

Annotated bibliography on complex networks

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We can find a report of the evolution of competition in air transport in several markets: Ref. [GV09] for the US, Ref. [BW15] for EU and [WBB16] for China.

References

- [ACNR12] ALDERIGHI, M.; CENTO, A.; NIJKAMP, P. AND RIETVELD, P., 2012. Competition in the European aviation market: the entry of low-cost airlines. *Journal of Transport Geography*, 24:223–233. doi:10.1016/j.jtrangeo.2012.02.008.

KEY: Alderighi2012

ANNOTATION: The aim of this paper is to investigate the price-setting behaviour of Full-Service Carriers in the European passenger aviation market, defining econometric models which in some cases include low-cost players. The introduction of the paper makes a short review of the evolution of the European air transport market.

- [BR13] BURGHOUWT, G. AND REDONDI, R., 2013. Connectivity in Air Transport Networks An Assessment of Models and Applications. *Journal of Transport Economics and Policy*, 47(January):35–53.

KEY: Burghouwt2013

ANNOTATION: The paper summarizes existing connectivity measures in air transport research, and compares them with size-related measures of airport importance, like flight frequency and capacity. The most important dimension of connectivity considered is the distinction between centrality and accessibility. Centrality considers the number and quality of direct and indirect connections available to the consumer at a certain airport. Accessibility measures the number of transfer opportunities available via a specific airport. A statistical assessment of these measures shows that traditional-size measures overestimate the centrality of small and medium-sized airports, but overestimate the accessibility of airports.

- [BW05] BURGHOUWT, G. AND DE WIT, J., 2005. Temporal configurations of European airline networks. *Journal of Air Transport Management*, 11(3):185–198. doi:10.1016/j.jairtraman.2004.08.003.

KEY: Burghouwt2005

ANNOTATION: Spatial and temporal concentration are the two main features of the hub-and-spoke network. Airlines using an hub-and-spoke configuration organize their flights in a wave-system structure, that helps them to offer many indirect connections around a hub.

In this paper, authors define a methodology to detect wave-system structures, and define a metric of indirect connectivity based on the number and quality of indirect connections generated by a flight schedule. The later metric is based on previous work reporting passengers' preferences with indirect connections. They use these concepts to analyze the effects of a wave-system structure on indirect connectivity.

- [BW15] BURGHOUWT, G. AND DE WIT, J. G., 2015. In the wake of liberalisation: long-term developments in the EU air transport market. *Transport Policy*, 43:104–113. doi:10.1016/j.tranpol.2015.05.006.

KEY: Burghouwt2015

ANNOTATION: Authors analyze the supply-side development within the common EU aviation market since the beginning of liberalisation over a 24-year period. They identify three distinct developmental phases. In the first phase (1990-1993) supply-side reactions remained very limited. On the second phase (1993-2000) the former flag carriers developed their hub-and-spoke systems. The third phase (2001-2015) saw the rise of low-cost market share. This growth was made by opening secondary routes with low fares that generated demand from extended catchment areas. During this phase, the European airline industry has consolidated (augmented concentration), although competition has increased at the route level. Authors predict the apparition of a fourth phase, in which direct competition between low-cost and full-service carriers will rise as the former begin operating at primary hubs. Two new business models are arising: long-haul, low-cost operators that use the possibilities of the B787 aircraft and lower-cost hub airlines of Turkey and the Gulf region.

- [FSSM15] FAGEDA, X.; SUAUA-SANCHEZ, P. AND MASON, K. J., 2015. The evolving low-cost business model: Network implications of fare bundling and connecting flights in Europe. *Journal of Air Transport Management*, 42:289–296. doi:10.1016/j.jairtraman.2014.12.002.

KEY: Fageda2015

ANNOTATION: This article reports the results of an empirical model at the route level of analysis, analyzing determinants of share of seats offered in each route from airlines following three business models: archetypal low-cost carriers (LCC), adapted LCCs that offer transfer services and fare bundling (hybrid approach group 2), and adapted LCCs that offer fare bundling, but not transfer services (hybrid approach group 3). Archetypal LCCs have a large share in long routes with low density, with high proportion of leisure travellers, and tend to operate routes in a monopolistic regime. Hybrid LCCs tend to have higher shares in routes with airports close to the city centre, and in routes that have a hub airport as an endpoint. LCCs that offer transfer services and fare bundling may be offering indirect service in city pairs with long distance or pairs not having yet a direct connection. The aim of offering fare bundling may be targeting business passengers, thus competing with full-service carriers. The

emergence of hybrid LCC business models can be an opportunity for some airports, that may act as hubs of connecting services offered by LCCs.

- [GV09] GOETZ, A. R. AND VOWLES, T. M., 2009. The good, the bad, and the ugly: 30 years of US airline deregulation. *Journal of Transport Geography*, 17(4):251–263. doi:10.1016/j.jtrangeo.2009.02.012.

KEY: Goetz2009

ANNOTATION: This is a review of the results of the deregulation of the airline sector by the Airline Deregulation Act in the period 1978-2008. This act allowed airlines to make all decisions regarding entry, exit and fares, while mergers and acquisitions have to be authorised by regulators. Previously, the sector was regulated by the Civil Aeronautics Board. The positive results of deregulation are lowering of average fares, providing more flights and increasing airline efficiency, while maintaining a good safety record. But fares and services for smaller cities, shorter-haul routes and more concentrated markets have been negatively affected. The worse consequences are the poor results of airlines and the bad working conditions for airline employees. Airline results depend heavily of economic cycle, and the oligopolistic nature of the market lead companies to strategic interdependence, resulting in waves of new entries and concentration.

- [JMA10] JARDIN, M.; MANEGOLD, D. AND APTE, A., 2010. Discrete-Event Simulation of Air Traffic Flow. In *AIAA Guidance, Navigation, and Control Conference*, August, pp. 1–15. American Institute of Aeronautics and Astronautics, Reston, Virginia. doi:10.2514/6.2010-7853.

KEY: Jardin2010

ANNOTATION: This communication describes a discrete-event simulation model of air traffic flow. It is based on MATLAB SimuLink and SimEvents packages. The communication includes a description of the model and a small-scale application and a large-scale model for the continental United States. The model includes the possibility of congestion of airports and air space regions, and can be useful to analyze delay propagation and test aircraft schedules.

- [RF10] REYNOLDS-FEIGHAN, A. J., 2010. The Impact of U.S. Airline Deregulation on Airport Traffic Patterns. *Geographical Analysis*, 30(3):234–253. doi:10.1111/j.1538-4632.1998.tb00398.x.

KEY: Reynolds-Feighan2010

ANNOTATION: The article describes the changes taking place in the U.S. national system of airports in the 1969-1993 period. Then the effect of the Airline Deregulation Act (ADA) on airport concentration can be studied. Additionally, the merits several possible measures for summarizing air traffic in airports are investigated. The Gini index resulted the most adequate measure, followed by Thiel relative entropy and Herfindahl-Hirschmann index. The article makes interesting generic considerations about the properties of

different indexes of concentration. Evaluation of Gini index showed that concentration in large hubs increased over time, especially after the enactment of ADA, together with an increase of carriers serving these large hubs. The Gini index for medium hubs was smaller than for large hubs, and the number of carriers serving small hubs increased in the deregulating period, as airlines created feeder routes for the large hubs.

- [Vel97] VELDHUIS, J., 1997. The competitive position of airline networks. *Journal of Air Transport Management*, 3(4):181–188. doi:10.1016/S0969-6997(97)86169-8.

KEY: Veldhuis1997

ANNOTATION: This note defines an indicator of route connectivity. The attractiveness of a route depends on travel time, frequencies and flights. As passengers generally perceive transfer time as more inconvenient than flying time, perceived travel time is defined as flying time plus three times waiting time. Authors also define a maximum perceived travel time, beyond which any passenger is supposed to take this route. Then, a number of “connectivity units” can be assigned to each route. They define a connectivity matrix for each airport, considering the direct flights and the indirect flights, the later forming onward connectivity and hub connectivity. This measures are illustrated with data from the Amsterdam Schiphol airport. It must be noted that all concerned measures are defined without considering routing factor.

- [WBB16] WANG, J.; BONILLA, D. AND BANISTER, D., 2016. Air deregulation in China and its impact on airline competition 1994–2012. *Journal of Transport Geography*, 50:12–23. doi:10.1016/j.jtrangeo.2015.03.007.

KEY: Wang2016

ANNOTATION: This article examines the evolution of deregulation of air transport in China, the reorganization of Chinese airlines and the evolution of airline competition. It includes a good literature review on airline competition, a report of the historical evolution of Chinese airline market, an examination of airline competition and an assessment of changes of geography of competition. Chinese airline deregulation has taken a state-led approach, focused in consolidating three national champions: China Air, China Southern and China Eastern. These three companies dominate trunk routes and core airports, while peripheral airports and thin routes are dominated by small companies in a monopolistic regime. Finally, the CAAC has been transformed from a regulator and operator to a supervisor.

- [WZ12] DE WIT, J. G. AND ZUIDBERG, J., 2012. The growth limits of the low cost carrier model. *Journal of Air Transport Management*, 21:17–23. doi:10.1016/j.jairtraman.2011.12.013.

KEY: DeWit2012

ANNOTATION: The route density problem consist in finding how

many people you can book in an airplane at the same time, to the same destination, at a combination of fares that will ultimately cover the total cost of operating the flight. The traditional business model of low cost carriers (LCC) is trying to widen their catchment areas and increase their market shares by offering flights at lower fares. As airlines primarily compete on their base ticket fares, LLCs unbundle the traditional all-inclusive product, offering many services as ancillaries. In addition to these services, LCCs offer also commission-based products (hotel rooms, car rentals, etc.) or sell frequent-flyer points to program partners (e.g., car rental companies). The parameters to evaluate the effectiveness of this business model are average weekly frequency and average distance of routes. With data up to 2010, authors detect that this model is going to their limits, as average frequencies decrease and average distance increases. They predict that LCCs' strategic actions will include shifts to primary airports, enhance random connect systems (self-hubbing), entering airline alliances or acquiring other companies.