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Measuring the vulnerability of global airline alliances to member exits

Oriol Lordan [a] , Richard Klophaus [b]

[a] Universitat Politècnica de Catalunya - Barcelona Tech., Department of Management, Colom 11, TR6, 3.17, 08222 Terrassa, Spain, Phone: +34 937398169, E-Mail: oriol.lordan@upc.edu

[b] Worms University of Applied Sciences, Competence Center Aviation Management, Erenburgerstraße 19, D-67549 Worms, Germany, Phone: +49 6241 509 375, E-Mail: klophaus@hs-worms.de

Abstract

We analyse the vulnerability of airline alliance route networks to the exit of member airlines. Vulnerability measures how easy it is to disconnect a network. The assessment is performed by applying the theory of complex networks. We compute the normalized vulnerability for Star Alliance, oneworld and SkyTeam using airline schedules data and derive a ranking of member airlines according to their share in the overall vulnerability of the respective alliance. One result of our paper is that oneworld is the most vulnerable global airline alliance, SkyTeam ranks second, followed by Star Alliance.

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Keywords: Global airline alliances; airline route networks; network vulnerability; complex networks

1. Introduction

The restructuring of airline activities into alliances has been one of the major traits of this industry since Star Alliance was founded in 1997. The number of members in all three global airline alliances (Star Alliance, oneworld and SkyTeam) has increased considerably over the years. The larger number of members is associated with a higher risk of defection. In 2014, Star Alliance lost two member airlines (US Airways and TAM) after these carriers merged with airlines from oneworld. Such an exit of partner airlines can be a precarious problem for airline alliances, e.g. in the form of sunk costs due to alliance-specific investments or the risk that former alliance members use confidential information to their competitive advantage. Further, it implies a decrease in network coverage.

Airline alliances provide global connectivity based on codesharing agreements between member airlines. The aim is that an airline alliance route network (AARN) appears to be an extension of each partner's network (Park and

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Zhang, 1998). Codesharing in combination with coordinated flight schedules allows the provision of continuous services for passengers connecting between airlines. With the extensive use of this practice, codesharing has become the hallmark of the alliance revolution in the aviation industry (Lordan et al., 2014a). It allows airlines to offer routes without operating them which is cost-efficient. Avoiding overlapping operations also implies less competition. The drawback is a dependency on partner airlines. A member exit leads to the deletion of routes (if not operated by other alliance members) which affects an alliance's global connectivity. Not all member exits have the same impact because some airlines contribute more to an AARN than others. Therefore, it is an important issue for the managing bodies of an alliance how to accurately assess the impact of a (potential) exit of a given member airline (e.g. in case of bankruptcy) and similarly, how to develop an AARN with appropriate partner selection. This paper studies the vulnerability of airline alliances to member exits. We propose measures that can be instrumental in assessing the dependency of an alliance on a member's route network and can also serve to develop a more resilient AARN.

The effects of airline alliances on traffic volumes, fares, and welfare have been studied by several researchers (e.g. Park, 1997; Brueckner, 2001; Zou et al., 2011). The trade-off between alliance benefits and risks has been analysed by Kleymann and Seristö (2001). Recently, Garg (2016) presented a model based approach to select strategic alliance partners. Different reasons for a company to leave an inter-firm co-operation are discussed by Sroka and Hittmár (2013). Our research adds to the literature on global airline alliances by quantifying the potential damage for airline alliance route networks caused by member exits. AARNs combine route networks of individual airlines. Hence, AARNs can be considered as multi-layered networks (Cardillo et al., 2013) that constitute an intermediate level of air transport networks between individual airline networks and the industry network (Lordan et al., 2014a). Vulnerability measures how easy it is to disconnect a network. The study of air transport networks includes the topological analysis of global (e.g. Guimerà and Amaral, 2004; Guimerà et al., 2005; Lordan et al., 2014b) and regional (e.g. Bagler, 2008; Zhang et al., 2010) route networks. Vulnerability has been investigated for global (e.g. Lordan et al., 2014b), regional (e.g. Chi and Cai, 2004) and airline alliance (Lordan et al., 2015) route networks.

In this paper, we analyse the vulnerability of AARNs as real world networks building on the theory of complex networks (Estrada, 2011; Estrada and Knight, 2015). More specifically, we measure AARN vulnerability using the concept of normalized average edge betweenness (Mishkovski et al., 2011; Lordan et al., 2015). AARNs are constructed as an aggregation of the airlines' route networks belonging to the alliance. Data comes from the OAG airline schedules database. The proposed methodology provides a normalized measure of the vulnerability of a given AARN to (potential) member exits. One result of applying this measure is that oneworld is the most vulnerable AARN, SkyTeam ranks second and Star Alliance is the most robust AARN. Further, the paper indicates a positive relation between network robustness and route overlaps among members of global airline alliances. We also rank member airlines according to their contribution to the overall AARN vulnerability. Our paper shows that the size of a carrier's scheduled operation is not strictly related to the carrier's importance for the vulnerability of an airline alliance route network.

2. Methodology

On principle, the analysis of network vulnerability assesses the stability and robustness of the global behaviour of complex network dynamics under external perturbations (Boccaletti et al. 2007). In this paper, airline networks are defined as airports (nodes) connected by operated routes (edges) and treated as undirected and unweighted networks, i.e., two airports are linked if an alliance member has one operating flight between them. Our approach is consistent with studies of the global air transport network (e.g. Guimerà and Amaral, 2004; Guimerà et al., 2005; Lordan et al., 2014b) and airline alliance route networks (Lordan et al., 2015) that assume networks to be undirected and unweighted in order to focus on network connectivity. We only consider operating flights and exclude codesharing flights from our analysis.

Average edge betweenness of the graph G is defined as (Boccaletti et al., 2007)

$$b(G) = \frac{1}{|E|}\sum_{l \in E} b_l \quad (1)$$