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Strategic groups and product differentiation: Evidence from the Spanish airline market deregulation

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We examine the rivalry of strategic groups of formerly regulated carriers and low-cost entrants. Profit effects stemming from strategic interactions at the group level and resulting in product differentiation are considered. A conjectural variations model, addressing a critique by Corts, is used to test the hypothesis that group-level effects stemming from product differentiation lead to asymmetric behaviours by both groups of carriers within and between strategic groups. The effects of group-level strategic interactions on firm performance are analysed for two of the busiest and highest density routes in the Spanish domestic market. We find evidence of asymmetric rivalry behaviour within and between strategic groups.

1. Introduction

Many scholars have studied strategic groups in the airline industry in an attempt to understand strategic behaviour, competition and differential firm performance (Bailey & Williams, 1988; Boyd, 2004; Carroll, 2018; Kling & Smith, 1995; Murthi et al., 2013; Pegels et al., 2000; Peteraf, 1993; Smith et al., 1997). Strategic groups are usually defined as sets of firms with similar strategies or as groups of firms isolated by common mobility barriers in an industry (Goll et al., 2006; Porter, 1979). Scholars have analysed the history of the U.S. airline industry to identify strategic groups after the deregulation that ended in 1978. In 1984, Peteraf (1993) identified formerly regulated carriers and post-deregulation new entrants. Bailey and Williams (1988) identified *trunks* and *locals* resulting from earlier U.S. regulation, and new-entrant carriers, as distinct strategic groups. These groups illustrate the different rent-producing sources that existed between 1978 and 1984 (post--deregulation period). The underlying idea is that strategic groups can develop in response to regulation and institutional structure.

Alternatively, Dranove et al. (1998) proposed a theory-based empirical approach to identify group-level effects on performance and thus show the existence of strategic groups. Based on this approach, a strategic group exists if the features of the group affect the performance of a firm independently of firm- and industry-level effects. We consider that group-level effects may arise in the airline industry in the form of product differentiation. We build our proposal on the logic that product differentiation varies amongst business and leisure travellers, and these segments are of varying relative importance to the different strategic groups in the industry (Markman & Waldron, 2014; Martínez et al., 2017; Murthi et al., 2013).

We follow the approach described by Dranove et al. (1998) and draw on industry history (Peteraf, 1993) to identify strategic groups of formerly regulated carriers and low-cost entrants in the Spanish domestic market after deregulation (see Section 3.1). We assume that the characteristics of these strategic groups can affect their group behaviour through the dynamic effect of product differentiation, which encourages or discourages competition in the airline industry. Following deregulation, pacific behaviour would not take place because established formerly regulated firms come under threat from low-cost entrants

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(Anderson et al., 2005; Pels, 2008; Pitfield, 2008). Instead, formerly regulated carriers must compete aggressively to defend their main segment of clients (business travellers) against low-cost entrants. In fact, as low-cost entrants become more established in a non-restricted market, they can expand their network and services to target this segment of less price-sensitive clients (business travellers). However, formerly regulated firms would remain non-aggressive with other group members with similar cost structures because they can take advantage of product differentiation, at least for the business traveller segment. We therefore predict asymmetric rivalry. Formerly regulated firms expect to be accommodated by firms within their group and by low-cost entrants, whilst low-cost entrants expect to experience substantial retaliation from formerly regulated firms and no reaction from other firms in their strategic group.

The aim of this study is to test the existence of asymmetric rivalry within and between strategic groups in the airline industry, under the assumption that strategic interactions result in product differentiation effects. We estimate the effect of group-level strategic interactions on firm performance using a conjectural variations model. We analyse data from the Spanish airline industry between 2002 and 2009 (immediately after deregulation).

2. Theory and research hypotheses

Scholars have devoted considerable attention to analysing the competitive reactions of established airlines in response to deregulation. In general, incumbent firms respond before and after the liberalisation of the entry of new competitors. This entry also improves incumbents' efficiency (Gagnepain & Marín, 2006; Gillen et al., 1990; Good et al., 1993; Forsyth, 2001). However, deregulatory processes may have a limited effect on prices because established firms usually retain strong market power and take advantage of economies of density (Marin, 1995; Fageda & Fernández-Villadangos, 2009). Several studies have suggested that price-competitive reactions of an established carrier depend on the level of similarity between the incumbent and entrant (full-service carrier vs. low-cost carrier). In the context of deregulation, the closer the entrant is to the established carrier, the greater the expected price response will be (Oliveira & Huse, 2009; Pinkse et al., 2002). Nevertheless, the entry of low-cost carriers under deregulation compels incumbent firms to reduce costs to remain competitive (Gagnepain & Pereira, 2007; Tsoukalas et al., 2008).

The strategic group literature in the airline industry has scarcely analysed specific deregulatory contexts.[1] Some studies have used industry history to identify strategic groups. Bailey and Williams (1988) classified carriers into trunks and locals resulting from earlier regulation in the U.S. airline industry. In contrast, Vila and Córcoles (2011) identified traditional flagship and low-cost airlines after European deregulation. Also, in the United States, Peteraf (1993) classified airlines into formerly regulated and post-deregulation newer carriers. The study examined the hypothesis that rivalry is greater between groups than within groups, with rivalry based on average price/cost ratios. The underlying logic is that within group rivalry is rare because members of a group respond in a similar way to environmental changes and can recognise their mutual dependence and steer competitive behaviour towards activities that create barriers to mobility (Porter, 1979).

Instead, we study asymmetric rivalry within and between strategic groups. We adopt the strategic group definition given by Dranove et al. (1998), where a strategic group exists if the performance of a firm in a group is a function of the features of the group after controlling for the characteristics of the firm and the industry. Murthi et al. (2013) also found evidence in favour of this definition of strategic groups in the U.S. airline industry. Using latent class regression, they clustered firms based on the similarities of the response coefficients that explain firm performance. However, they did not explicitly study rivalry within and between groups. Complementing the previous research, our study presents a new empirical industrial organisation (NEIO) model to estimate the conjectural variations that capture the asymmetric competitive conduct of strategic groups. We assume that members' strategic interactions derive from product differentiation, which is vital for there to be group-level effects on performance. We also assess whether dynamic rivalry within and between groups is systematically and predictably asymmetric.

2.1. Asymmetric rivalry within and between strategic groups of formerly regulated firms and low-cost entrants

Theory on strategic groups based on members' strategic interactions (see Dranove et al., 1998) suggests that strategic interactions depend on expectations about rivals' decisions. Hence, a variety of combinations of collective and competitive actions can coexist (Mas-Ruiz et al., 2005). Here, we must consider whether firms in groups behave strategically.

Normative game theory models developed in Industrial Organisation research identify several optimal behavioural strategies (see Fudenberg & Tirole, 1984; Tirole, 1988; Tombak, 2006) that an established firm (hereinafter the incumbent) may adopt in response to a threat from a non-established firm (hereinafter the entrant or competitor). According to the *top-dog strategy*, an incumbent should overinvest by, for example, increasing its client base (being big or strong to look tough and aggressive) to deter or accommodate the entrant (gentle behaviour; Tirole, 1988). When an incumbent pursues a *fat-cat* strategy, it should overinvest (being big or strong to look soft and harmless) to accommodate the entrant by acting less aggressively thereafter. For instance, the incumbent will advertise heavily to soften the entrant's pricing behaviour. Under a *lean-and-hungry look* strategy, the incumbent should underinvest (being small or weak to look tough and aggressive) to deter or accommodate the entrant. As an illustration, the incumbent will underinvest in advertising because by lowering its stock of goodwill, it establishes a credible price-cutting threat in the event of entry. Lastly, under the *puppy-dog ploy*, an incumbent should underinvest by, reducing its supply (being small or weak to look soft and harmless) to accommodate the entrant rather than reacting aggressively.

These behaviours and their evolution can be examined in the airline industry. We argue that group characteristics can affect group behaviour and firm profitability through the effect of product differentiation.

2.1.1. Product differentiation as a group-level effect in the airline industry

In airline markets, the importance of product differentiation varies by user. Business travellers attach major importance to frequent schedules and a large, single-carrier network, perhaps with a first-class service. In contrast, leisure travellers care little about these conveniences (Fageda & Fernández-Villadangos, 2009; Martínez et al., 2017). Firms belonging to such markets can effectively implement product differentiation through price discrimination and can therefore coexist at different levels of rivalry (Berry, 1990; Mas-Ruiz et al., 2005).

In general, the theoretical approaches by Schmalensee (1983) and Fudenberg and Tirole (1984) consider the *fat-cat* strategy optimal for incumbents in some regulated industries such as the airline industry (see Call & Keeler, 1985; Sancho-Esper & Mas-Ruiz, 2019; Tombak, 2006). An established firm with a large market share can adjust prices to match

[1] Kling and Smith (1995) and Cappel et al. (2003) applied Porter's (1980) model to the U.S. airline industry to identify strategic groups (quality differentiation, cost leadership, focus and stuck in the middle). Boyd (2004) identified strategic groups (national flag carriers, international carriers and regional carriers) in the worldwide airline industry for the period 1998 to 2000 through cognitive perceptions of industry experts, but no significant differences in performance were found between groups. Finally, cluster analysis has been applied to strategic variables to identify strategic groups (entrenched-dominant, high-end flyer and niche-seeker) in the U.S. domestic industry between 1978 and 1986 (Smith et al., 1997) and in the European airline industry (low-cost and full-service airlines) in 2012 (Carroll, 2018).

those of the entrant when the incumbent can fully discriminate between customers who prefer its products and those who are indifferent to its products and the products of the new entrant. The new entrant must provide leisure travellers with a service that replaces the service provided by the incumbent, and the incumbent must provide a more extensive network, higher frequency or better in-flight service to capture business travellers. Therefore, price elasticity in the demand should be higher for leisure travellers than for business travellers (Daraban & Fournier, 2008; Martínez et al., 2017). In this situation, if the new entrant mainly serves leisure travellers, the incumbent will set lower prices with some restrictions of advance purchase, minimum stay and limited numbers of seats (Marin, 1995). In contrast, in the business market, the incumbent will maintain high prices. Thus, product differentiation decisions (for example, lavish in-flight services on established airlines) are intended to replace price reductions and lead firms to seek niche markets for their products (Tirole, 1988). An incumbent firm's strategic response to new entrants would be to keep business-oriented fares and offer extra benefits to retain the loyalty of frequent flyers (Levine, 1987; Oliveira & Huse, 2009).

Nevertheless, competitive response in these product markets is also sensitive to the relative costs of established and entrant companies (Call & Keeler, 1985). If both firms (incumbent and new entrant) had the same cost structure and the incumbent could discriminate between prices for business and leisure travellers, the incumbent would keep charging a high price in the business travel market to take advantage of its strong positioning within this market. The incumbent would also impose a series of restrictions (for example, advance purchase and length-of-stay requirements) that would reduce the price only for the tourist market (Marin, 1995). Thus, if the incumbent airline and the entrant knew each other's costs, the incumbent could always prevent entry to the tourist market, and the entrant would not even try to enter. Therefore, the price would remain high in the tourism market (Call & Keeler, 1985).

On the contrary, if the entrant had lower costs than the incumbent, it would set lower prices for the tourism market and would force established carriers to cut prices and costs (Evanoff & Ors, 2008; Gatignon & Bansal, 1990). In this case, the new entrant would set a lower price and would attract a significant portion of the tourism market. The incumbent would have little incentive to reduce its prices because by doing so it would reduce profits from the business market. In fact, it might increase its prices because the only market it would consider would be the business market, where demand is less elastic (Call & Keeler, 1985). Under this scenario, the airline industry seems to be characterised by *fat-cat* formerly regulated firms pursued by new entrants with similar cost structures and by new low-cost entrants.

It is assumed that markets with product differentiation are stable and include incumbents that act as less aggressive *fat cats*, whilst new entrants focus on the leisure travel market. However, the opposite scenario is also possible (Fudenberg & Tirole, 1984). Under a change in market conditions (for example, elimination of capacity constraints for entrants), incumbents may act more aggressively when low-cost entrants threaten the business segment. Thus, product differentiation itself can lead to major *dynamic effects*.

New entrants' lower costs, which allow new entrants to set lower prices than incumbents, enable new firms to steal the tourism market from incumbents. After some time, incumbents will cease to apply the *fat-cat* strategy to face low-cost entrants because the growing recognition of these new entrants allows them to expand flight schedules, build their own networks and even target business travellers (Call & Keeler, 1985). Some low-cost firms can use their cost advantages to provide a better service than incumbents without charging high prices. In Spain, low-cost carriers such as Ryanair and easyJet have increased flight frequencies and improved services to accommodate business travellers (Beria et al., 2017; Fageda et al., 2015). Therefore, incumbents are forced to adjust prices to compete with these new entrants to avoid being pushed out of the market. Thus, the complex structure of the *fat-cat* strategy followed by formerly regulated firms would be eroded over time because of the availability of unrestricted low fares.

The underlying idea is that as time passes and new low-cost firms enter and expand their networks, incumbents lose their supremacy in the market and the market power that once allowed them to charge high prices (Fu et al., 2011). In this situation, product differentiation between formerly regulated firms and low-cost entrants is low. Passengers who seek the benefits of low unrestricted prices can get them easily, at least on busier routes (Call & Keeler, 1985; Ferrier et al., 1999). In this context, the industry seems to comprise aggressive formerly regulated firms pursued by low-cost entrants. However, for the business travel market, established firms can still take advantage of product differentiation with respect to entrants with similar cost structures. In this situation, the industry seems to consist of non-aggressive formerly regulated firms pursued by entrants with similar cost structures and more established route networks.

Hence, the effects of product differentiation may lead to dynamic asymmetric rivalry within and between groups of formerly regulated and low-cost firms in a period in which capacity constraints for entrants are eliminated. Thus, asymmetric rivalry can be predicted as formerly regulated firms evolve from less aggressive *fat cats* to more aggressive *top dogs* when facing low-cost entrants in the business traveller segment (that is, in a situation of low product differentiation). However, formerly regulated firms would remain non-aggressive towards entrants with similar cost structures because they can still take advantage of product differentiation in the business traveller segment. We therefore propose that:

H1. In the period after deregulation, the members of the group of formerly regulated carriers would expect to be accommodated by other members of their own strategic group and by members of the strategic group of low-cost carriers.

H2. In the period after deregulation, the members of the strategic group of low-cost carriers would expect substantial retaliation from members of the strategic group of formerly regulated carriers and no reaction from other low-cost firms within the same strategic group.

3. Research design

3.1. Strategic groups in the Spanish airline industry

The Spanish airline industry provides an interesting research setting. Its history helps explain how strategic groups of formerly regulated firms and new low-cost entrants have formed, promoting members' strategic interactions in terms of product differentiation.

Market structure regulation on new company entry and the regulation of firm behaviour through price setting have shaped the history of the European airline industry (Bel et al., 2006; Pitfield, 2008). The airline market is highly deregulated in Spain, which has one of the largest domestic airline markets in the European Union (Fageda and Fernández-Villadangos, 2009). Initially, regulation removed competition, and only the monopolistic carrier, the state-owned company Iberia, could provide airline services. Air transport deregulation in Europe began in 1987 with the First Package of measures (defence of competition, the directive on fares and the decision on bilateral air transport agreements). However, the full effects of deregulation were actually felt in 1993, when the Third Package of measures allowed new companies to access the domestic market (Button et al., 1998; Doganis, 1994; Pitfield, 2008).

Despite this deregulation, competition within the Spanish domestic market still remained limited between 1993 and 1997 because of three idiosyncratic features: restrictions on the entry of foreign firms until 1997, Iberia's monopoly on access to time slots and the monopoly on handling activities by the state-owned company AENA (responsible for all Spanish civil airports) until 1996 (Rey, 2003). Thus, from 1987 until full liberalisation in 1997, some Spanish newcomers (Air Europa and

Spanair) competed on certain routes (for example, Madrid to Barcelona and peninsula to islands) and gradually expanded to other high- and low-density routes. Other Spanish newcomers (Air Nostrum, Panair and Air Truck) offered services on regional routes. These private entrants, which offered low prices, could be considered *puppy dogs* because they maintained their limited capacity for capturing clients and posed no major threat to the large established firm (Iberia). Iberia behaved like a *fat cat*. According to Levine (1987), the product differentiation associated with business and leisure travellers temporarily allowed Iberia to keep its high-paying business customers. Simultaneously, by offering discount fares with restrictions, Iberia appealed to price-sensitive travellers attracted to new private airlines.

However, in 1997, these private carriers raised their economy fares by a proportionally higher degree than Iberia did. As small-scale companies, they seemingly opted to sign a peace settlement (Rey, 2003). This assumption of collusion was supported by an interline agreement during the same period, which allowed consultation concerning fares but expressly excluded the striking of deals. This competitive situation can be explained by similarities in the cost structures of the incumbent and private newcomers (see Section 2).

This situation substantially changed after the removal of entry restrictions to foreign companies in 1997. Small foreign low-cost carriers (for example, Virgin Express, Eurowings and easyJet) entered the Spanish market, but they started operating in secondary markets because established carriers were using their control over slots and gates as entry barriers. As stated earlier, in a heterogeneous market with product differentiation, this combination of capacity restrictions on entrants and cost differences between incumbents and entrants suggests that dual segmentation (leisure and business) would diminish price competition in markets. Low-cost entrants would act aggressively, whilst formerly regulated firms would act as less aggressive *fat cats*.

Afterwards, capacity restrictions were removed in Spain when AENA began to make huge investments in airport infrastructures in 2004 to increase capacity. Following this disappearance of first-mover advantages in terms of locational endowments (slots and gates), cost structure differences between established firms and new firms became a key issue. Labour costs became an important disadvantage to formerly regulated carriers because of the strength of the trade unions and the average age of staff, whereas new low-cost entrants were at a competitive advantage (Peteraf, 1993). Additionally, low-cost carriers increased their presence on domestic routes (Fageda and Fernández-Villadangos, 2009; Sancho-Esper & Mas-Ruiz, 2016), and their more optimal cost structures forced established carriers to cut prices and costs. In parallel, Iberia was gradually privatised until 2001. It took over Aviaco, incorporated Binter Canarias and Binter Mediterráneo, and signed a franchise agreement to make Air Nostrum a regional subsidiary. Moreover, Iberia became a member of the Oneworld alliance in 1999, which is the third largest global airline alliance (IATA, 2019). Finally, Iberia and British Airways announced a plan to merge in July 2008, and IAG was launched in 2010. Another network carrier, Spanair, was integrated into Star Alliance and ceased operating in 2012. The third largest Spanish carrier, Air Europa, was owned by the tourist operator Globalia S.A. Thus, airlines' freedom to access the market led to the concentration of the formerly regulated carriers through a process of mergers, takeovers and alliances to improve efficiency (Fageda and Fernández-Villadangos, 2009). This scenario shows that the less aggressive *fat-cat* strategy pursued by established firms no longer applies when reacting to low-cost entrants because incumbents are forced to lower their prices and costs to respond to the threat of new entrants.

In short, unique conditions at the start of deregulation allowed formerly regulated carriers to differentiate themselves from low-cost entrants through first-mover advantages at thin-monopoly or congested space-constrained airports, but with higher factor costs. In addition, the history of the Spanish airline industry shows that group-level effects can arise in the form of product differentiation, and diverse levels of rivalry can therefore coexist.

3.2. Methodology and variables

We follow the theory-based empirical approach presented by Dranove et al. (1998) to identify group-level effects on firm performance. This approach allows us to distinguish between true (group-level) and spurious (firm- or industry-level) effects. In this study, we develop a model to determine whether a strategic group actually exists. By estimating conjectural variations (see Amit et al., 1988; Du et al., 2008) based on strategic interactions, this model can be used to test the existence of asymmetric rivalry within and between strategic groups of formerly regulated firms and low-cost entrants.

The conjectural variations approach has been used repeatedly to infer competitive behaviour. Its main advantage is that a rival's reaction can be captured by a single parameter (Iwata, 1974). However, authors such as Corts (1999) and Kim and Knittel (2004) have pointed out that the conjectural variations approach has potential weaknesses and, in some cases, can yield biased results. Because of the theoretical difficulties in associating the estimated parameters with the underlying economic model, the term 'conjectural variations' has even been avoided by some scholars. Many authors use the term 'conduct parameter' instead to avoid these problems (Oliveira, 2005; Orea & Steinbuks, 2018). Puller (2009) also offers an alternative method, which addresses the critique by Corts (1999) to avoid inconsistent estimates that underestimate firms' market power. Conversely, other authors have reported that the conjectural variations approach still deserves credit (Roy et al., 2006). Roy et al. (2006) compared this approach with other methods (that is, Granger causality and non-nested models) in five industries. The comparison suggests that conjectural variations estimates are more consistent for the analysis of the form of competition between firms and reveals no evidence of inconsistencies in previous studies. and Wolfram (1999) found that differences in the estimation of conjectural variations models are comparable to the direct measures of interaction obtained using cost data (see Kadiyali et al., 2001). In short, the conjectural variations framework has been popular in the airline industry (e.g., see Reiss & Spiller, 1989; Oum et al., 1993; Brander & Zhang, 1990, 1993; Fageda, 2006; Fischer & Kamerschen, 2003; and Murakami, 2011, 2013), but theoretical complications can now generate concerns for empirical analyses.

3.2.1. Econometric specification and estimation procedure

We develop a conjectural variations model for the strategic dimension of quantity of output (volume of passengers) to test for asymmetric within- and between-group rivalry in the Spanish airline industry. Brander and Zhang (1990, 1993) and Oum et al. (1993) used passenger volume as one of the main strategic variables to measure competition. Conjectural variations reflect agents' adaptations of expectations of a firm's strategic behaviours as a function of experience (Fischer & Kamerschen, 2003). To estimate this strategic behaviour, we develop a model by simultaneously considering the specifications of cost, price and rivals' reactions for a set of firms ($i = 1, \ldots, n$). To better illustrate the econometric method underlying this study, the three main specifications are presented separately.

Cost specification: The implementation of the model requires the calculation of the cost structure (c_{it}) for each carrier i at time t. This cost structure is affected by quantity of output (q_{it}) and the price of the input factors (w_{it}) of each airline i at time t:

$$c_{it} = c(q_{it}, w_{it}) \quad (1)$$

Price (inverse demand) specification: The price function (p_{it}) for firm i at time t is a function of the firm's own (q_{it}) and rivals' ($q_{jt}; j = 1, \ldots, n; j \neq i$) outputs and a vector of exogenous factors influencing overall inverse demand (z_{it}):

$$p_{it} = p(q_{it}, q_{jt}, z_{it}); \; j = 1, \ldots, n; \; j \neq i \quad (2)$$

To specify the price equation for each airline, the log-linear function is used. This function is widely used in the literature because of its flexibility and relative ease of analysis:

$$lnp_i = \alpha_0 + \alpha_i lnq_i + \sum_{\substack{j=1 \\ j \neq i}}^{n} \alpha_j lnq_j + \alpha_{por} lnpor_i + \alpha_{pde} lnpde_i + \alpha_{dis} lndis_i + \alpha_{ops} lnops_i + \alpha_{ali} lnali_i + \alpha_{gdp} lngdp_i + \alpha_{tur} lntur_i + \alpha_{ffp} ffp_i \quad (3)$$

where α_0 is the intercept; α_i is the elasticity effect of firm i's passenger volume; α_j is the elasticity effect of the quantities (passenger volume) of firm i's rivals; α_{por} is the effect of origin population size; α_{pde} is the effect of destination population size; α_{dis} is the impact of the distance between origin and destination; α_{ops} is the effect of the number of operations of airline i; α_{ali} is the effect of belonging to an alliance of companies; α_{gdp} is the impact of gross domestic product (GDP) in the province where firm i operates; and α_{tur} is the tourism GDP in the destination province. Specifically, this inverse demand function considers the destination tourism index ($lntur_i$), which captures the relative tourist orientation of passengers on a given route as a function of the number of tourist passengers at the destination (Borenstein, 1989). It is a proxy for the predominant customer profile for the route (leisure or business traveller). Finally, α_{ffp} is the effect of offering a frequent flyer program (FFP) to passengers.

The estimation of Equation (3) is affected by the high number of degrees of freedom due to the high number of firms in our sample. Our approach helps overcome this issue. We assume that the airline industry comprises n firms that can be placed into two mutually exclusive strategic groups. To operationalise these groups, we replace the (n-1) individual rivals' demand terms (q_j) with two (one per strategic group) condensed measures, which are computed as two weighted averages of the rivals' quantities of output. The average passenger volumes for the formerly regulated carrier strategic group (q_{frc}) and for the low-cost carrier strategic group (q_{lcc}) are calculated for each airline to express the output of all other airlines competing for the same route in each group. Thus, for each firm, there are two measures that weight the q_{frc} and q_{lcc} values for the firm's rivals. These measures reflect the rivalry the firm faces from each strategic group. Hence, the inverse demand for each airline can be written as follows:

$$lnp_i = \alpha_0 + \alpha_i lnq_i + \alpha_{frc} lnq_{frc} + \alpha_{lcc} lnq_{lcc} + \alpha_{por} lnpor_i + \alpha_{pde} lnpde_i + \alpha_{dis} lndis_i + \alpha_{ops} lnops_i + \alpha_{gdp} lngdp_i + \alpha_{tur} lntur_i + \alpha_{ali} ali_i + \alpha_{ffp} ffp_i \quad (4)$$

where α_{frc} and α_{lcc} are the elasticity effects of the quantities (passenger volume) of firm i's rivals from the frc and lcc strategic groups, respectively.

Rivals' reactions specification: Finally, each firm seeks to maximise its profits (π_{it}):

$$\pi_{it} = r(q_{it}, q_{jt}, z_{it})q_{it} - c(q_{it}, w_{it}) \quad (5)$$

We maximise profits and obtain the following expression

$$(p_i - cmg)/_{p_i} = -\left(\alpha_i + \alpha_{frc} \frac{q_i}{q_{frc}} (SG_i \beta_{frc,frc} + (1 - SG_i)\beta_{frc,lcc}) + \alpha_{lcc} \frac{q_i}{q_{lcc}} (SG_i \beta_{lcc,frc} + (1 - SG_i)\beta_{lcc,lcc}) \right) + \sum_{k=1}^{k\,firms} \alpha_k dummy_k \quad (6)$$

where SG_i is a dummy variable that takes the value 1 if airline i belongs to strategic group frc and 0 otherwise; $\propto_i = \left(\delta p_i / _{\delta q_i} \; q_i / _{p_i} \right)$ is the own-price inverse elasticity of demand for passenger volume; and $\propto_{frc} = \left(\delta p_i / _{\delta q_{frc}} \; q_{frc} / _{p_i} \right)$ and $\propto_{lcc} = \left(\delta p_i / _{\delta q_{lcc}} \; q_{lcc} / _{p_i} \right)$ represent rivals' cross-price inverse elasticities of demand for passenger volume for groups frc and lcc, respectively.

Regarding the conjectural variation parameters, $\beta_{frc,frc} = \left(\delta q_{frc} / _{\delta q_i} \right)$ ($i \, \varepsilon \, frc$ group) is the reaction in the output quantity (marginal change in output) of firms in strategic group frc to an initial quantity move (marginal change in output) of firm i, which belongs to the same group. This parameter measures competitive interaction within strategic group frc in the airline industry. Similarly, $\beta_{frc,lcc} = \left(\delta q_{frc} / _{\delta q_i} \right)$ ($i \, \varepsilon \, lcc$ group) is the reaction in the output quantity (marginal change in output) of firms in strategic group frc to an initial quantity move (marginal change in output) of firm i, which belongs to strategic group lcc. This parameter measures the competitive interaction between strategic groups when the initial action is from lcc. The same interpretation can be made for the rest of the conjectural variation parameters, where $\beta_{lcc,lcc}$ is the competitive interaction within group lcc, and $\beta_{lcc,frc}$ is the competitive interaction between groups when the initial action is from frc.

The system of Equations (4) and (6) was simultaneously estimated using three-stage least squares. Before the estimation was performed, the indications of Puller (2009) were followed to include time fixed effects with 4-year sub-periods in the model to address the aforementioned empirical criticisms. Assuming that the instrumental variables approach should be used for our estimation, we followed the indications of Bowden and Turkington (1984) to assess the requirements that instruments should meet to ensure unbiased and consistent estimates. Our selection of instruments included the values of the variables taken from routes different to the ones used in our sample (see Section 3.2.2.) and two demand shifters (monthly interest rate and the overall consumer price index) that were independent of the errors. Second, regarding the instrument selection, we checked whether some potentially endogenous independent variables were indeed endogenous. After testing for endogeneity, we excluded two variables from our initial selection on the grounds of not being exogenous. Third, a Sargan test was used to test the exogeneity of the instrumental variables (Perera & Tan, 2019). If instruments are endogenous, and thus produce inconsistent parameter estimates, the overidentified moment restrictions may be systematically violated. The calculated value in this case was below the critical value at the 1% error level, so it is not possible to reject the null hypothesis that the instruments are orthogonal to the errors. Fourth, we also tested for weak instruments. Weak instruments were not a problem because the F statistic for the regression in the reduced form equation exceeded 10 (Wooldridge, 2002). Finally, Hausman's specification test was used to determine whether there were significant differences between the OLS and the instrumental variable estimators. Both the significant differences between OLS and instrumental variable estimates and the value of the test statistic for Hausman's test indicated that the instrumental variable estimator was more efficient than the OLS estimator.

We assume that a positive value of the conjectural variation reflects collusion between firms, whereas a negative value reflects competition. Both assumptions refer to the Cournot situation (see Brander & Zhang, 1990, 1993; Oum et al., 1993). A positive parameter ($\delta q_{jt}/\delta q_{it} > 0$) indicates cooperative activity (if both move in the same direction and have the same volume, the result is 1, which indicates collusion; see Murakami, 2011) because firm j's output makes firm i's profit margin larger than it would be under Cournot competition. We characterise this situation as cooperative output. Conversely, a negative parameter indicates that firm i's profit margin is smaller than it would be under Cournot competition. We describe this situation as competitive output. Testing diverse null hypotheses on the estimated coefficients allows us to examine asymmetric intra- and inter-strategic group rivalry (Hypotheses 1 and 2).

3.2.2. Sample, data and variables

Our empirical analysis was based on data for a set of routes in the Spanish domestic air travel market in the period following a deregulation, from 2000 to 2009. This 10-year period was considered optimal for two reasons. First, it was after the removal of domestic operating restrictions for other EU countries in Spain (since 1997). Second, it covered the period when capacity restrictions were relaxed (in the 2000s).

Our sample covers the two busiest and most fiercely competed routes in the Spanish domestic market (Madrid to Palma de Mallorca and Barcelona to Palma de Mallorca, both ways). These routes are amongst the busiest and highest-density routes in the European Union (EUROSTAT, 2019). During the period under study, these routes were operated by seven carriers. Three are formerly regulated carriers: Iberia, Spanair and Air Europa. Four are low-cost carriers: Ryanair, Vueling, Air Berlin and easyJet. Clickair was a low-cost subsidiary of Iberia, so it was removed from the analysis. Vueling and Clickair merged at the end of 2008. The selected sample accounts for 4.6 per cent of Spanish domestic operations and 3.5 per cent of passengers between 2000 and 2009.

Our variables fall into three categories. The first category consists of variables to delimit the groups. Air carriers were clustered into two naturally arising strategic groups (formerly regulated carriers, *frc*, and new-entrant low-cost carriers, *lcc*) based on the history of the Spanish airline industry. The *frc* group accounted for 92.3 per cent of the airline market for the sampled routes between 2000 and 2009. The *lcc* group accounted for 7.7 per cent of this market in this period.

The second category consists of variables used to model the conjectural variations (Equation (6)), inverse demand (Equation (4)) and operating cost function (Equation (1)). The term p_i is the average price per flight of carrier i,[2] and c_i is the average cost per flight of carrier i. The calculations of the flight price and cost are based on accounting and financial data available in accounting statements and annual reports of the carriers. These data were therefore sourced from published figures of prices and costs per available seat kilometre (ASK) for each carrier.[3] The average price or cost for a carrier for a specific route is the product of the price or cost per ASK, the maximum number of passengers (PAX) and the distance of the route in kilometres. The term q_i is the passenger volume for carrier i in month t.[4] The term q_{frc} is the passenger volume for each carrier i in month t weighted by the rivals in strategic group *frc*. The term q_{lcc} is the passenger volume for each carrier i in month t weighted by the rivals in strategic group *lcc*. The term ops_i is the number of operations (flights) by firm i in month t. Data for these variables were obtained from *AENA* database. For the demand variables, the approach of Calzada and Fageda (2012) and was followed. Province-level data (NUTS 3 level of EUROSTAT classification of Territorial Units for Statistics) were used. This level is more accurate, especially in provinces where there is only one commercial airport, as is the case in Spain. The term pde_i is the population in the destination province for a specific route. The term por_i is the population in the province of origin for a specific route. The term dis_i is the distance between origin and destination. The term gdp_i is the GDP per capita in the province of origin. These variables were obtained from the *Spanish National Institute of Statistics (INE)*. The term tur_i is the tourism GDP of the destination province. It captures tourism GDP in the destination province relative to total GDP. Thus, it proxies the predominant customer profile for the route (that is, leisure or business traveller). It was obtained from the *Spanish Annual Statistical Report 'La Caixa'* for the years 2000–2009. The term ffp_i is a frequent flyer program dummy variable that takes the value 1 if carrier i offered an FFP in month t and 0 otherwise. The term ali_i is an international alliance dummy that takes the value 1 if carrier i belonged to an international alliance (for example, Oneworld) in month t and 0 otherwise.

The third category consists of variables used in the measurement of firm performance. Firm performance is measured as the average profit per flight of carrier i (average flight price – average flight cost). Table A1 (see Appendix) presents the statistics for these variables.

4. Results

The proposed system of equations is estimated using the first-order condition (Equation (6)) and the inverse demand function (Equation (4)). As stated earlier, time fixed effects with 4-year sub-periods were included in the estimation to address the critique by Corts. The estimation of the model including 1-year or 2-year time dummies was also tested, but there was no convergence. Our model is theoretically complex and requires the estimation of four parameters of competitive behaviour instead of a single parameter. The estimation of a single parameter is the case in most of the previous studies conducted under the conjectural variations approach, including the general case specified by Puller (2009). For the inverse demand equation (Table 1), the coefficients for numbers of passengers per month of firm i (α_i) and for the *lcc* group firms (α_{lcc}) are negative and significant, suggesting that an increase in these variables is related to a decrease in the ticket price of firm i. Table 1 shows that most of coefficients for variables included in this equation are positive and highly significant, which suggests that an increase in these variables is linked to an increase in price. Furthermore, the coefficients for the rivalry both within and between groups are significant, which provides a better understanding of the strategic-group-level competitive asymmetry predicted by our hypotheses.

Regarding rivalry within groups, the analysis reveals independent behaviour, or a Nash equilibrium, within the group of low-cost carriers ($\beta_{lcc,lcc}$; Table 1). The coefficient is non-significant, which suggests that firms in this group did not expect to experience any reaction from other firms in the same group. When any firm changed its output, the other *lcc* carriers ignored this action in their own decision-making processes, taking their group rivals' actions as a given and acting to maximise profits. In contrast, our analysis reveals cooperative behaviour between formerly regulated firms in the Spanish airline market, with a positive, significant value of $\beta_{frc,frc}$ at a 1 per cent confidence level. A formerly regulated carrier that modified its output expected to be accommodated by other group members. For instance, if formerly regulated firms moved in the same direction and had the same volume, the formerly regulated firms' output made other *frc* firms' profit margins larger than they would have been under Cournot competition. These findings provide evidence of asymmetric rivalry within groups.

Regarding rivalry between groups, whereas $\beta_{frc,lcc}$ is negative and significant, $\beta_{lcc,frc}$ is positive and significant at a confidence level of 1 per cent, which suggests that competitive interaction between the members

[2] The average price per passenger on a route is the single most important indicator for the firm's pricing strategy in this market (Oum et al., 1993). Airlines generate product lines that consist of numerous price classes (first class, standard economy and various levels of shallow and deep discounts). This situation makes it impossible to study price behaviour in the airline industry by examining all price levels and volumes. In fact, firms use complex yield management systems that allow them to assign seats of a flight in a dynamic way as they observe the progress of the actual reservations on that flight (Brumelle et al., 1990). Because the allocation of seats for a flight between numerous price levels changes daily or even hourly, a firm's prices are not transparent, even for travel agencies. It is therefore easier for a firm to charge a high average price for the same price class packages on a route, which is recorded in its yield management programme. Thus, the only feasible way to explore the pricing behaviour of a firm is to consider the overall result of the firm's yield management practices.

[3] Sources of data by carrier included in our study: IBERIA (Annual Report, 2000–2009), Spanair (Annual Report Globalia, 2000–2009), Spanair (Annual Report SAS group, 2000–2009), Vueling (*Cuentas Anuales e Informes de Gestión*, 2004–2009), Air Berlin (Annual Report, 2006–2009), EasyJet (Annual Report and Accounts, 2005–2009) and Ryanair (Annual Report & Financial Statements, 2000–2009).

[4] Passenger volume is aggregated for the product categories (first class, standard economy and discount categories) and is treated as a single output. The distinction between categories is unreliable and inconsistent across airlines because they apply sophisticated forms of seat allocation through several types of prices (yield management). Thus, grouping them constitutes best practice, especially when the purpose of the study is to understand the firm's price behaviour (Brander & Zhang, 1993; Oum et al., 1993).

Table 1
Empirical results for the demand and competitive behaviour equations (standard error in parentheses).

Demand equation	Competitive behaviour equation				
Parameter	Coefficient	Intra-group rivalry	Inter-group rivalry		
α_0 (intercept)	−92.732*** (6.24)	Within group frc	Between groups frc and lcc		
α_i(pass/month)	−2.193*** (0.05)	$\beta_{frc,frc}$	2.417*** (0.38)	$\beta_{frc,lcc}$	−4.719*** (0.75)
α_{frc} (pass/month) frc	1.165*** (0.09)	Within group lcc		$\beta_{lcc,frc}$	0.634*** (0.11)
α_{lcc} (pass/month) lcc	−0.171*** (0.02)	$\beta_{lcc,lcc}$	0.366 (0.44)		
α_{por} (home population)	3.196*** (0.26)	Time fixed effect			
α_{pde} (destin. population)	3.127*** (0.23)	T2002-2005	−0.014** (0.00)		
α_{dis} (distance)	0.777*** (0.02)				
α_{ops} (operations)	2.509*** (0.06)				
α_{ali} (alliance)	0.029 (0.03)				
α_{ffp} (FFP)	0.076*** (0.02)				
α_{gdp} (GDP)	−0.524** (0.21)				
α_{tur} (GDP touristic)	−0.126 (0.11)				
Demand equation	Adj. R2 0.87	Competitive behaviour equation	Adj. R2 0.40		

*** = prob. < 0.01; ** = prob. < 0.05; * = prob. < 0.10.

of these groups is asymmetric. Given this strategic interaction pattern, formerly regulated firms expected to be accommodated (cooperative behaviour) by low-cost firms ($\beta_{lcc,frc}$). When *frc* firms changed their output, *lcc* firms moved in the same direction (that is, prices of *lcc* firms were almost the same as prices of *frc* firms) and profit margins were larger than they would have been under Cournot competition. In contrast, when firms in the low-cost group changed their output, they expected to experience strong retaliation from formerly regulated firms ($\beta_{frc,lcc}$). Thus, *lcc* firms expected more competitive behaviour by *frc* firms than the Cournot competition level, which likely took the form of *frc* firms moving in the opposite direction to compete with the marginal change in the output of *lcc* firms. Firms in the *frc* group adopted such behaviour because they sought to create new demand by reducing fares. Therefore, from the perspective of firms in the *lcc* group, the interaction pattern is closer to a competitive pattern than to a pattern based on a Nash equilibrium. Indeed, these findings suggest asymmetric behaviour between groups.

Comparing several rivalry patterns within and between groups, we observe that low-cost firms expected to experience strong reprisals from formerly regulated firms ($\beta_{frc,lcc} = -4.719$, the largest of all coefficients) and expected no response from firms in their own group ($\beta_{lcc,lcc}$). Furthermore, formerly regulated firms expected to experience accommodation from other firms in their group and from low-cost firms ($\beta_{frc,frc}$ and $\beta_{lcc,frc} = 2.417$ and 0.634, respectively, both of which are smaller than the value for $\beta_{frc,lcc}$). Accordingly, we do not reject the proposed hypotheses H1 and H2, which predict that asymmetric rivalry exists at the strategic-group level.

A plausible explanation for these findings for both within and between group rivalry is that the group characteristics promote group behaviour, where the group-level effect takes the form of product differentiation. The dynamic effects of product differentiation lead to a new strategy to defend the market position of incumbents when low-cost entrants threaten the market (inter-group rivalry). Thus, after deregulation in the Spanish airline industry, formerly regulated firms threatened by low-cost firms were unable to adopt the pacific attitude of a *fat cat* because product differentiation was lower than before. As new low-cost entrants became more established in a market that did not restrict their capacity, they were able to expand their ser-vices and became more committed, even to the least price-sensitive customers (Call & Keeler, 1985; Ferrier et al., 1999). This finding may explain the aggressive attitude of formerly regulated firms towards low-cost firms. In addition, formerly regulated firms remained non-aggressive towards new entrants in their own group with similar cost structures (intra-group rivalry) since they still enjoyed product differentiation advantages in the business travel market.

5. Conclusions, managerial implications and limitations

We selected a set of Spanish domestic routes, which are amongst the busiest and highest-density routes in the European Union. During the period under study, seven carriers were operating these routes. The main objective of our selection is to test the presence of intra- and inter-group asymmetric rivalry in a deregulated industry. Our hypotheses predicted that the degree of rivalry depends on which competitor (same or different strategic group) is under consideration. One justification of these hypotheses is that group characteristics can affect group behaviour through the dynamic effect of product differentiation, which encourages or discourages formerly regulated firms and low-cost newcomers to compete. The proposed model was tested by estimating the effect of group-level strategic interactions on firm performance.

Our findings reveal the existence of an asymmetric rivalry interaction within and between strategic groups of airlines. Formerly regulated companies (*frc*) expected to be accommodated by firms in their own strategic group and by low-cost companies (*lcc*). However, *lcc* firms expected strong retaliations from *frc* firms but did not expect any response from firms in their own strategic group. Therefore, the present study shows that firms from the *frc* group only acted as dominant firms against new low-cost entrants in Spain during the period of deregulation.

The managerial implications of these findings are multiple. First, managers should observe their competitors in terms of group membership when strategic interactions amongst group members result in product differentiation. In a scenario of low product differentiation (deregulated and unconstrained period), formerly regulated firms are competitive agents that aggressively respond to attacks only from firms in a different group (that is, low-cost firms). Thus, as reported by Pels (2008), firms from a different group constitute the primary target of counterattack by formerly regulated firms. Second, an important question for a firm interested in initiating an action is whether that action can be designed to avoid retaliation. The attributes of formerly regulated firms and new low-cost entrants provide a useful reference. Our results suggest that in a deregulated market, high product differentiation helps formerly regulated firms mitigate the response of other formerly regulated firms in the same strategic group. Third, our findings enable analysis of the impact of a managerial choice such as a change in output (variation in the volume of passengers) on a rival's most likely response. To evaluate the most likely impact of a change in output, airline managers must consider the direction and magnitude of a rival's most likely response (conjectural variation) when deciding how to compete.

This paper has several limitations. First, we used proxy variables to measure several unavailable variables of cost and demand at the firm level. Second, we assumed the absence of the multi-market effect of mutual forbearance (Edwards, 1955). Its presence would have led to a more complex model. Third, to obtain a more realistic overview of the industry, we estimated two equations (costs and rivalry) simultaneously. Nevertheless, we estimated the model in three stages to reduce the large number of parameters that simultaneous estimation would have entailed. Fourth, this paper analyses the Spanish domestic airline industry in the period 2002 to 2009, which does not cover the major changes in the airline industry over the subsequent 10 years. However, this study has historical value, as well as offering the possibility of using these European findings in other less consolidated markets.

Several avenues for further research can be derived from this study. First, although we analysed rivalry in terms of output quantity (volume of passengers), it would be of interest to assess competitive interaction in terms of other strategic variables such as advertising expenditure. Second, it would be helpful to characterise multi-market competition through patterns of asymmetric interaction in terms of both strategic groups. In fact, the number of geographical markets where formerly regulated firms compete with one another is greater than the number of geographical markets where they compete with low-cost entrants. This situation leads them to compete less aggressively within the group of formerly regulated firms for fear of retaliation in other markets (Peteraf, 1993). Third, the results are specific to the Spanish domestic air travel market. Thus, the analysis of other countries or industries would be helpful to test the relevance of our oligopolistic model in similar circumstances of deregulation in markets characterised by product differentiation. Finally, the conjectural variations model can be problematic. Future studies should address these problems to make its use feasible. An alternative method that should be considered in future studies is the Markov decision process (MDP), which can be used to incorporate heuristics into this economic problem. This method would allow agents to learn a near optimal strategy by experience. In an MDP, in each period, an agent observes a state variable and then chooses an action. For any state variable and action, the agent obtains a reward, and the system moves on to the next state, according to a (time invariant) probability distribution. This method has been applied several times in recent years in the airline industry, with a predominant focus on pricing strategies such as revenue management (for example, Barz & Gartner, 2016; Etebari, 2020; Yu et al., 2019).

CRediT authorship contribution statement

Felipe Ruiz-Moreno: Conceptualization, Methodology, Software, Resources, Formal analysis, Investigation, Writing - original draft-Writing – original draft, Writing - review & editingWriting – review & editing, Funding acquisition, Project administration, Funding acquisition. **Francisco J. Mas-Ruiz:** Conceptualization, Writing - original draftWriting – original draft, Writing - review & editingWriting – review & editing. **Franco M. Sancho-Esper:** Conceptualization, Methodology, Resources, Formal analysis, Investigation, Writing - original draft-Writing – original draft, Writing - review & editingWriting – review & editing.

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APPENDIX

Table A1
Descriptive statistics of the variables in the study

Variable	Mean	S.D.	Correlations										
			Avg. flight cost	Avg. flight price	Avg. pass. per flight	Origin pop.	Dest. pop.	Route. dist.	Op.	Alliance	FFP	GDP origin	Tour. GDP dest.
Avg. flight cost[1]	3874	2564	1	.985**	.068**	.051*	.118**	.732**	.063**	.353**	.296**	.404**	.059*
Avg. flight price[1]	3939	2547		1	.081**	.050*	.117**	.753**	.097**	.391**	.319**	.392**	.069**
Avg. passengers per flight	111	22			1	.056*	.024	.256**	−0.150**	−0.131*	−0.055**	.295**	.024
Origin population	3,256,087	2,300,025				1	−0.974*	.080*	−0.041	.018	.035	.525**	.867**
Destination population	3,256,087	2,300,025					1	.080*	−0.023	.018	.035	.525**	−0.862*
Route distance (km)	380	177						1	−0.110**	.029	.016	.246**	.173**
Operation (total month)	149	73							1	.634**	.189*	−0.272**	.018
Alliance (%)	46.0%	49.9%								1	.739**	.152**	−0.02
FFP (%)	61.0%	49.9%									1	.372**	−0.048*
GDP origin	24,148	3228										1	0.275
Tourist GDP destination	12.0%	2.6%											1

All figures are monthly average values for all established carriers in the sample. The total number of observations is 1890. ** = prob. < 0.05; * = prob. < 0.10.

[1] In constant Euros (deflated, base year = 2008).

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