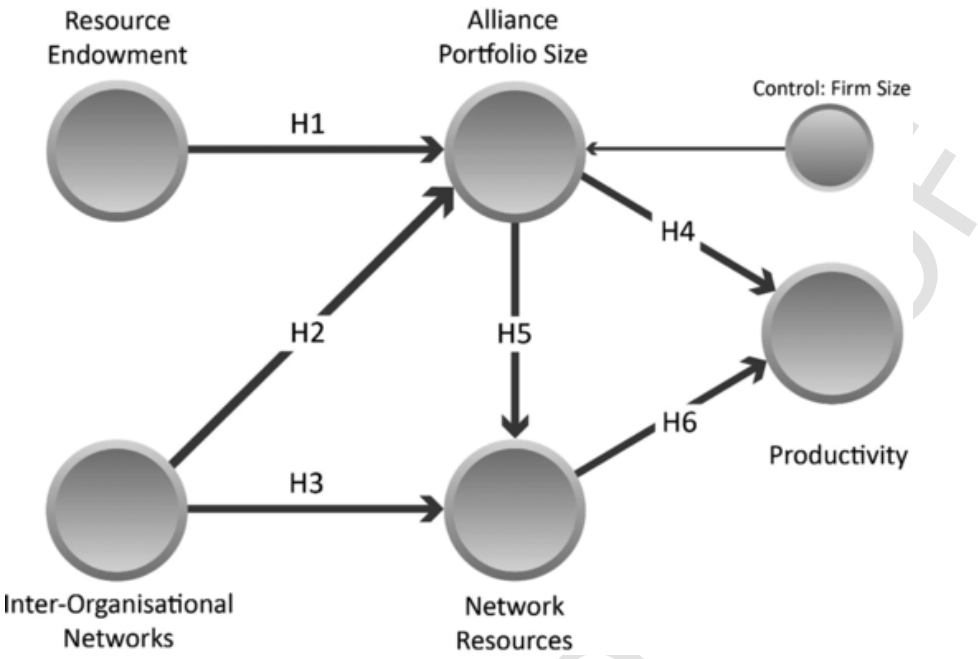

Fig. 1. Conceptual model.

considered that an airline has an alliance portfolio when it has at least two active alliances (Lavie, 2007; Wassmer, 2010). We used codeshare agreements as exploitation alliances. These agreements consist of a joint collaboration for the sale of flight tickets (Casanueva et al., 2014). Thus, two companies sell tickets for the same flight that only one of them operates. After applying this criterion, a sample of 110 airlines was obtained.

3.2. Variables

3.2.1. Dependent variables

The dependent variable of this study, the *productivity* of the company, is composed of four operational indicators that are considered standard indicators in the airline industry: the Revenue Passenger Kilometres (RPK) per employee, the Available Seat Kilometres (ASK) per employee, the Load Factor (LF) of the focal airline and the Revenues per employee.

1) **Revenue passenger kilometres (RPK) per employee:** This is a measure directly linked to passenger traffic and, therefore, to the airline's demand. It measures the number of passengers actually transported based on the kilometres flown of the focal airline in 2011 divided by the number of employees in that year.
2) **Available Seat Kilometres (ASK) per employee:** This measures an airline's carrying capacity and is equal to the number of seats available multiplied by the number of kilometres flown of the focal airline in 2011 divided by the number of employees in that year.
3) **Load Factor (LF):** This indicator measures the airline's capacity utilisation. This airline industry metric measures the percentage of available seating capacity that is filled with passengers.
4) **Revenue per employee**: This indicator is calculated by dividing the revenue in 2011 of the focal airline by the number of employees in that year.

3.2.2. Independent variables

1) **Resource endowment of the focal firm.** This variable is measured through three indicators:
   a) **Routes:** number of routes of the focal airline in 2011.
   b) **Destinations:** number of destinations of the focal airline in 2011.
   c) **Fleet**: number of aircraft available to the focal airline in 2011.

2) **Inter-organisational networks.** This variable refers to the focal airline belonging to one of the three main constellations (Star Alliance, Oneworld and SkyTeam) of the industry analysed. This construct is defined by the following indicators:
   a) **Constellation.** This is a dichotomous indicator in which the value 0 has been attributed to companies that were not part of any of the three main constellations and 1 otherwise.
   b) **Constellation size.** This indicator measures the number of partners that are part of the constellation to which the focal airline belongs. If the company does not belong to any, the value 0 is attributed.
3) **Alliance portfolio size.** This variable refers to the dimensions of the company's alliance portfolio. The indicators that make up this variable are:
   a) **Portfolio size.** This is the number of partners present in the focal company's alliance portfolio.
   b) **Partners from the same constellation**. This is the number of members belonging to the same constellation as the focal airline.
   c) **Reciprocal partners.** This is the number of partners that at the same time provide and receive routes of the focal company.

4) **Network resources.** This variable refers to the network resources that a company is able to mobilise or obtain through its associative behaviour. Through codeshare agreements, the airlines mobilise the customer base of their partners and at the same time increase their own. As a proxy of the customer bases, we used indicators of route exchanges between the focal airline and its partners.
   a) **Number of routes provided.** This is the total number of routes that a focal company shares with its partners. It is calculated as the sum of the routes that the focal airline makes available to each partner.
   b) **Number of routes received.** This is the total number of routes that a focal company receives from its partners. It is calculated

as the sum of the routes that the focal airline receives from each partner.

c) **Mean of routes provided.** This indicator represents the average number of routes that the focal airline provides to each partner.

d) **Mean of routes received.** This indicator represents the average number of routes that the focal airline receives from each partner.

e) **Collaboration level of the focal airline**. This indicator shows what percentage of its routes the focal airline lends to its partners.

f) **Average n° of partners in routes provided.** This indicator represents the average number of partners to which the focal airline lends its routes in codeshare.

3.2.3. Control variable

Size of the focal firm. This variable measures the size of the focal company through the natural logarithm of the number of employees in 2011.

3.3. Data analysis method

To estimate and validate the proposed model, we use a structural equation model, based on the partial least squares approach (PLS-SEM). There are different reasons for the choice of this technique. First, due to its casual and predictive nature. Second, due to the small sample size (Chin & Newsted, 1999; Reinartz, Haenlein, & Henseler, 2009), since it is made up of 110 companies. And finally, this technique is the most appropriate for analysing secondary data sets (Gefen, Rigdon, & Straub, 2011). The software used to treat the model was SmartPLS (v. 3.3.2) (Ringle, Wende, & Becker, 2015).

To evaluate the robustness and consistency of the model, the endogeneity present in the model was tested (Hult et al., 2018) by performing a Gaussian copula analysis (Park & Gupta, 2012). The statistical software R (v. 4.0.2) was used for this analysis, adding the "KScorrect" package to perform the Kolmogorov–Smirnov test with Lilliefors correction (Sarstedt & Mooi, 2014) and the "car" package to create and evaluate the Gaussian copula function (Hult et al., 2018). This analysis rejected the presence of endogeneity in the model presented in this paper. Additionally, a sensitivity analysis of the results has been carried out to check if the results could be driven by the presence of one of the three constellations. A brief description of the statistical procedures and their results are discussed in the Appendix.

4. Results

The PLS-SEM evaluation was carried out in two stages (Roldán & Sánchez-Franco, 2012): the assessment of the measurement model and that of the structural model.

4.1. Measurement model

Since our main constructs are artefacts, the indicators of the composites could probably be correlated (Henseler, 2017). Due to this, we estimated our model in Mode A using correlation weights (Table 1) (Rigdon, 2016). In this modality, the indicators are manifestations of the constructs and, therefore, each indicator reflects the essence of the construct that it defines (Diamantopoulos & Siguaw, 2006).

Following the process in the analysis of this type of models, we determined the measures of internal consistency, reliability, and validity of all the elements involved in the model (Henseler, Hubona, & Ray, 2016; Henseler, Ringle, & Sarstedt, 2016). Not all the indicators have loadings above 0.7, however, these weak indicators were maintained as they help to extract useful information to create a better score for the latent variables (Hair, Sarstedt, Ringle, & Mena, 2012) (Table 1). In addition, all the components achieve a composite reliability (ρc) greater than 0.7 (Table 1), and hence these variables reach a satisfactory construct reliability (Chin, 1998). The average variance extracted (AVE) is then applied to assess the convergent validity (Henseler, Ringle, & Sinkovics, 2009). All the composites meet this criterion since their AVEs exceed the 0.5 level (Table 1).

Table 1
Measurement model. Results.

Construct/indicator	Loadings	Weights	Cronbach's Alpha	ρc	AVE
Productivity			0.886	0.928	0.772
ASK/Employees	0.977	0.303			
RPK/Employees	0.982	0.312			
Load Factor	0.527	0.173			
Revenues/Employees	0.944	0.325			
Resources Endowment			0.921	0.949	0.861
Routes	0.874	0.264			
Destinations	0.941	0.435			
Fleet	0.967	0.372			
Inter-Organisational Networks			0.930	0.966	0.935
Constellation	0.963	0.491			
Constellation size	0.970	0.543			
Alliance Portfolio size			0.962	0.975	0.929
Portfolio size	0.959	0.320			
Partners from the same constellation	0.948	0.362			
Reciprocal partners	0.983	0.356			
Network Resources			0.801	0.861	0.518
Number of routes provided	0.838	0.285			
Number of routes received	0.886	0.321			
Mean of routes provided	0.740	0.169			
Mean of routes received	0.712	0.163			
Collaboration level	0.587	0.213			
Average n° of partners in prov. Routes	0.470	0.235			
Size			1	1	1
N° of employees	1	1			

ρc composite reliability, *AVE* average variance extracted

Finally, all the variables attain discriminant validity. This is evaluated by applying Fornell and Larcker's (1981) criterion and the Heterotrait-Monotrait Ratio (HTMT) of 0.9 criteria (Henseler, Ringle, & Sarstedt, 2015) (Table 2). This means that each variable differs from the others.

4.2. Structural model

Next, the sign, size and significance of the structural path coefficients, the f^2 values, the R^2 values of the relationships established between the constructs are assessed (Roldán & Sánchez-Franco, 2012). A bootstrapping process (10,000 subsamples) was used to generate t-statistics and confidence intervals (Streukens & Leroi-Werelds, 2016). This enables the evaluation of the statistical significance of the path coefficients. Four of the six direct effects, described in Table 3 and Fig. 2, are significant. These direct effects support hypothesis 1, 2, 5 and 6.

The explained variance (R^2) is 0.655 for the alliance portfolio size construct, 0.315 for the network resources construct, and 0.286 for the productivity construct (Table 3). These values exceed the 0.25 minimum value established by Hair, Sarstedt, Hopkins, and Kuppelwieser (2014).

Due to the relations present in the model and following the guidelines proposed by Nitzl, Roldan, and Cepeda (2016), we calculated indirect effects to test hypotheses 3 and 4, whose direct effects have not been significant (Table 4). The bootstrapping procedure has been used to test the indirect effects using the percentile confidence intervals (Real, Roldán, & Leal, 2014). As Table 4 shows, all the total and indirect effects are significant. These results lead us to support H3 and H4. With respect to both hypotheses, the results show a case of full mediation be-

Table 2
Measurement model. Discriminant validity.

Fornell–Larcker criterion							Heterotrait–Monotrait ratio (HTMT)					
	APS	RE	IN	NR	P	S		APS	RE	IN	NR	P	S
APS	**0.964**						APS						
RE	0.479	**0.928**					RE	0.491					
IN	0.780	0.362	**0.967**				IN	0.819	0.379				
NR	0.561	0.713	0.437	**0.720**			NR	0.596	0.823	0.480			
P	0.371	0.806	0.240	0.527	**0.879**		P	0.379	0.867	0.253	0.616		
S	0.392	0.594	0.312	0.391	0.729	**1**	S	0.401	0.603	0.326	0.424	0.760	

APS alliance portfolio size, RE Resource endowment, IN inter-oganisational networks, NR Network resources, P productivity, S Size.
Fornell–Larcker criterion: Diagonal elements (bold) are the square root of the variance shared between the constructs and their measures (average variance extracted). Of-diagonal elements are the correlations between constructs. For discriminant validity, diagonal elements should be larger than of-diagonal elements.

Table 3
Effects on endogenous variables.

	Direct Effect	*t*-value	*p* value	PCI	Explained variance (%)	f^2
Productivity (R^2 = 0.286)						
H4 (+): Alliance Portfolio Size	0.109	0.912	0.181	[−0.154; 0.245] N. Sig.	4	0.011
H6 (+): Network Resources	0.466	4.743	0.000	[0.381; 0.715] Sig.	24.6	0.209
Alliance Portfolio Size (R^2 = 0.655)						
H1 (+): Resource endowment	0.192	3.616	0.000	[0.110; 0.286] Sig.	9.2	0.066
H2 (+): Inter-Organisational Networks	0.691	12.391	0.000	[0.594; 0.777] Sig.	53.9	1.184
CV: Firm size	0.062	1.077	0.282	[−0.056; 0.172] N. Sig.	2.4	0.007
Network Resources (R^2 = 0.315)						
H3 (+): Inter-Organisational Networks	−0.002	0.02	0.492	[−0.164; 0.126] N. Sig.	−0.1	0
H5 (+): Alliance Portfolio Size	0.563	5.636	0.000	[0.440; 0.771] Sig	31.6	0.181

PCI percentile confidence interval. Bootstrapping based on n = 10,000 bootstrap samples. Paths from hypothesised effects are assessed by applying a one-tailed test for a t Student distribution (PCI 90%). Effects from the control variable are assessed by applying a two-tailed test (PCI 95%). Sig. denotes a significant direct effect; N.Sig. denotes a non-significant direct effect.

cause the direct effects are not significant (Nitzl et al., 2016). This means for H3 that the effect of the variable inter-organisational networks on network resources is completely transmitted with the help of the variable alliance portfolio size. Regarding H4, the results show that the effect of the alliance portfolio size on the firm's productivity is completely transmitted with the help of the variable network resources. As there are two cases of full mediation, it is not necessary to calculate the variance accounted for (VAF) index (Hair, Hult, Ringle, & Sarstedt, 2017).

The following figure (Fig. 2) shows the empirical results of our model.

5. Discussion and conclusions

This article studies the impact that a basic aspect of a company's alliance portfolio has on performance using the company's productivity, a measure little used in the literature. This indicator is appropriate when exploitation alliances are used, as in the airline industry. The article also investigates some of the antecedents that determine the size of a company's portfolio.

Regarding the antecedents, the size of a company's alliance portfolio is determined, among other factors, by an internal variable, the company's resource endowment, and by an external one, its membership in inter-organisational networks. In relation to the former, the results show that the focal company's resource endowment is a key variable when explaining the size of the alliance portfolio. This confirms the ideas of the literature as the company's resource endowment represent a source of attraction for partners (Ahuja, 2000b; Gulati & Gargiulo, 1999; Hoehn-Weiss & Karim, 2014). In relation to the latter, this work demonstrates that belonging to an inter-organisational network facilitates the formations of alliances, favouring a larger portfolio size. Participation in a network encourages the development of both collective and individual social capital (Lin, 1999), facilitating the establishment of relationships to exploit resources (Adler & Kwon, 2002; Koka & Prescott, 2002).

Regarding the impact of the size of the alliance portfolio on productivity, this study considers the direct relationship but also the mediation effect through the variable network resources. The inclusion of network resources is relevant because the literature considers that they constitute the basic element for obtaining competitive advantage and superior performance (Gulati et al., 2011; Lavie, 2006). The results suggest that the size of the alliance portfolio does not have a direct effect on productivity, but rather that its effect is manifested in a mediated way through network resources, as theoretically pointed out by Gulati et al. (2011). This mediating effect suggests that, in the case of exploitation alliance portfolios, the productivity of the company depends largely on the degree to which a company can leverage the relationships that make up its portfolio; that is, on the amount of network resources that the focal company obtains from its allies and combines with its own resources (Lavie, 2006).

Accordingly, the network resources that a company can leverage with its own resources directly affects the company's productivity (Lavie, 2006). These network resources are determined by the size of the alliance portfolio but not directly by the participation of the focal firm in inter-organisational networks. The size of the alliance portfolio fully mediates the relationship between the inter-organisational networks and the network resources. These results are relevant to understand the dynamics of these resources and their impact on performance. Belonging to an inter-organisational network does not directly influence the formation of network resources, although in principle it is related with two of the factors that facilitate their creation: reach (possibility of access) and richness (partner resources) (Gulati et al., 2011). This lack of a direct relationship is explained by the important distinction between access and resource mobilisation (Casanueva et al., 2014). The network resources, and therefore the productivity of the airlines, do not mainly depend on whether they belong to a large alliance, but rather on the network of relationships that the firms can establish and mobilise. However, belonging to a large alliance facilitates the creation

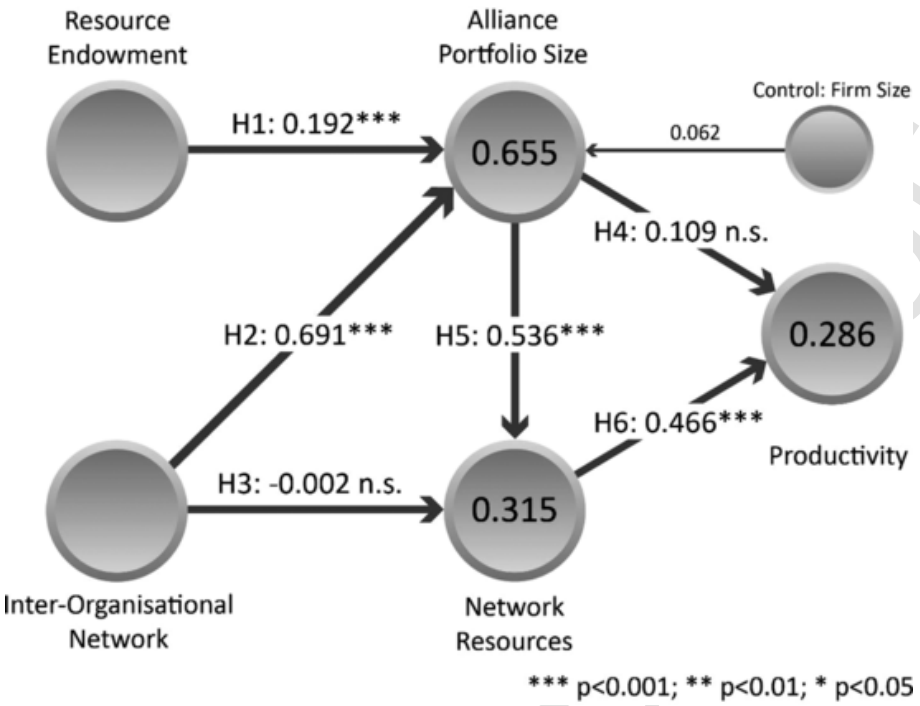

Fig. 2. Empirical results.

Table 4
Summary of mediating effect test.

Total Effect			Direct effect			Indirect effect			
Hypothesis	Coefficient	*p* value		Coefficient	*p* value		Point estimate	PCI	VAF (%)
H3 (+)	0.387	0.000	H4(+): IN to NR	−0.002[ns]	0.492	H4(+): IN to NR (via APS)	0.389	[0.296; 0.555] Sig.	1.01
H4 (+)	0.371	0.000	H5(+): APS to P	0.109[ns]	0.181	H5(+): APS to P (via NR)	0.262	[0.204; 0.494] Sig.	70.6

ns: not significant.
PCI percentile confidence interval. Bootstrapping based on $n = 10{,}000$ bootstrap samples. *APS* alliance portfolio size, *IN* inter-organisational networks, *NR* network resources, *P* productivity.
Paths from hypothesised effects are assessed by applying a one-tailed test for a *t* Student distribution (PCI 90%). Sig. denotes a significant direct effect. *VAF* variance accounted for.

of these relationships and as a result increases the alliance portfolio and network resources, with the consequent impact on productivity.

The sum of all these relationships between variables reflects the importance of the alliances in the productivity of the company, in an industry in which having wide networks of routes and destinations has a remarkable importance for customers (Doganis, 2006): a greater number of active alliances gives rise to a bigger alliance portfolio of alliances and a greater amount of network resources, which determines a significant increase in the company's productivity.

From an academic point of view, this work makes several contributions. First, the antecedents of the alliance portfolio are explored, a little studied issue in the literature and only through case studies (Capaldo, 2007; Lavie & Singh, 2012). The consideration of inter-organisational networks as an antecedent of the alliance portfolio is an original aspect, since it emphasises how the development of collective social capital (Lin, 1999) influences the size of the alliance portfolio.

Second, although the relationship between the alliance portfolio and performance has been extensively studied in the literature, very few works use productivity to measure the dependent variable. Each performance measure must be appropriate to the type of alliance analysed, so that when considering exploitation alliances, it seems logical to use performance indicators that are more related to the operating results of the companies. The high variance explained in the models analysed confirms this statement.

Third, studies confirming the importance of the size of the alliance portfolio on performance (Ahuja, 2000b; Kim et al., 2015; Kim & Choi, 2014; Mouri et al., 2012) point out the need to go deeper into that relationship and understand the underlying variables. This work includes a variable that according to the literature can explain the performance of companies in interconnected environments: network resources (Gulati et al., 2011; Lavie, 2006). The empirical analysis of this variable is a relevant contribution because, although it has been analysed somewhat at a theoretical level, there are few studies that attempt to operationalise it. The results show the importance of these network resources to explain the performance of the company, measured through productivity.

From the business perspective, the results show the importance of the focal firm's resource endowment and inter-organisational networks in developing an alliance strategy. The objective of this strategy is to determine a broad alliance portfolio to increase the network resources available to the company. In turn, the leverage of these network resources will increase the focal firm's productivity. In order to achieve a broad alliance portfolio, the focal firm has to equip itself with a series of resources that make it attractive to potential partners. In the same way, participation in inter-organisational networks represents a relevant factor to build up a broad alliance portfolio. The combination of these two factors can lead to a virtuous circle in the company's alliance strategy. Therefore, managers must be proactive to intensify the formation of relationships with their partners.

The present work has certain limitations that should be noted. First, it only considers one type of resource. Although the previous literature has established that routes and destinations are key resources in the airline industry (Wassmer & Dussauge, 2012), there are other resources that have not been borne in mind in this work and can complement the results obtained. Second, we have analysed one type of exploitation alliance, codeshare agreements, not including other exploitation agreements, such as those destined for marketing activities. However, the literature of the sector shows that codeshare agreements are the most common form of cooperation in the airline industry (Doganis, 2006). Third, the cross-sectional nature of the study makes it difficult to verify causal relationships, although they are firmly established in the literature. Finally, the peculiarities of the industry analysed can hinder the generalisation of the results, though we consider that our theoretical arguments are valid for all those environments characterised by interconnected firms, where companies develop an intense cooperative activity (Lavie, 2006).

These limitations may provide opportunities for future research. First, we suggest the replication of this study in other industrial contexts, which are characterised by a close relationship between competitors. Second, it would be interesting to include other types of resources and alliances, such as the exploration alliance, in order to generalise the results obtained. Finally, a longitudinal study is necessary to verify the causality of established relationships and to understand the dynamics that companies follow in the formation of their alliance portfolios. This issue has been analysed in various case studies (Capaldo, 2007; Lavie & Singh, 2012) but has barely received attention in research using large data samples.

Uncited references

Park et al., 2015
Sarkar et al., 2009

CRediT authorship contribution statement

Marco Castiglioni: Conceptualization, Methodology, Software, Formal analysis, Writing - original draft, Writing - review & editing, Visualization. **Mar Cobeña:** Conceptualization, Methodology, Formal analysis, Writing - original draft. **José Luis Galán:** Conceptualization, Writing - original draft, Writing - review & editing, Supervision.

Declaration of Competing Interest

None.

Appendix A. Sensitivity checks and endogeneity analysis

A.1. Sample selection

With this analysis it has been verified whether the results are biased due to sample selection which generally arises when the criteria for choosing observations are dependent on the outcome variable (Heckman, 1979). In this paper, while observations based on the outcome variable were nor chosen, in the sample some of the airlines are, however, members of one of the three constellations that dominate the industry. Therefore, a sensitivity analysis was carried out to check if the results could be driven by the presence of one of the three constellations. For this reason, the results were verified using alternative samples (subsamples) without the presence, alternately, of one of the three constellations. The results of the three tests performed do not differ significantly from those of the full sample. So, the presence of none of the constellations distorts the results.

A.2. Endogeneity

In order to reject the presence of endogeneity in the model, the Gaussian copula approach has been carried out following the recommendations of Hult et al. (2018).

This approach controls for endogeneity by directly modelling the correlation between the endogenous variable and the error term by means of a copula. This statistical test was introduced by Park and Gupta (2012). For each construct of the model, its latent variable score has been determined. Subsequently, and as a prerequisite for the Gaussian copula approach, it has been verified through the Kolmogorov–Smirnov test with the Lilliefors correction (Sarstedt & Mooi, 2014) that each variable did not follow a normal distribution. After these checks of requirements, the Gaussian copula analysis was performed for each of the three dependent variables of the model (i.e., productivity, alliance portfolio size and network resources). In this analysis, to determine whether endogeneity is at a critical level, researchers need to assess the significance of the copula coefficient. A significant coefficient indicates a critical level of endogeneity. The other coefficients present in the models can be significant. The significance of the coefficients is calculated through a regression based on bootstrapped standard errors (Park & Gupta, 2012).

The different analyses of the three dependent variables of the model rule out endogeneity problems. The next table (Table 5) presents the results of the endogeneity analysis of the final dependent variable: productivity. As the table shows, none of the Gaussian copulas is significant ($p < 0.1$). The results of the endogeneity tests of the other variables can be requested from the authors.

Table 5
– Results of the Gaussian copula analysis (Dependent variable: Productivity).

	Original model		Gaussian copula Model 1 (endogenous variable: Alliance Portfolio Size)		Gaussian copula Model 2 (endogenous variable: Network Resources)		Gaussian copula Model 3 (endogenous variable: Alliance Portfolio Size; Network Resources)	
Variable	Value	*p*-value	Value	*p*-value	Value	*p*-value	Value	*p*-value
Alliance Portfolio Size	0.109	0.279	0.074	0.786	0.110	0.272	0.075	0.783
Network Resources	0.466	0.001	0.466	0.001	0.472	0.169	0.474	0.157
Copula (All. Portfolio Size)			0.035	0.897			0.036	0.898
Copula (Network Resources)					−0.007	0.976	−0.008	0. 971

To rule out endogeneity problems between the variables, the *p*-values of the copula functions have to be non-significant (*p*-value >0.10).

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