

The Social Cost of Air Traffic Delays

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- Study commanded by the DGAC
- European Commission (2005): “Strengthening passenger rights within the European Union”
 - Increases monetary compensations for denied boarding.
 - Includes compensations for some kind of cancelation and covers long delays.
- Airlines: increase in costs that will be translated to an increase in price.

Delays in Europe

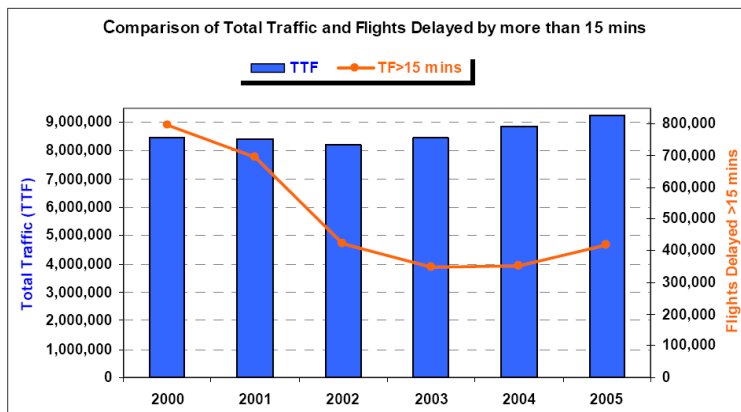


Figure: eCoda Annual Report 2005

How can we define delays

- Review of applied literature: few studies, most of them compute total delays and multiply them by some measure of value of time.
- Problems: Several definitions of delays and of value of time.
- Few studies about buffer time
 - Mayer and Sinai (2003)
 - University of Westminster (2004)
- Buffer delay or buffer time: actual time minus minimum feasible travel time.
- Example: Toulouse - Paris, scheduled time is 80 minutes, average observed time is < 70 minutes.

Are delays so bad?

- Delays as a congestion externality: tragedy of the commons.
- Jan K. Brueckner (2002)
- A single dominant carrier should internalize much of the externality
- Mayer and Sinai (2003): delays appear due to network benefits.

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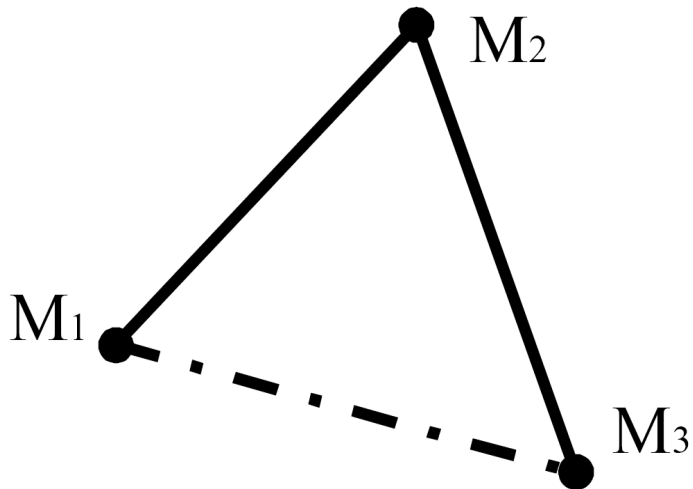
- Delays as a congestion externality: tragedy of the commons.
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- A single dominant carrier should internalize much of the externality
- Mayer and Sinai (2003): delays appear due to network benefits.
- When we estimate delay costs we should not consider the whole delay, but the difference with respect to the optimal level of delays, for both airlines and passengers.

Definition of delays

- Optimal delay
 - Value of delays that maximizes welfare
- Equilibrium delay
 - Value of delays that maximizes firm's profit

- Objective: Evaluation of the cost of delays
 - Welfare at optimum-Welfare at equilibrium
- Welfare = Utility of traveling for the passengers - Costs for the passengers + Profit of the firms
- We use observed data to calibrate the parameters of the demand function

Specific Network



- Hub-and-spokes network

$$C_{ij}(X_{ij}) = F + (\alpha + \beta X_{ij}) d_{ij}$$

Components and assumptions of the model

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- Stochastic delay $\epsilon_{ij} \sim \Phi(\epsilon_{ij})$

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- Stochastic delay $\epsilon_{ij} \sim \Phi(\epsilon_{ij})$
- Passengers connect at the hub
- Airline introduces δ and can introduce γ

$$\gamma \leq \delta$$

Components and assumptions of the model

- Firm is a monopoly
- Faces 6 demands

$$X_{ij} = a_{ij} + b_{ij} (P_{ij} + cEtt_{ij})$$

- Firm maximize profits with respect to P_{ij} , δ and γ

Three possible demands

- Demand for (1,2)

$$X_{12} = a_{12} + b_{12} (P_{12} + cEtt_{12})$$

- Demand for (2,3)

$$X_{23} = a_{23} + b_{23} \left(P_{23} + c \left[T_{23} + \int_{\delta}^{\delta+\gamma} (\epsilon_{12} - \delta) \phi(\epsilon_{12}) d\epsilon_{12} \right] \right)$$

- Demand for (1,2,3)

$$\begin{aligned} X_{123} = & a_{123} + b_{123} [P_{123} - C_{lf}(1 - \Phi(\delta + \gamma)) \\ & + c(T_{12} + T_{23} + \delta + \int_{\delta}^{\delta+\gamma} (\epsilon_{12} - \delta) \phi(\epsilon_{12}) d\epsilon_{12}) \\ & + (1 - \Phi(\delta + \gamma)) Ewt] \end{aligned}$$

| Direct Flights | Toulouse-Paris | Paris-Nice | Toulouse-Nice |
|-------------------------------|----------------|------------|---------------|
| Total passengers | 177414 | 166831 | 5568 |
| Total number of flights | 1432 | 1228 | 151 |
| Average Passengers per flight | 123.9 | 135.9 | 36.9 |
| Travel time (minutes) | 80 | 85 | 90 |
| Frequencies ^a | 23.5 | 20.1 | 2.5 |
| Airplane ^b | A320 | A320 | ATR72 |
| Capacity ^c | 161.9 | 168.1 | 68 |
| Average occupation | 76.5% | 80.8% | 54.3% |

^a Average frequency of flights per day; ^b Most frequent plane; ^c Average capacity of the used planes on the route

Flights

- 32% at departure and 16% at arrival
- 4.38 minutes and 2.89 minutes
- Average delay for delayed flights is 14.2 and 8.4 minutes
- 6.3% delayed more than 15 minutes

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Passengers

- 18.6% suffer an arrival delay
- 5.28 minutes
- Average delay for delayed passengers is 12.2 minutes
- 7% suffer a delay superior to 15 minutes

- Prices: 80€ Toulouse-Paris, 95€ Paris-Nice, 120€ Toulouse-Paris-Nice and 150 Toulouse-Nice.
- Waiting time at Paris
- Extra delays
- Costs for the airlines

$$X_{12} = 306.81 - 1.73 (P_{12} + 0.36Ett_{12})$$

$$X_{23} = 331.89 - 1.60 (P_{12} + 0.36Ett_{12})$$

$$X_{123} = 16.34 - 0.056 (P_{12} + 0.36Ett_{12})$$

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- Sensitivity Analysis

- Under the assumptions of linear demand, monopoly and same value of time for all the passengers we obtain that the buffer time should decrease and the extra delays introduced by the airline should increase.
- Some of the actual limitations of the model
 - We assume same value of time for all passengers
 - The monopoly assumption

Jan K. Brueckner, AER Dec. 2002, "Airport Congestion when carriers have market power"

Mayer and Sinai , AER, Nov. 2003: "Network effects, Congestion Externalities, and Air Traffic Delays: Or why not all delays are evil"

