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# A Novel Pairwise Competitive Intensity Indicator for Airlines

Qian LIU

► **To cite this version:**

Qian LIU. A Novel Pairwise Competitive Intensity Indicator for Airlines. The 21st GARS Junior Research Workshop, Jun 2024, Anvers (Antwerpen), Belgium. <hal-05524276>

**HAL Id: hal-05524276**

**<https://hal.science/hal-05524276v1>**

Submitted on 24 Feb 2026

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# Measures of competitive intensity between airlines are compared, based on their flight supply strategies.

## A Novel Pairwise Competitive Intensity Indicator for Airlines

Qian LIU, Paul ROCHET, Chantal ROUCOLLE

### 1 Introduction

- **Objective:** Study airline behavioral changes in response to competition.
- **Research Gap:** The intensity of competition is typically analyzed either as a static state or as a dynamic process of rivalry [1][2]. There is no comparable research in the literature.
- **Contributions:** Our pairwise measure can promptly reveal the competitive relationship between two parties.

### 2 Methods

The index can be constructed based on the following notions and information used:

- **Correlation:** Pearson's  $r^{(a)}$ .
- **Distance:** Distance between a pair of distributions  $(a)$ .
- **Similarity:** Jaccard similarity coefficient  $(b)$ ; Cosine similarity  $(a)$ .

- (a) *Flight frequency* ;  
 (b) *Binary representation (1 if presented on a route, 0 otherwise).*

### 3 Data

- **Source:** Official Airline Guide (OAG).
- **Time period:** July-September 2023.
- **Scope:** Flights originating and terminating within the 41 Eurocontrol member states. **Top 50** operating airlines who have the most routes.

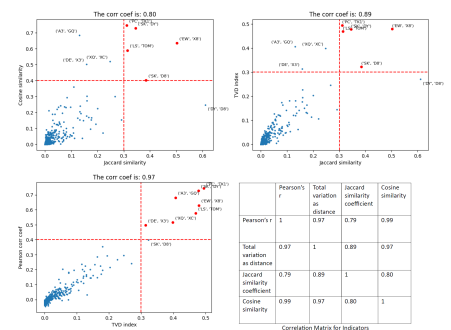
### 4 Results

- All proposed indices from the 'Method' section are highly correlated with each other. Additionally, they are consistent, as they share the same nine outliers, which have large values:  $(A3,GQ)$ ,  $(XQ,XC)$ ,  $(DE,X3)$ ,  $(DY,D8)$ ,  $(SK,D8)$ ,  $(LS,TOM)$ ,  $(SK,DY)$ ,  $(PC,TK1)$ ,  $(EW,X8)$ .
- Results suggest a special collaboration pattern, since airlines with high index values often include parent companies and subsidiaries. This contrasts with the typical collaboration through complementary networks.
- Airlines tend to avoid competition, as the majority of the values for all the proposed indicators are small (most are  $<0.4$ ).

### 5 Future works

- Account for asymmetry, weight route importance, and uncover competition's time evolution.
- Study airline group competition.

### Extra figures



Letters  $a$  and  $b$  signify two airlines. Note that Pearson's  $r$  takes values in the range  $[-1, 1]$ , and all other indicators are in the interval  $[0, 1]$ , where 1 indicates the most intense competition and 0 indicates no competition.

**Pearson's  $r$ :**

$$\sigma^{(a,b)} = \frac{1}{|R|} \sum_{i=1}^n (f^a(r_i) - \bar{f}^a)(f^b(r_i) - \bar{f}^b)$$

$$I_1^{(a,b)} = \frac{\sigma^{(a,b)}}{\sqrt{\sigma^{(a,a)}} \sqrt{\sigma^{(b,b)}}}$$

**(Total variation) Distance between distributions:**

$$p^a(r_i) = \frac{f^a(r_i)}{f^a(R)}; p^b(r_i) = \frac{f^b(r_i)}{f^b(R)}$$

$$\text{TVD}(p^a, p^b) = \frac{1}{2} \sum_i |p^a(r_i) - p^b(r_i)|$$

$$I_2^{(a,b)} = 1 - \text{TVD}(p^a, p^b)$$

**Jaccard similarity coefficient:**

$$I_3^{(a,b)} = \frac{N(a \cap b)}{N(a \cup b)}$$

**Cosine similarity:**

$$I_4^{(a,b)} = \frac{\sum_i f^a(r_i) f^b(r_i)}{\sqrt{\sum_i f^a(r_i)^2} \cdot \sqrt{\sum_i f^b(r_i)^2}}$$

### References

1. OECD (2021), *Methodologies to measure market competition*, OECD Competition Committee Issues Paper, <https://oe.cd/mmmc>
2. LIJESSEN, Mark G., NIJKAMP, Peter, et RIETVELD, Piet. *Measuring competition in civil aviation*. *Journal of Air Transport Management*, 2002, vol. 8, no 3, p. 189-197.



← Connect with the author  
 Email: [qian.liu@enac.fr](mailto:qian.liu@enac.fr)

