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Codesharing network vulnerability of global airline alliances

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ABSTRACT

Global airline alliances provide connectivity based on codesharing agreements between member airlines. An alliance member exit leads to the deletion of routes (if not operated by other members) which affects network connectivity. The paper measures the vulnerability of the codesharing network (CN) of Star Alliance, SkyTeam and oneworld, respectively, by applying the theory of complex networks. A normalized CN vulnerability metric is proposed. Using airline schedules data, a ranking of member airlines according to their share in the overall CN vulnerability is derived. The results for CNs are compared with the ones for the respective total network (TN) that includes routes with and without codesharing. The findings show that oneworld is the most vulnerable global airline alliance, SkyTeam ranks second followed by Star Alliance. The proposed graph theory approach might become a building block for a more comprehensive measurement of real world airline networks.

1. Introduction

The restructuring of airline activities into branded global alliances has been one of the major traits of this industry since Star Alliance was founded in 1997, followed by the formation of oneworld in 1999 and SkyTeam in 2000. Global alliances provide network connectivity based on codesharing agreements between member airlines. Codesharing is an interline partnership where one carrier sell tickets by placing its designator code on another carrier's flights. The airline selling seats is referred to as the marketing carrier and the airline providing the flight is referred to as the operating carrier. While codesharing dates back to the 1960s, it only became common in the early 1990s. The launch of the modern era of global airline alliances began with the large-scale codesharing agreement between Northwest Airlines and KLM in 1989. The aim is that the route network of a global alliance appears to be an extension of each partner's network. Codesharing in combination with coordinated flight schedules allows the provision of continuous services for passengers connecting between airlines. However, alliance members may take advantage of the route networks of partner airlines even without codesharing, e.g., due to interline agreements between individual airlines that cover connecting flights. A codeshare agreement usually requires an interline agreement.

At present, Star Alliance has 28 member airlines, SkyTeam 20, and oneworld 14 (cf. Appendix A) which together have a share of around 60% in worldwide air traffic. Extensive codesharing among global alliances 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 network connectivity. In 2014, US Airways and TAM left Star Alliance after these two carriers merged with airlines from oneworld. oneworld on its part lost Malév after the financial collapse of this former Hungarian flag carrier in 2012. In early 2016, Qatar Airways threatened to withdraw from oneworld should fellow member American Airlines continue to push the US government to restrict market access for the Gulf

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carriers. An exit of partner airlines has negative consequences for global 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. The assessment of the (potential) damage to the codesharing network (CN) of global airline alliances is the subject matter of the present paper.

Not all member exits have the same impact because some airlines contribute more to the CN of a global alliance than others. Therefore, it is an important issue for the managing bodies of an alliance how to accurately assess the impact of an exit of a given member airline and similarly, how to develop a CN with appropriate partner selection. This paper studies the CN vulnerability of global 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 CN. The results for CNs are compared with the ones for the respective total network (TN) that includes routes with and without codesharing.

Research on airline alliances and codesharing among airlines includes several studies on the effects of airline alliances on traffic volumes and airfares (Oum et al., 1996; Park, 1997; Park and Zhang, 1998; Brueckner, 2001; Brueckner et al., 2011; Zou et al., 2011). Kleymann and Seristö (2001) analyzed the trade-off between alliance benefits and risks. Douglas and Tan (2017) examined whether the formation of global airline alliances resulted in an increase in profitability for the founding members. 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). The welfare effects of codesharing agreements have been investigated by Hassin and Shy (2004) and, more recently, Adler and Hanany (2016).

There is an increasing and extensive literature of transport vulnerability studies. This paper measures the (potential) damage for the CNs of global airline alliances caused by member exits. Such alliances constitute an intermediate level of air transport networks between individual airline networks and the industry network (Lordan et al., 2014a). Mattsson and Jenelius (2015) provide an overview of recent research on vulnerability and resilience of transport systems. While they point out that there is no commonly agreed definition of transport system vulnerability, they conceptualize vulnerability as the susceptibility of transport systems to infrequent events that can result in considerable network degradations. In the context of the present paper, the infrequent event is a member exit having an adverse impact on the CN of a global airline alliance. The study of air transport networks includes the topological analysis of global (Guimerà and Amaral, 2004; Guimerà et al., 2005) and regional (Bagler, 2008; Zhang et al., 2010) route networks. Vulnerability is investigated for global (Lordan et al., 2014b) and regional (Chi and Cai, 2004; Du et al., 2016) networks. Lordan et al. (2015) examine the robustness of alliance airline route networks based on the assumption of unweighted networks only considering operating flights. Hence, the differing economic relevance of a given route operated by one member to other alliance members is disregarded. Weights could be based on the number of flight frequencies or seat capacities, and also by distinguishing between domestic, continental and intercontinental routes. The consideration of codesharing as an indicator of route relevance from the perspective of partner airlines represents a basic weighting scheme to enhance the practical meaning of the vulnerability measures. CNs are subsets of the respective TNs which consist only of operated routes that have a marketing flight number by at least one other carrier belonging to the same alliance. Our paper only looks at codesharing between member airlines of the same global alliance. In spite of this, the industry showcases other codesharing partnerships. There is codesharing between aligned and non-aligned airlines (e.g., Qantas and Emirates) and between carriers belonging to the same holding company (e.g., Lufthansa and Eurowings). Codesharing across global alliances is rather unusual. One example is Aeroflot and Finnair on the Helsinki-Moscow-route.

In this paper, CN vulnerability of real world networks is analyzed building on the theory of complex networks (Estrada, 2011; Estrada and Knight, 2015). More specifically, CN vulnerability is measured using the concept of normalized average edge betweenness (Mishkovski et al., 2011). The proposed method to measure CN vulnerability relates to work using a graph theory approach to develop strategies to increase the resilience of air traffic networks to disruptive events, such as extreme weather events, strike action or terrorist threats (Dunn and Wilkinson, 2015). It might also be valuable for a more comprehensive study of route networks that include other network indicators such as hubness and size (Roucolle et al., 2017).

The proposed methodology provides a normalized measure of the vulnerability of a given CN to (potential) member exits. Data comes from the OAG airline schedules database. One result of applying this measure is that oneworld is the most vulnerable CN, SkyTeam ranks second and Star Alliance is the most robust CN. 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 CN 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. Finally, a comparison with results for TNs as unweighted alliance route networks illustrates the importance of bringing out relevant routes in future analysis of airline route networks.

2. Methodology

A codesharing network (CN) contains airports (nodes) connected by codeshared routes (edges), i.e., two airports are linked if an alliance member is operating flights between them with a designator code of another carrier from the same alliance. The proposed metric to assess CN vulnerability extends the graph theory concept of average edge betweenness as introduced by Boccaletti et al. (2007) for the graph G:

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