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**The Economic effects of High-Speed Rail Investment**

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# Outline

- The objective of HSR investment
- Costs and benefits of the HSR
- Basic model for the economic evaluation of HSR
- Intermodal effects
- Conclusions

# High Speed Rail

- The proposals of the European Commission for the Trans European Transport Network envisage expenditure of 600b euros, of which 250b euros is for priority projects, and a large part of this expenditure is for high speed rail.
- HSR investment is seen as a second best policy with the aim of changing modal split.

# CBA of HSR

## **COSTS**

- Infrastructure
- New rolling stock
- Maintenance of infrastructure
- Maintenance of rolling stock
- Operating costs
- Externalities
  - Land take
  - Visual intrusion
  - Noise
  - Air pollution
  - Global warming

## **BENEFITS**

- Time savings
- Intermodal effects
  - Time savings (road, air, conventional train)
  - Externalities
  - Cost savings in alternatives modes
  - Reliability and reduction of overcrowding
  - Reduction in accidents
- Generated demand
- Wider economic benefits

# High Speed Rail

- To enumerate the list of the social benefits generated by the HSR, even if some number are associated to the description is as irrelevant as to show how expensive is the new technology.
- In economic terms, the net balance is what really matters, and this net result cannot be obtained without due consideration of the case base, compared with different `projects´ available for the solution of the `transport problem´ under evaluation.
- HSR is one alternative whose net benefit has to be compared with those resulting from other actions as the construction or upgrading of a conventional railway line, the construction of new airports or road capacity, or the introduction of congestion pricing, alone or combined with different investment plans.

## HSR as an improvement of railway transport

$$\int_0^T B(H)e^{-(r-g)t} dt > I + \int_0^T C_f e^{-rt} dt + \int_0^T C_q(Q)e^{-(r-g)t} dt$$

where:

$B(H)$ : annual social benefits of the project.

$C_f$ : annual fixed maintenance and operating cost.

$C_q(Q)$ : annual maintenance and operating cost depending on  $Q$ .

$Q$ : passenger-trips.

$I$ : investment costs.

$T$ : project life.

$r$ : social discount rate.

$g$ : annual growth of benefits and costs which depends on the level of real wages and  $Q$ .

# HSR as an improvement of railway transport

$$\int_0^T B(H) e^{-(r-g)t} dt = \int_0^T [v(\tau^0 - \tau^1) Q_0 + C_C](1 + \alpha) e^{-(r-g)t} dt + \sum_{i=1}^N \int_0^T \delta_i (q_i^1 - q_i^0) e^{-(r-g)t} dt$$

where:

$v$ : average value of time (including differences in service quality).

$\tau^0$ : average user time per trip *without* the project.

$\tau^1$ : average user time per trip *with* the project.

$Q_0$ : first year diverted demand to HSR.

$C_C$ : annual variable cost of the conventional mode.

$\alpha$ : proportion of generated passengers *with* the project with respect to  $Q_0$ .

$\delta_i$ : distorsion in market  $i$ .

$q_i^0$ : equilibrium demand in market  $i$  *without* the project.

$q_i^1$ : equilibrium demand in market  $i$  *with* the project.

# Optimal timing

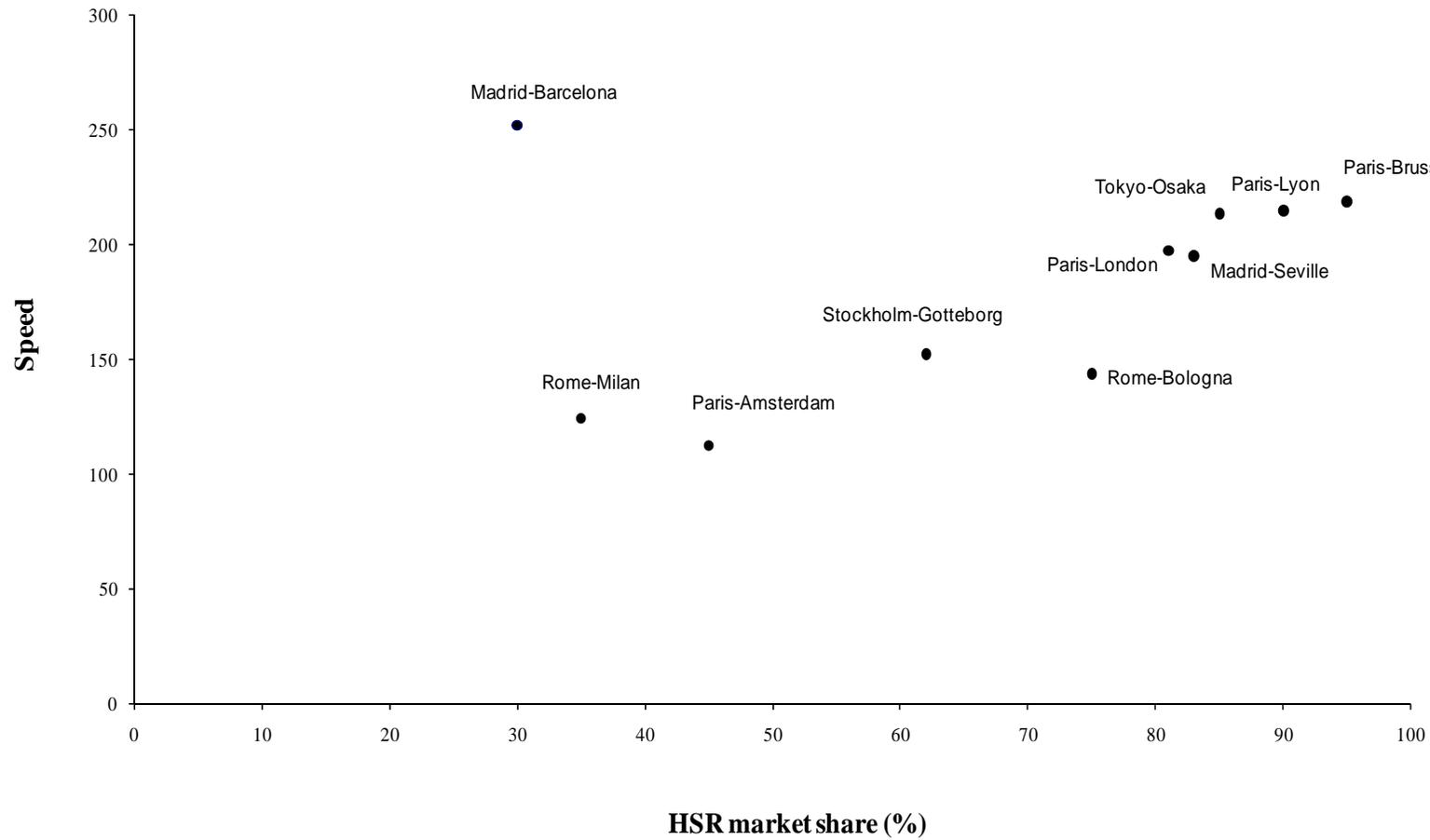
$$\frac{rI}{1+r} + \frac{B_{T+1} - C_{T+1}}{(1+r)^{T+1}} > \frac{B_1 - C_1 + C_{C1}}{1+r}$$

$$B_1 > rI + C_1 - C_{C1}$$

# Intermodal effects: two types

- Direct effects.
- Indirect effects.

# HSR market share and railway speed



# Intermodal direct effects

- The high market share of railways in medium distance corridors has been an argument in favour of investing in the HSR technology.
- If passengers freely decide to shift from air to rail it follows that they are better off with the change.
- The problem is that a passenger decides to move from air to rail because his generalized cost of travel is lower in the new alternative but this is not a guarantee that society benefits with the change.

# Intermodal direct effects

- The intermodal effects measured in the primary market consist of the product of the value of time, the average time savings and the number of passengers shifting from the conventional mode to the new transport alternative.
  
- These average values hide useful information regarding user behaviour and the understanding of intermodal competition:
  - Savings from access, egress and waiting time have more value than savings 'in vehicle time'.
  
  - Time saving benefits from deviated traffic (road and air).

# Effects on secondary markets: Intermodal indirect effects

$$\sum_{i=1}^N \int_0^T \delta_i (q_i^1 - q_i^0) e^{-(r-g)t} dt$$

$$\int_0^T (p_A - cm_A) q_A \varepsilon_{AH} \frac{\Delta p_H}{p_H} e^{-(r-g)t} dt$$

# Conclusions

- High speed rail infrastructure is considered more efficient and less environmentally damaging than air or road transport.
- The truth in both arguments rests heavily on the volume of demand of the affected corridors and several key local conditions, as the degree of airport or road congestion, the existing capacity in the conventional rail network, values of time, travel distance, construction costs, or the source of electricity generation and the proportion of urban areas crossed by the trains.

# Conclusions

- HSR investment may be adequate for some corridors, with capacity problems in their railway networks or with road and airport congestion, but its value heavily depends on the volume of demand to be attended.
- Moreover, even in the case of particularly favourable conditions, HSR investment projects have to be compared with other `do something´ alternatives (including road or airport pricing and/or investment, upgrading of conventional trains, etc.).