The evolution of air transport networks and impacts on shortest travel times between NUTS-3 regions – a case study for intra-European trips originating in Germany

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Agenda

- Introduction
- Research Questions
- Methodology
- Results
- Conclusions
- Outlook

Introduction

Key developments that have shaped the European air transport industry in the past two decades:

- Rise of low cost carriers
- Demise of regional air transport with small turboprops / regional jets
- Market entry of military-civilian conversion airports (Hahn, Weeze, Memmingen...)
- Market exit of airports (e.g. Altenburg, Bayreuth, Berlin-Tempelhof, Cochstedt, Hof, Kiel, Lübeck and Zweibrücken in Germany; Blackpool, Manston, Plymouth and Sheffield in the UK and Aosta, Bolzano and Crotone in Italy)
- Withdrawal of network carriers from non-hub operations
- Hybridisation of low cost carriers / convergence of business models
- New players in the travel industry: Metasearchers and mobility providers
- Facilitated self connections and low cost carrier transfer offers

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Research Questions

- Given the circumstances in European air transport, how have shortest travel times between regions developed?
- How does air transport compare to trips by car when it comes to shortest travel times?
- Which cities / regions have benefitted most from the growth in air transport connectivity?
- What are the benefits of facilitated self hubbing / low cost carrier connections?
- Is it realistic to reach the Flightpath 2050 goal that 90% of travellers can complete their trips door-to-door within 4 hours?

⇨ Application of the model to the case of intra-European trips originating in Germany

Methodology

Objectives of the methodology

- Identification of the shortest travel times between regions in Europe on a small geographical resolution
- Comparison of shortest travel times with car as only mode and a combination of car and scheduled air transport
- Analysis capabilities on aggregated and disaggregated geographical resolutions

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Methodology

Inputs for the model:

- EUROSTAT Geospatial databases: shapes and centroid coordinates of all 1,394 NUTS-3 regions in Europe
- DLR-developed airport database: coordinates of European airports (587 airports in NUTS-3 regions plus 39 additional airports in neighbouring countries with scheduled services between 2000-2017)
- Google Distance Matrix API: driving times between geographical coordinates
- Innovata flight schedules for 2000, 2005, 2010, 2015 and 2017

Preparatory steps:

- Generation of a matrix with driving times between NUTS-3 regions
- Generation of a matrix with driving times between airports and NUTS-3-regions
- Generation of a matrix with shortest flight times between airports

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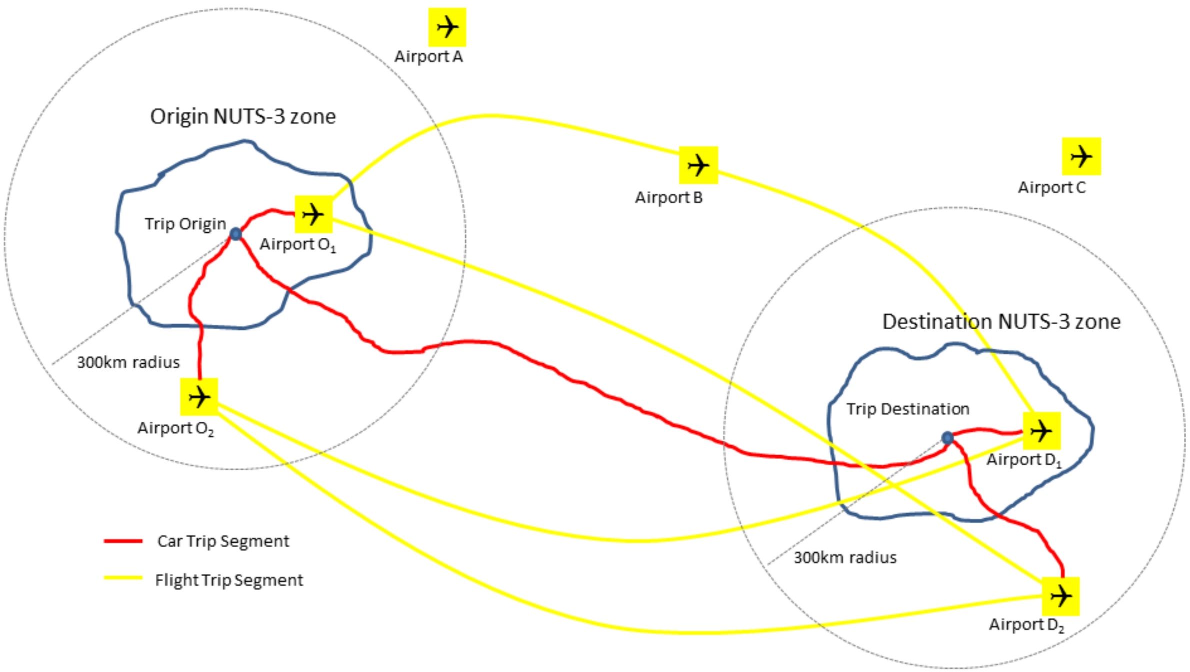
Methodology

Assumptions of the model

- Trip origins: centroids of German NUTS-3 regions, trip destinations: centroids of European (incl. German) NUTS-3 regions, independently of distance
- Non-stop, one-stop and two-stop connections in air transport
- One-stop and two-stop connections must fulfil the following conditions:
  - A valid connection is available at least once a week
  - Minimum connection time is 45 minutes, maximum connection time is 4 hours. These values are uniformly applied for all airports/airlines;
  - A valid connection must be online (same airline operating all flight segments) or codeshare (the same marketing airline code must be placed on all flight segments);
  - Initially, no transfers between low cost carriers are allowed.
- Connections between car and air are subject to a penalty of 90 minutes: 60 minutes arrival at the airport prior to departure,
- Airports under consideration must be within a 300 km radius of the NUTS-3 centroid

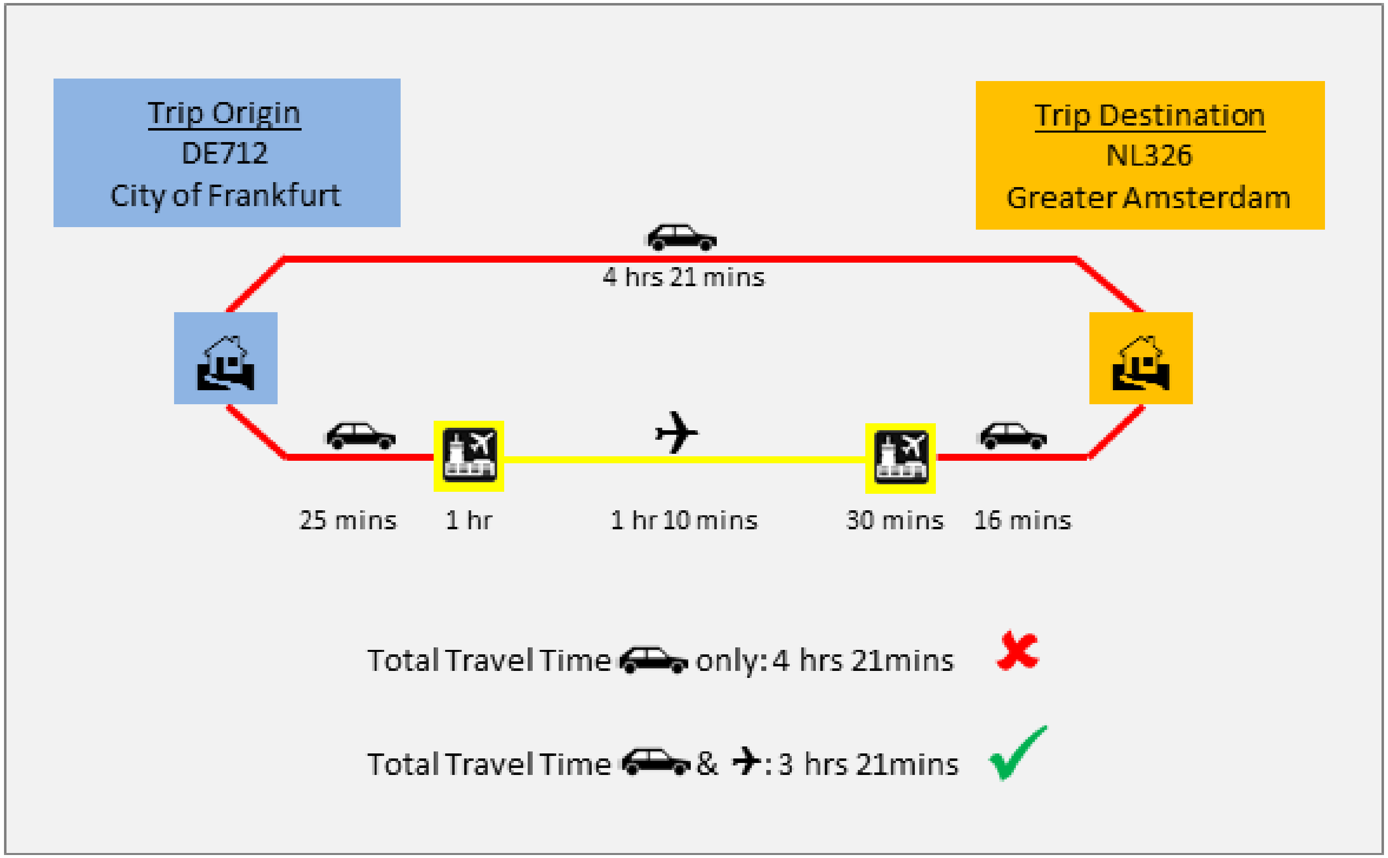
Methodology

Model schematic overview



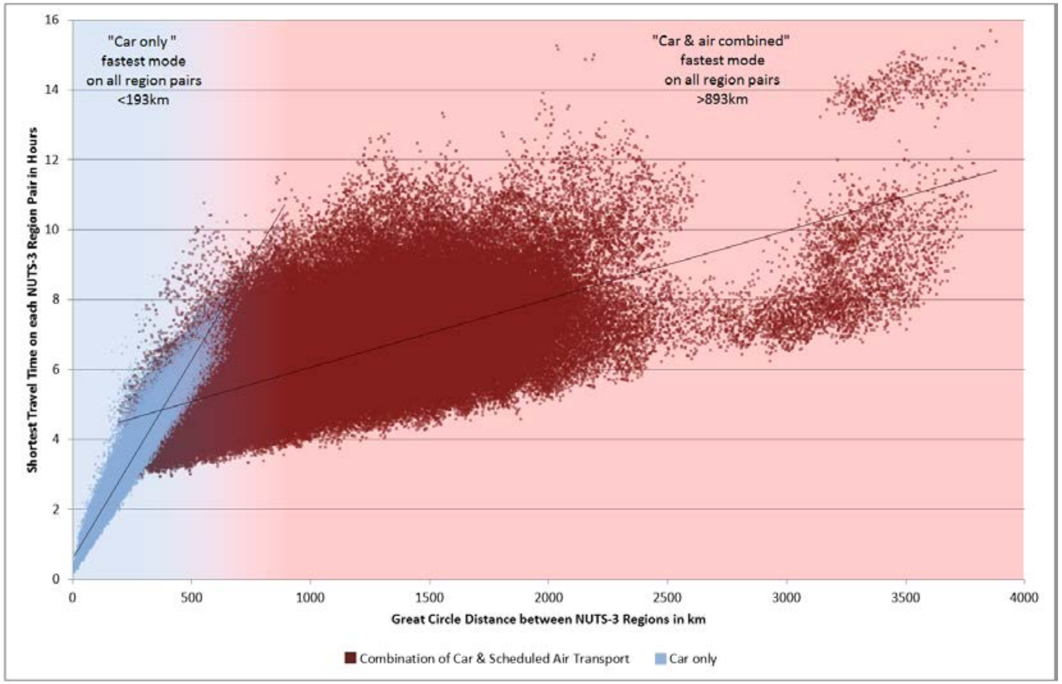
Methodology

Model results for a particular NUTS-3-region pair



Results

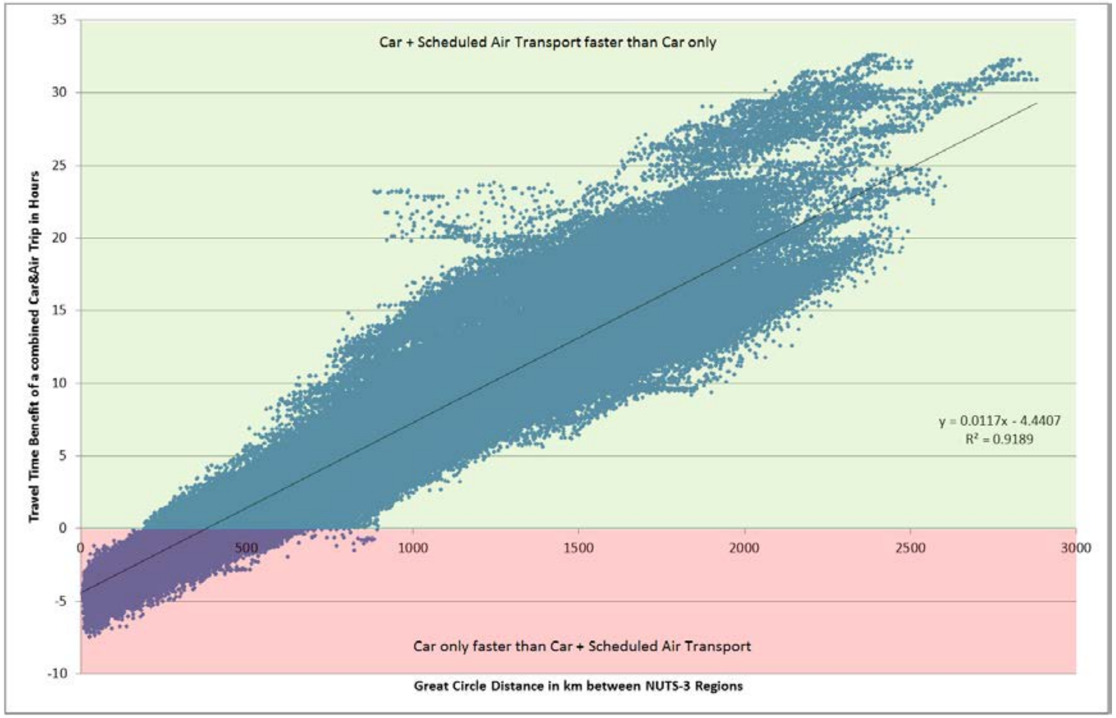
Shortest travel times by great circle distance for all 559,986 NUTS-3 region pairs from Germany to Europe, 2017



- ⇨ „Car only“ is fastest mode on all region pairs <193 km
- ⇨ „Car & air combined is fastest mode on all region pairs >893 km
- ⇨ Between 193 km and 893 km, fastest mode depends on region pair

Results

Travel time benefits of combined car-air trips by distance from Germany to Europe, 2017

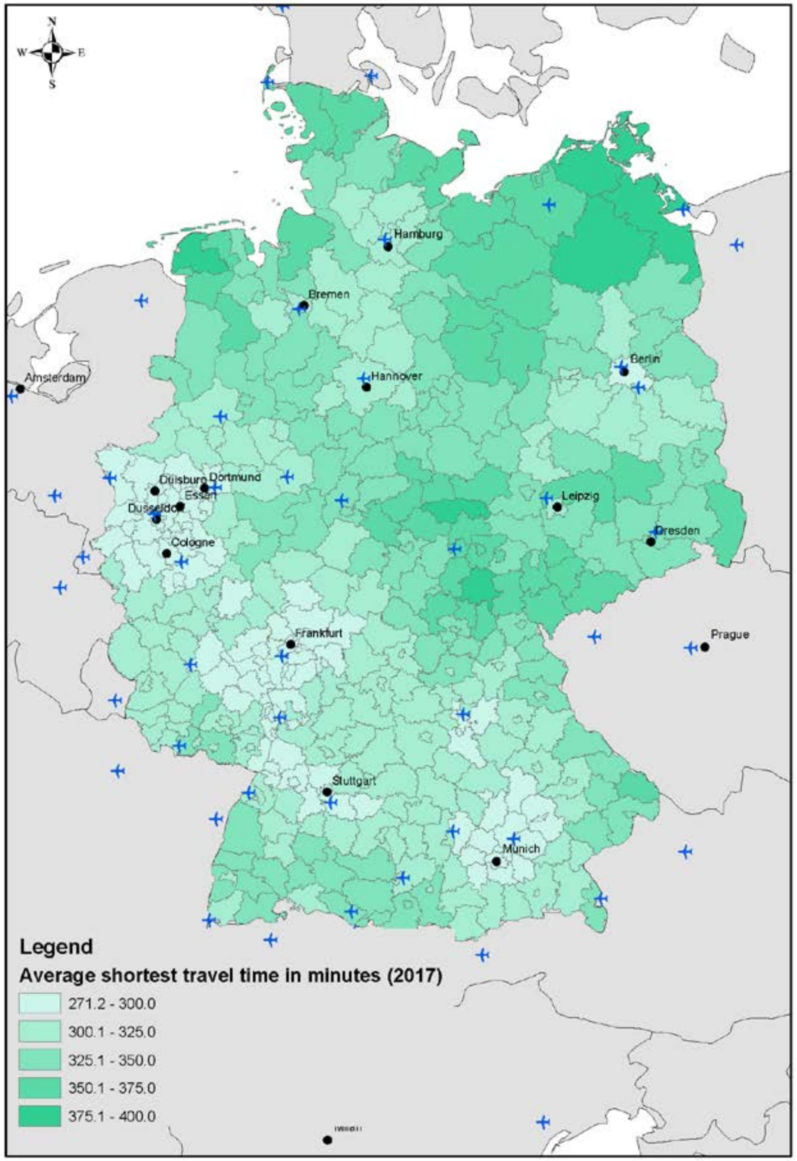


⇨ Out of the 559,986 NUTS-3 region pairs Germany-Europe, 137,643 (24.6 %) are connected by car-only as fastest mode. 422,343 are served fastest with car and air combined

Results

<u>**Average shortest travel times (2017)**</u>

- Not surprisingly, best connected regions in Germany are around the major airports, further contributing factor: dense autobahn infrastructure
- Best connected regions: Frankfurt (270 minutes average shortest travel times to all other NUTS regions), Duisburg (273 minutes) and Freising (273 minutes)
- Worst connected regions: Vorpommern-Rügen (389 minutes), Saalfeld-Rudolstadt (381 minutes) and Mecklenburgische Seenplatte (380 minutes)
- Connectivity gaps in the East-center (Thuringia), Northeast (Mecklenburg-Vorpommern) and East Frisia (Lower Saxony)



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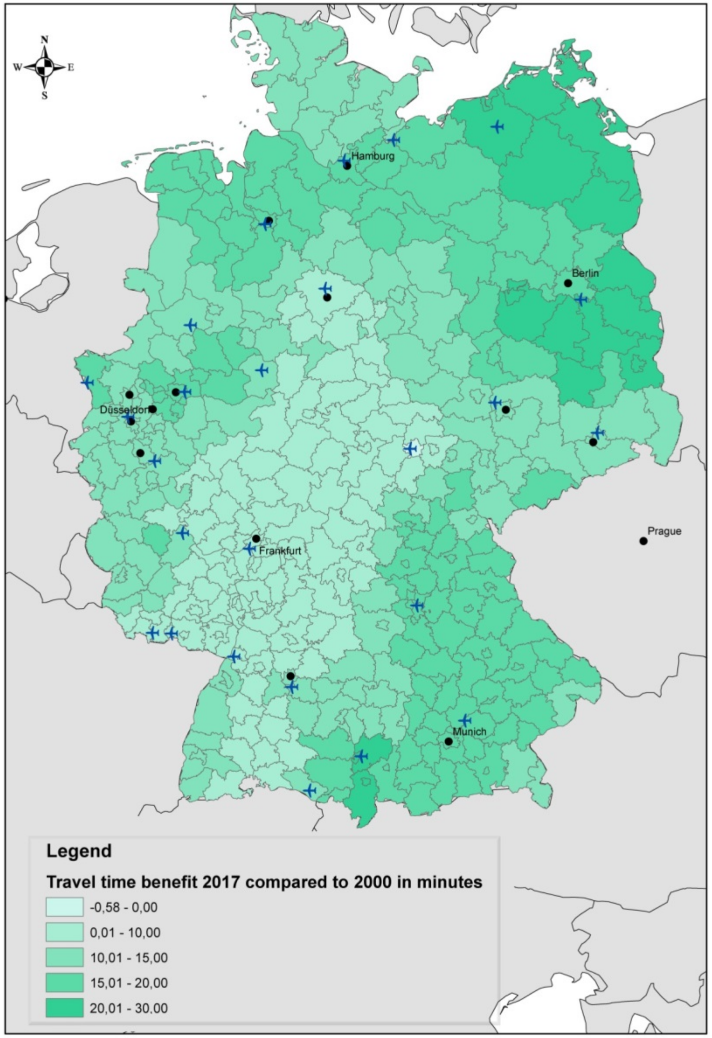
Results

Comparison average shortest travel times 2000 and 2017

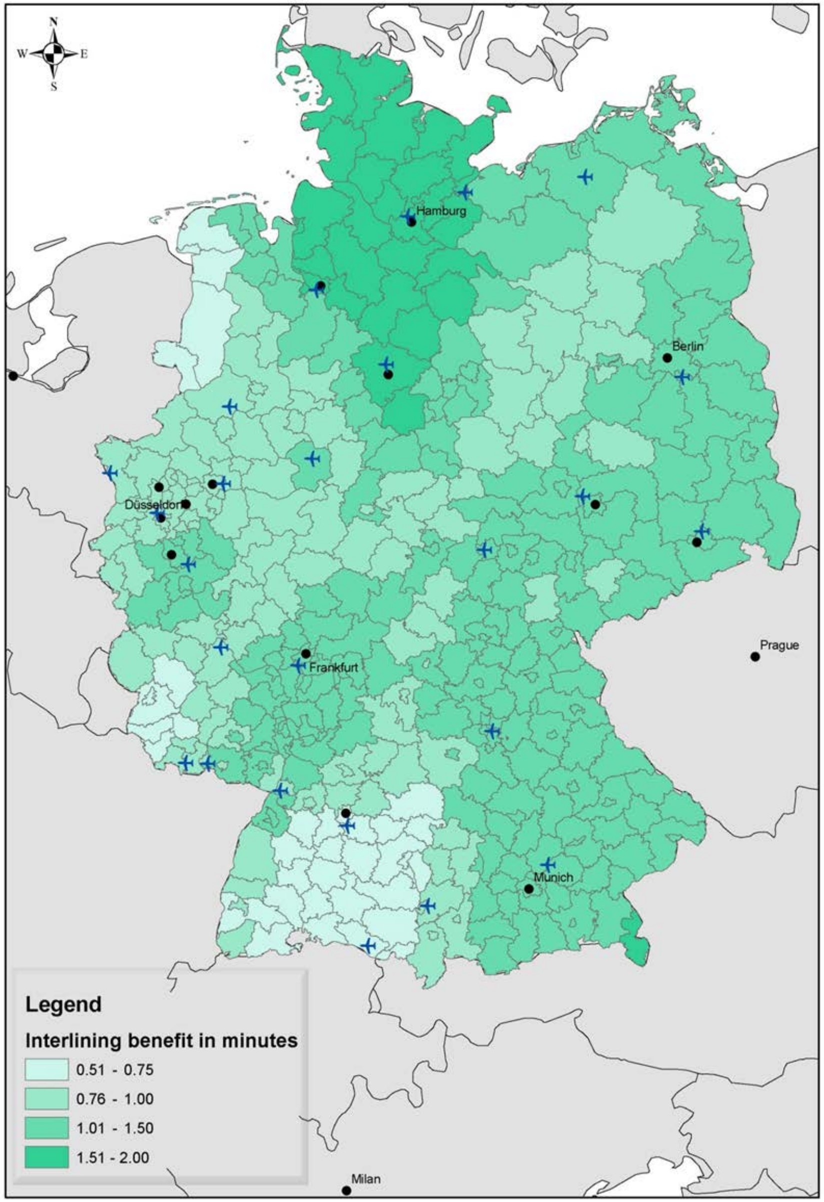
- Highest improvements in Mecklenburg-Vorpommern due to some additional flights in Rostock and Heringsdorf, Southern Brandenburg (LCC growth in Berlin-Schönefeld) and Allgäu (emergence of Memmingen airport)
- Small improvements around Hamburg, Bremen, Rhein-Ruhr and Bavaria (LCC growth, hub establishment in Munich)
- Virtually no improvements in the Western Center along a line from Hannover via Frankfurt to Stuttgart (air transport growth in Frankfurt did not significantly reduce shortest travel times



Results

<u>Benefits of "full interlining" between all available airlines</u>

- Although the number of city pairs served increases strongly (170,987 in full interlining scenario vs. 67,009 online and codeshare scenario) improvements in shortest travel times are insignificant (maximum 2 minutes)
- Model on shortest travel times inherently prefers car travel even on longer distances
- LCC transfers are relatively inefficient time-wise, as waiting time and flight times are in many cases higher than driving times to an airport offering non-stop flights further away



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Conclusions

- Air travel can be beneficial even on shorter distances. Shortest relation where air travel offers travel time benefits is 193 km.
- Between 2000 and 2017 some improvements in shortest travel times have occurred. Particularly benefitted have Mecklenburg-Vorpommern, Southern Brandenburg and the Allgäu region in Western Bavaria
- The travel time improvements in Mecklenburg-Vorpommern come from relatively few flights, showing that it is initially rather easy to reduce travel times, but with an increasing supply, it gets more difficult to further reduce travel times
- Full interlining / low cost carrier connections generate much less benefits in the reduction of average shortest travel times than initially perceived when taking a look at the impact of airport pairs served (170,987 in full interlining scenario vs. 67,009 online and codeshare scenario)

⇨ Flightpath 2050 objectives rather challenging to reach, but emergence of new concepts (e.g. autonomous on-demand air taxi) may change the picture

Outlook

Potential further applications for the presented connectivity model:

- Impacts of the potential market exit of regional airports, given the European Commission's decision to limit operating aid for regional airports
- Impacts of new air services (e.g. on-demand air taxis)

Envisaged extensions of the model:

- Inclusion of public ground transport (short & long distance)
- Addition of a generalised cost model