



How does environmental awareness for HSR influence the necessity for short-haul flight bans?

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15/02/2024



Hi! I'm Adrián Nerja, Assistant Professor in the Department of Applied Economics and Economic Policy at the University of Alicante. I research with a focus on transportation economics and sustainability.

In this presentation, we will discuss the necessity of banning short-haul flights, the preferences of high-speed rail (HSR) passengers compared to plane passengers, and the level of sustainability awareness among passengers.



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What is it about?

1 Introduction

The objective of this paper is to examine the necessity of banning short-haul flights for environmental reasons, considering the potential preference of passengers for traveling by high-speed rail (AVE).



In the name of climate change

1 Introduction

Pedro Sánchez: 'Impulsaremos la reducción de los vuelos domésticos en aquellas rutas en las que exista una alternativa ferroviaria con una duración menor de dos horas y media, salvo en casos de conexión con aeropuertos-hub que enlacen con rutas internacionales.'

Flights mainly affected:

- Madrid-Valencia 1h. 35 min.
- Madrid-Alicante 2h. 31 min.
- Madrid-Sevilla 2h. 30 min.
- Madrid-Málaga 2h. 40 min.



Is it necessary to impose a ban on flights?

1 Introduction

1. According to [COIAE](#), if the Madrid-Barcelona air bridge were replaced by a rail connection, 0.41% of the total aviation emissions in Spain would be reduced and 0.03% of the total emissions in Spain in 2022.
2. Passengers would be redirected to use HSR and road transport, resulting in an additional CO_2 emission cost.
3. The market has the ability to regulate itself based on the preferences of passengers for emerging transportation methods.



Impact of HSR implementation on demand for flights

1 Introduction

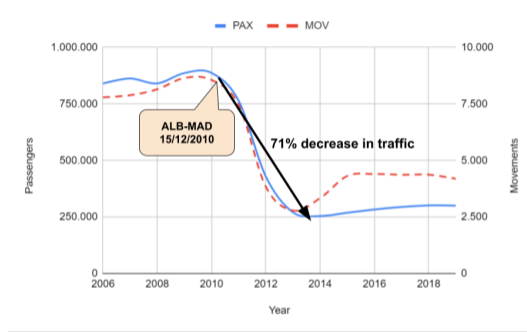


Figure: ALC-MAD



Impact of HSR implementation on demand for flights

1 Introduction

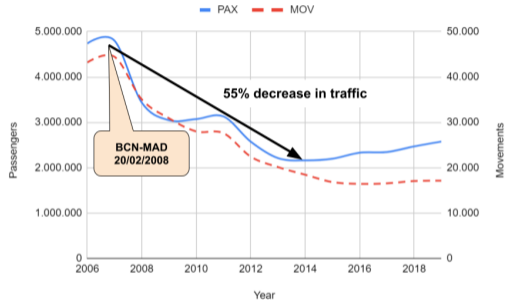


Figure: BCN-MAD



Impact of HSR implementation on demand for flights

1 Introduction

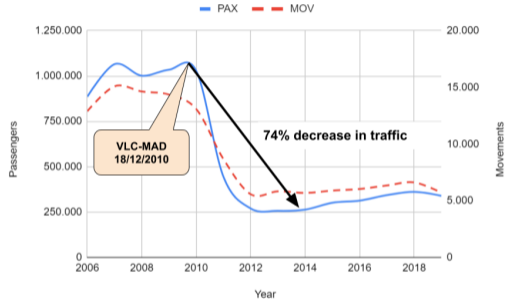


Figure: VLC-MAD



Higher willingness to pay to travel by HSR

1 Introduction

- convenience, comfort, and accessibility
- spacious and comfortable travel experience with amenities like larger seats and ample legroom
- perceived reliability with fewer delays and cancellations
- pricing structure with additional services or benefits included in the ticket price
- targeting of a specific market segment
- **environmental consciousness and sustainability**



Question

1 Introduction

Given that passengers are more willing to pay for High-Speed Rail (HSR) travel due to their concern for the environment, is it necessary to ban short-haul flights?



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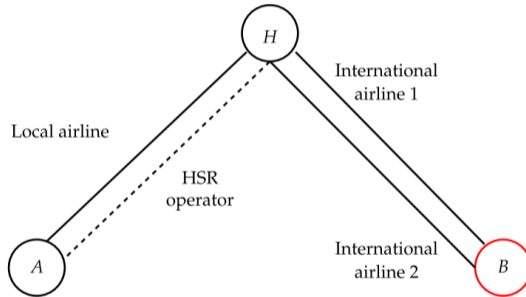
▶ Summary

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The Model

2 Analysis





Environmental awareness

2 Analysis

The parameter $\theta > 1$ is a multiplier that increases the maximum willingness to pay for HSR passengers.

- The railway is more environmentally friendly than air travel.
- There are passengers willing to pay a higher price to travel by HSR.



3 Markets¹

2 Analysis

$$U_l = \theta a_l q_t + a_l q_a - \frac{b}{2}(q_t^2 + q_a^2) - d_l q_t q_a \quad (1)$$

$$U_i = a_i(q_{i1} + q_{i2}) - \frac{b}{2}(q_{i1}^2 + q_{i2}^2) - d_i q_{i1} q_{i2} \quad (2)$$

$$U_c = \theta a_c(x_{t1} + x_{t2}) + a_c(x_{a1} + x_{a2}) - \frac{b}{2}(x_{t1}^2 + x_{t2}^2 + x_{a1}^2 + x_{a2}^2) - d_c(x_{t1}x_{t2} + x_{t1}x_{a1} + x_{t1}x_{a2} + x_{t2}x_{a1} + x_{t2}x_{a2} + x_{a1}x_{a2}) \quad (3)$$

¹Economides and Salop (1992) was the first to employ this demand structure.



Demands

2 Analysis

i) Local market demand system, *AH* market:

$$q_t(p_t, p_a) = \frac{a_l(\theta b - d_l) - bp_t + d_l p_a}{b^2 - d_l^2} \quad (4)$$

$$q_a(p_t, p_a) = \frac{a_l(b - \theta d_l) - bp_a + d_l p_t}{b^2 - d_l^2} \quad (5)$$

ii) International market demand system, *HB* market:

$$q_{i1}(p_{i1}, p_{i2}) = \frac{a_i(b - d_i) - bp_{i1} + d_i p_{i2}}{b^2 - d_i^2} \quad (6)$$

$$q_{i2}(p_{i1}, p_{i2}) = \frac{a_i(b - d_i) - bp_{i2} + d_i p_{i1}}{b^2 - d_i^2} \quad (7)$$



Connected demands

2 Analysis

iii) Connecting market demand system, AB market:

$$x_{t1}(s_{t1}, s_{t2}, s_{a1}, s_{a2}) = \frac{a_c(\theta b - (2 - \theta)d_c) - (b + 2d_c)s_{t1} + d_c \sum_{\forall l \neq t1} s_l}{(b - d_c)(b + 3d_c)} \quad (8)$$

$$x_{t2}(s_{t1}, s_{t2}, s_{a1}, s_{a2}) = \frac{a_c(\theta b - (2 - \theta)d_c) - (b + 2d_c)s_{t2} + d_c \sum_{\forall l \neq t2} s_l}{(b - d_c)(b + 3d_c)} \quad (9)$$

$$x_{a1}(s_{t1}, s_{t2}, s_{a1}, s_{a2}) = \frac{a_c(b - (2\theta - 1)d_c) - (b + 2d_c)s_{a1} + d_c \sum_{\forall l \neq a1} s_l}{(b - d_c)(b + 3d_c)} \quad (10)$$

$$x_{a2}(s_{t1}, s_{t2}, s_{a1}, s_{a2}) = \frac{a_c(b - (2\theta - 1)d_c) - (b + 2d_c)s_{a2} + d_c \sum_{\forall l \neq a2} s_l}{(b - d_c)(b + 3d_c)} \quad (11)$$

where $s_{t1} = p_t + p_1$



Profits and strategic effects

2 Analysis

$$\pi_t = (p_t - c_t)Q_t \quad (12)$$

$$\pi_a = (p_a - c_a)Q_a \quad (13)$$

$$\pi_{i1} = (p_{i1} - c_a)Q_{i1} \quad (14)$$

$$\pi_{i2} = (p_{i2} - c_a)Q_{i2} \quad (15)$$



Stages

2 Analysis

1. The four transport firms compete in prices.
2. We compare the results with the benchmark case, $\theta = 1$.
3. In order to solve mathematically, we make some assumptions:
 - $a_l = a_i = a$
 - $a_c = 2a$
 - $b = 1$
 - $d_l = d_i = d_c = d$, then $0 < d < 1$
 - $cl = ca = 0$



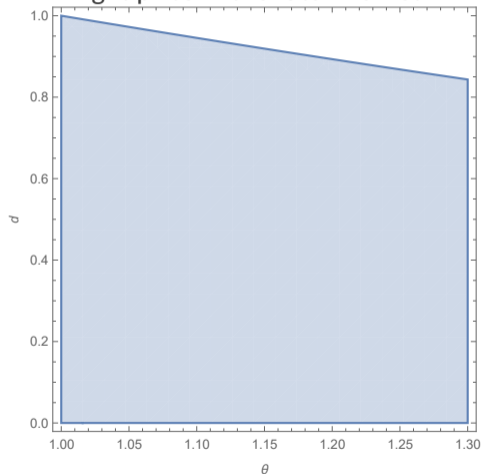
Main Result

2 Analysis

Result

The local flight would cease to exist, provided that passengers are sufficiently environmentally aware.

Flight price in the local market



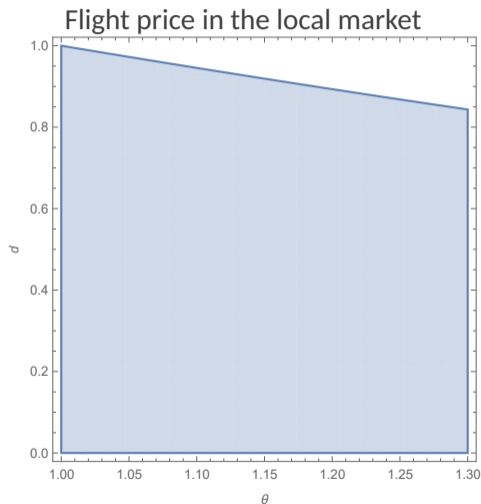


Main Result

2 Analysis

Table: Service differentiation and passenger awareness

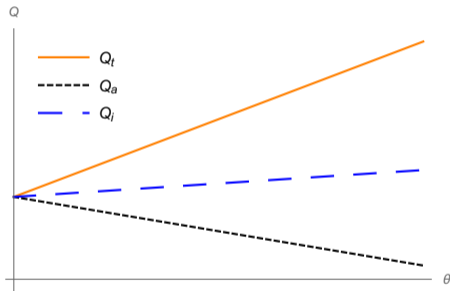
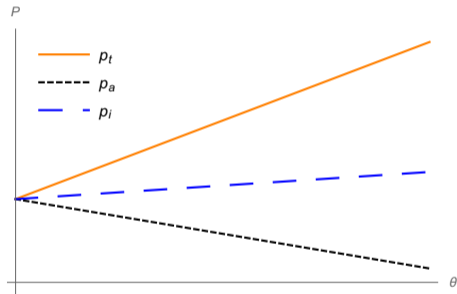
d	$\hat{\theta}$
1	1
0.95	1.09
0.9	1.19
0.85	1.29





Effects of a higher environmental awareness

2 Analysis





Competition effect

2 Analysis

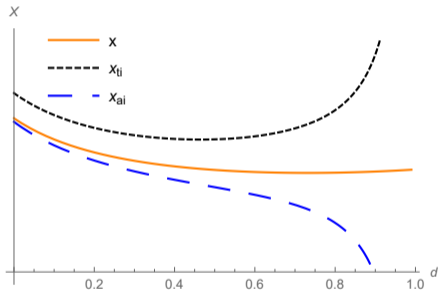
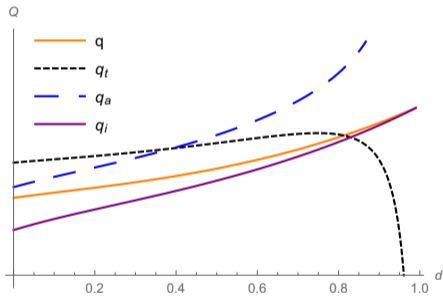




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What do we do?

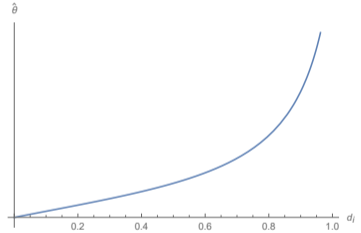
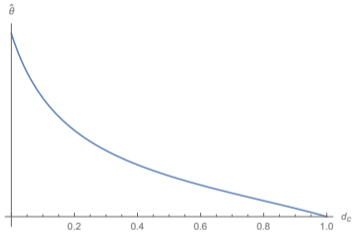
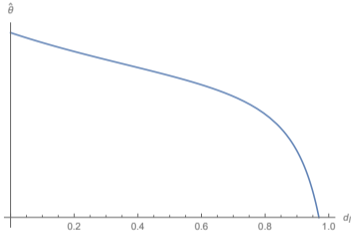
3 Numerical analysis

This section investigates the relationship between market competition and the maximum willingness-to-pay threshold required for the local airline to maintain its operations.



Markets competition and environmental awareness

3 Numerical analysis





Analysis stages

3 Numerical analysis

1. We design an experiment

- Factorial experiment in which multiple factors are manipulated simultaneously in order to observe their combined effect on a response variable.
- Factors: d_l , d_i , d_c , with values (1, 0.9, 0.8).
- 27 combinations

2. ANOVA to analyze the impact of markets competition on the threshold.



Factorial experiment

3 Numerical analysis

ID	d_i	d_l	d_c	$\hat{\theta}$
1	1	1	1	1
2	1	1	0.9	1
3	1	1	0.8	1
4	1	0.9	1	
5	1	0.9	0.9	1.19341
6	1	0.9	0.8	1.34907
7	1	0.8	1	
8	1	0.8	0.9	1.21689
9	1	0.8	0.8	1.41969
10	0.9	1	1	
11	0.9	1	0.9	1
12	0.9	1	0.8	1



ANOVA - $\hat{\theta}$

3 Numerical analysis

	Sum. Sq.	d.f	Quadratic Mean	F value	<i>p</i>
Model	0.74079	18	0.04116	3444.49	<.001***
d_i	0.08227	2	0.04113	3382.93	<.001***
d_l	0.00356	2	0.00178	146.38	<.001***
d_c	0.161	2	0.0805	6620.55	<.001***
$d_i * d_l$	0.000222	4	0.0000556	4.57	0.063
$d_i * d_c$	0.12013	4	0.03003	2469.9	<.001***
$d_l * d_c$	0.37362	4	0.0934	7681.92	<.001***
Residues	0.0000608	5	0.0000122	NA	NA

Significance levels: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$



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Conclusions

4 Summary

- Passengers' increasing environmental consciousness is driving the market towards more sustainable modes of transportation.
- Considering the interrelated market and its influence is crucial.



Food for thought

4 Summary

- Is it essential to have regulation?
- Considering diversity and respecting the preferences or requirements of others holds significance.
- The aviation industry is continually undergoing a green technological evolution, aiming to find more sustainable alternatives.
- The environmental impact of changing the modes of transportation is also significant.



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Connect!

5 Connect

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- [Google Scholar](#)
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How does environmental awareness
for HSR influence the necessity for
short-haul flight bans? *Thank you for listening!*

Any questions?