Substitution path between air and rail in Europe: a measure of demand drivers

Preliminary results – do not quote

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INAIR 2022 – Bratislava, 9-10 November

EUROPEAN PARTNERSHIP

This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation program under grant agreement No 891166.

Co-funded by the European Union

Motivation

- Context
  - increasing environmental awareness, regulatory measures, capacity shortages across different modes, and the need for a more seamless passenger journey
  - optimization and alignment of multimodal transport in Europe to improve the overall performance of the (future) transport system

  → Modus Project (https://modus-project.eu/)

- Objective of this paper
  - identifying the determinants of passengers' choice of transportation

  ➢ ***assessing the substitution paths between air and rail on French, German and Spanish markets***

Literature review

- Inter-modal competition has been extensively studied in the literature
  - Most focus on air-rail competition only ((Albalate et al., 2015), (Behrens & Pels, 2012), (Ortúzar & Simonetti, 2008), (Park & Ha, 2006) , Ivaldi & Vibes (2008)
  - Others consider sets of other modal alternatives as bus, car-pooling and private cars (Bergantino & Madio, 2020)
- Some authors consider inter and intra-modal competition (Bergantino et al. 2015, Ivaldi & Vibes, 2008)

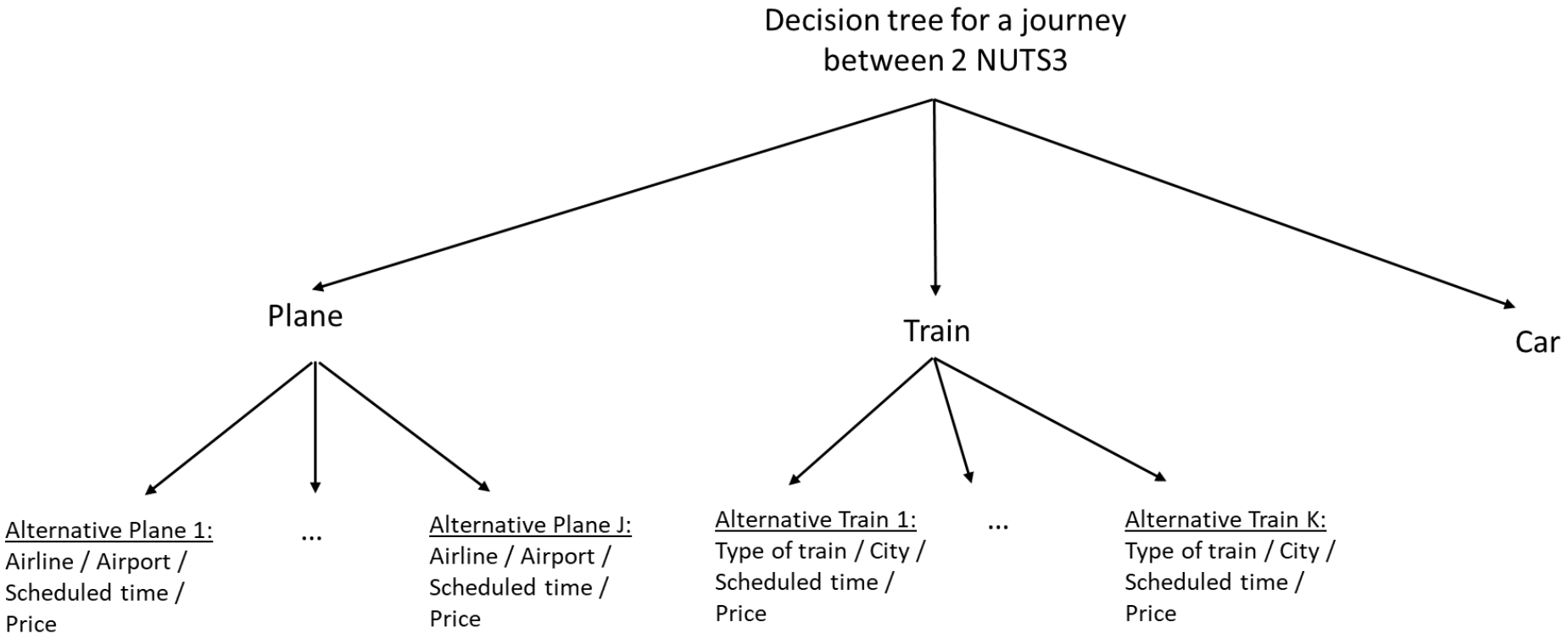
➢ In this paper, we ambition to go ahead with the work of Ivaldi and Vibes (2008) by considering a much larger network

Origin-Destination and transport supply

- Origin-Destination definition and selection
  - Selection of geographic areas larger than the cities: NUTS3 level
    - ➢ *Several airports and railway stations in departure and arrival OD*
  - Selection of OD where both air and rail are available – direct routes

- Quality in transport supply
  - Train: HSR, Intercity, Night
  - Plane: Majors, Low-Cost Carriers
    - ➢ *Major supply: HSR, Legacy carriers*
    - ➢ *Low-Cost supply: Intercity, Night, Low-Cost Carriers*
  - Car as another possible mode of transportation

A two-stages decision model



Alternative: a combinaison of a mode, service provider, type of service & corresponding price

Objective of the model:

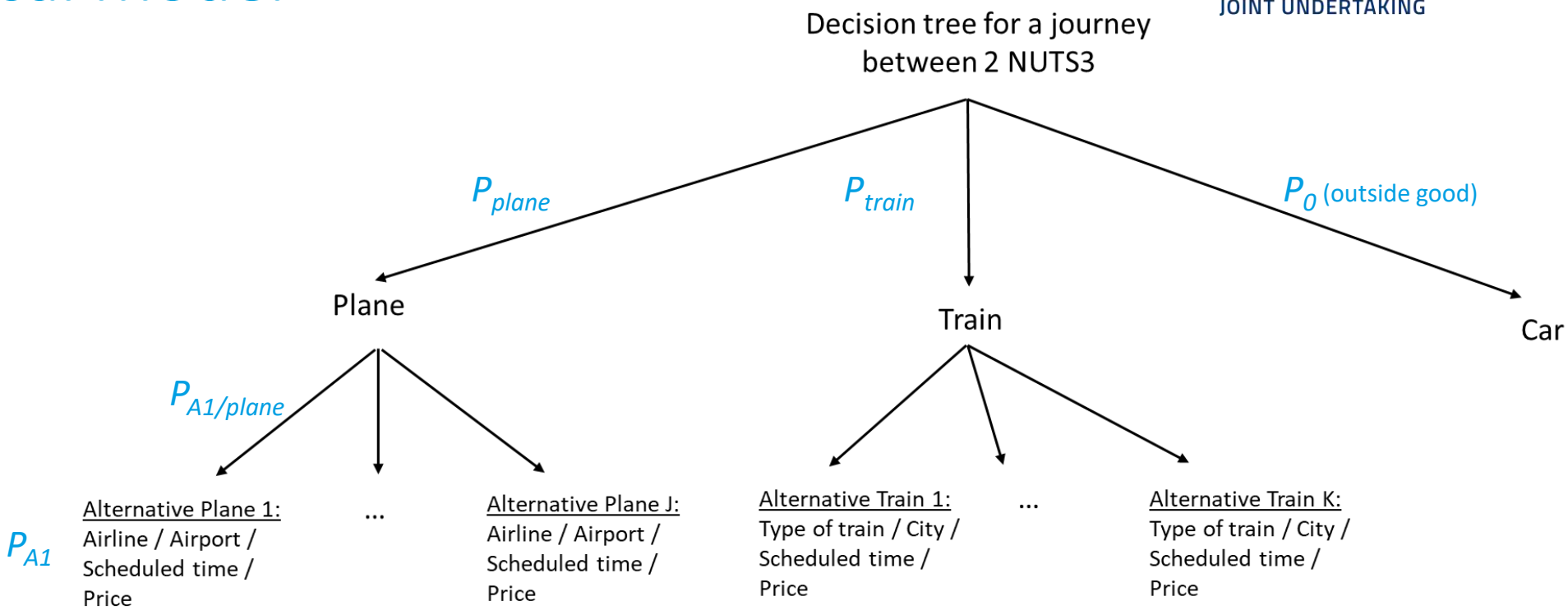
- *To determine what is the intensity of competition between modes: intermodal competition*
- *To determine what is the intensity of competition within modes: intramodal competition*

Theoretical model

P_g
(probability to choose mode *g*)

$P_{j/g}$
(probability to choose Alternative *j* given mode *g* is chosen)

P_j
(probability to choose Alternative j)



P_j, $P_{j/g}$, P_g : theoretical probabilities

➢ we observe the empirical probabilities: market shares s_j, $s_{j/g}$, s_g

$\sum_j P_j = 1$ and $\sum_j s_j = 1$

Demand is expressed in terms of market share

Demand function

$$ln(s_j) - ln(s_0) = \psi_j + hp_j + \sigma ln(s_{j/g})$$

- s_j : market share of alternative *j*
- s_0 : market share of the outside good
- p_j : price of alternative *j*
- $s_{j/g}$: market share of alternative *j* given the choice of mode *g*
- ψ_j : vector of characteristics for the alternative j
  - type of the service; city or airport departure/arrival; scheduled day and time; distance
  - proxy for the size of the market: GDP or population or household average income in departure and arrival areas
- *h* : part of the measure of demand sensitivity to price
- σ : measure of the degree of intra-group correlation; σ belongs to [0,1]

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Data collection

Data sources

For air: OAG Schedule Analyzer, FRACS (France Aviation Civile Services) database, airline annual reports, IATA paxIS

For rail: MERITS (UIC database), SNCF, RENFE, Deutsche Bahn

➢ ***A unique air and rail aggregated database in 2016***

Per month, per OD, per alternative:

we observe the frequency, the total number of passengers, the average price

➢ *frequency is used as a weight in our analysis*.

Alternative: combination of transport mode, operator, type of service

We observe also several characteristics:

For the alternatives: % of departure during the week-end, % of departure across several time slots, distance

For the OD, socio-economic characteristics: GDP, population, GDP/capita

Estimation - results

- One model per country
- Use of ***instrumental variable*** method to control for endogeneity between price and market-share
  - Instrumental variables: Current (monthly 2016) and lagged (monthly 2015) price of energy
- GDP as a proxy of market size – NUTS3 level

Main results

- Statistical significance of the estimated parameters
- Validity of the instruments

Variables	Model France	Model Germany	Model Spain
Price (Price Minimum for Spain)	-0.0443***	-0.0191***	-0.0561***
	(0.00392)	(0.000870)	(0.0101)
Ln(sj/g)	0.428***	0.936***	0.929***
	(0.0589)	(0.0160)	(0.0725)
GDP NUTS 3 departure (thousand)	0.00248	0.0539***	0.0316***
	(0.00641)	(0.00421)	(0.0112)
GDP NUTS 3 arrival (thousand)	0.00265	0.0591***	0.0327***
	(0.00602)	(0.00441)	(0.0106)
Attributes of alternatives	YES	YES	YES
Market fixed effect	YES	YES	YES
Carrier fixed effect	YES	YES	YES
Month fixed effect	YES	YES	YES
Observations	2,162	3,086	386
Model Statistics			
R-squared	0.841	0.947	0.973
F-Test	666.5	5437	1303
loglikelihood	-3281	-2908	-288.6
Tests of instrumental variables			
Kleibergen-Paap rk LM	128.9	272.7	73.68
p value	0	0	0
Cragg-Donald Wald F	228.6	442.4	99.21
Kleibergen-Paap rk Wald F	114	469.5	148.4
Hansen J	3.552	2.539	2.041
Chi-sq() P-val	0.0595	0.111	0.153
Endogeneity_test	216.8	441.5	41.46
Chi-sq() P-val	0	0	1.21e-10

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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Main results

- Statistical significance of the estimated parameters
- Validity of the instruments
- ***Price:*** correct negative sign
- ***Intra-mode competition:*** high for Germany and Spain, low for France

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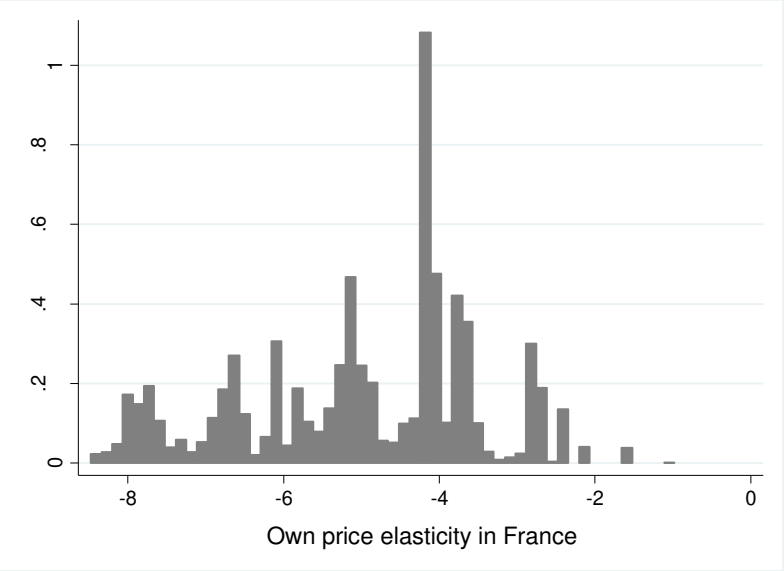
Measures of demand sensitivity

- ***Price elasticity of demand***

$$\eta_j = \frac{dq_j}{dp_j} \times \frac{p_j}{q_j} = hp_j \left(s_j - \frac{1}{1-\sigma} + \frac{\sigma}{1-\sigma} s_{j/g} \right)$$



Country	Obs	Mean	Std. Dev.
France	1,961	-5.338775	1.5893
Germany	2,582	-9.111078	7.718956
Spain	272	-10.78422	9.738804

	France		Germany		Spain	
	Major	Low-Cost	Major	Low-Cost	Major	Low-Cost
Plane	-6.03	-4.74	-6.11	-13.54	-17.58	-28.53
	(1.18)	*(1.90)*	*(7.04)*	*(6.99)*	*(7.06)*	*(0.55)*
Train	-5.21	-3.01	-4.62	-13.44	-1.53	-14.32
	(1.39)	*(1.54)*	*(4.13)*	*(7.824)*	*(0.37)*	*(6.23)*

Conclusion

Preliminary results

- Strong sensitivity of demand to changes in fares leading to substitution between transport modes
- Intra-mode competition: high for Germany and Spain, low for France
  - Competition between modes is higher when intramode competition is lower.
- Higher price sensitivity of travelers using low-cost supply
- Higher price sensitivity of air travelers

Next steps – policy implications

Investigate on the characteristics of the supply (frequency, days and hours of departure) that regulators should consider to influence the PAX choice towards choices that could be more valued from a societal point of view.

THANK YOU FOR YOUR ATTENTION

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