Can The Invisible Hand Draw The Railroad Timetable?

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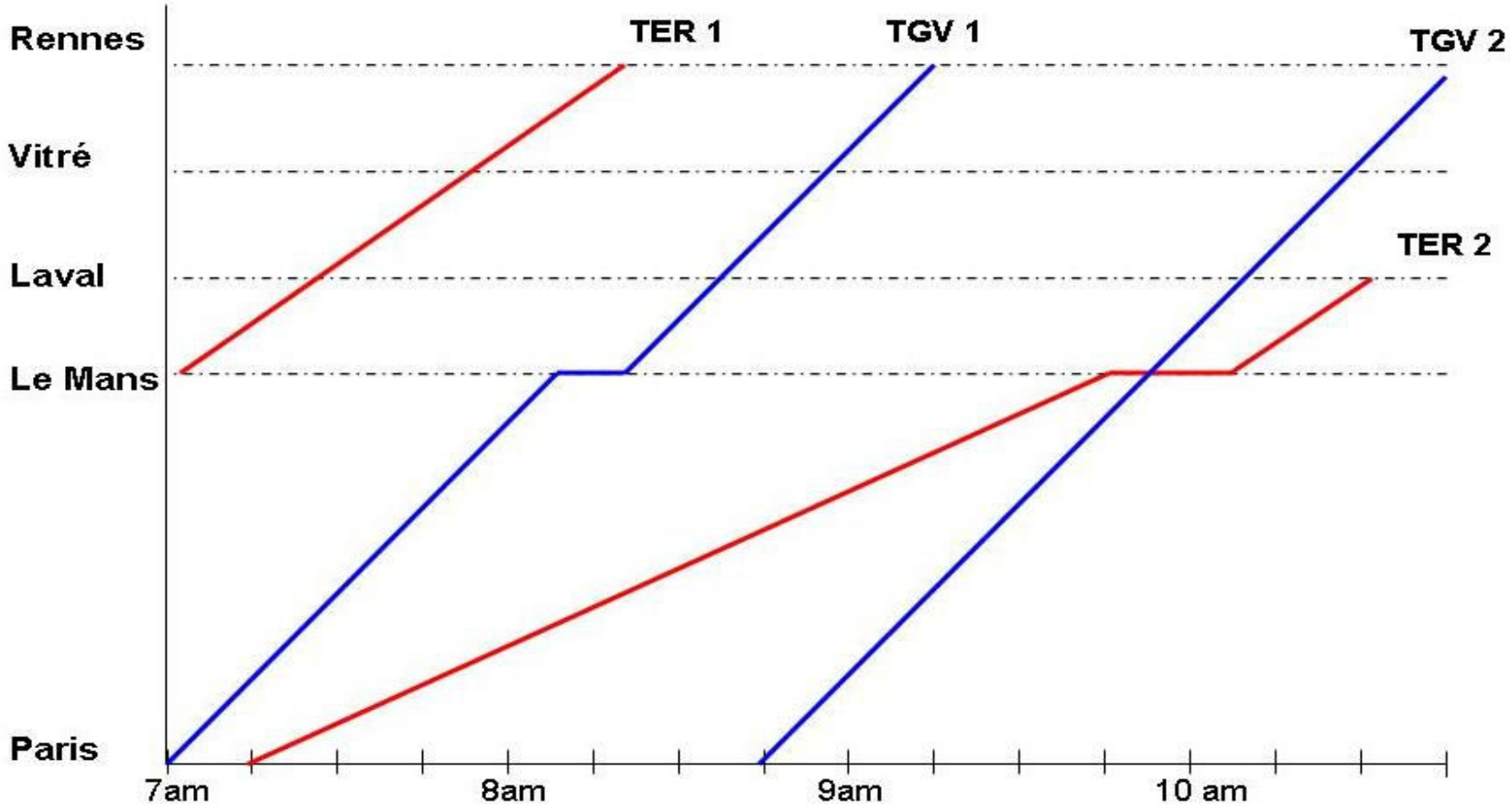
Introduction (1/2)

- The railroad industry is currently being liberalized in Europe under the influence of the European Commission
- Goal of this process: to reduce costs and prices in the industry, trains can re-earn market shares over trucks, airplanes, personal cars, etc.
- This liberalization has lead to a separation between infrastructure and operations

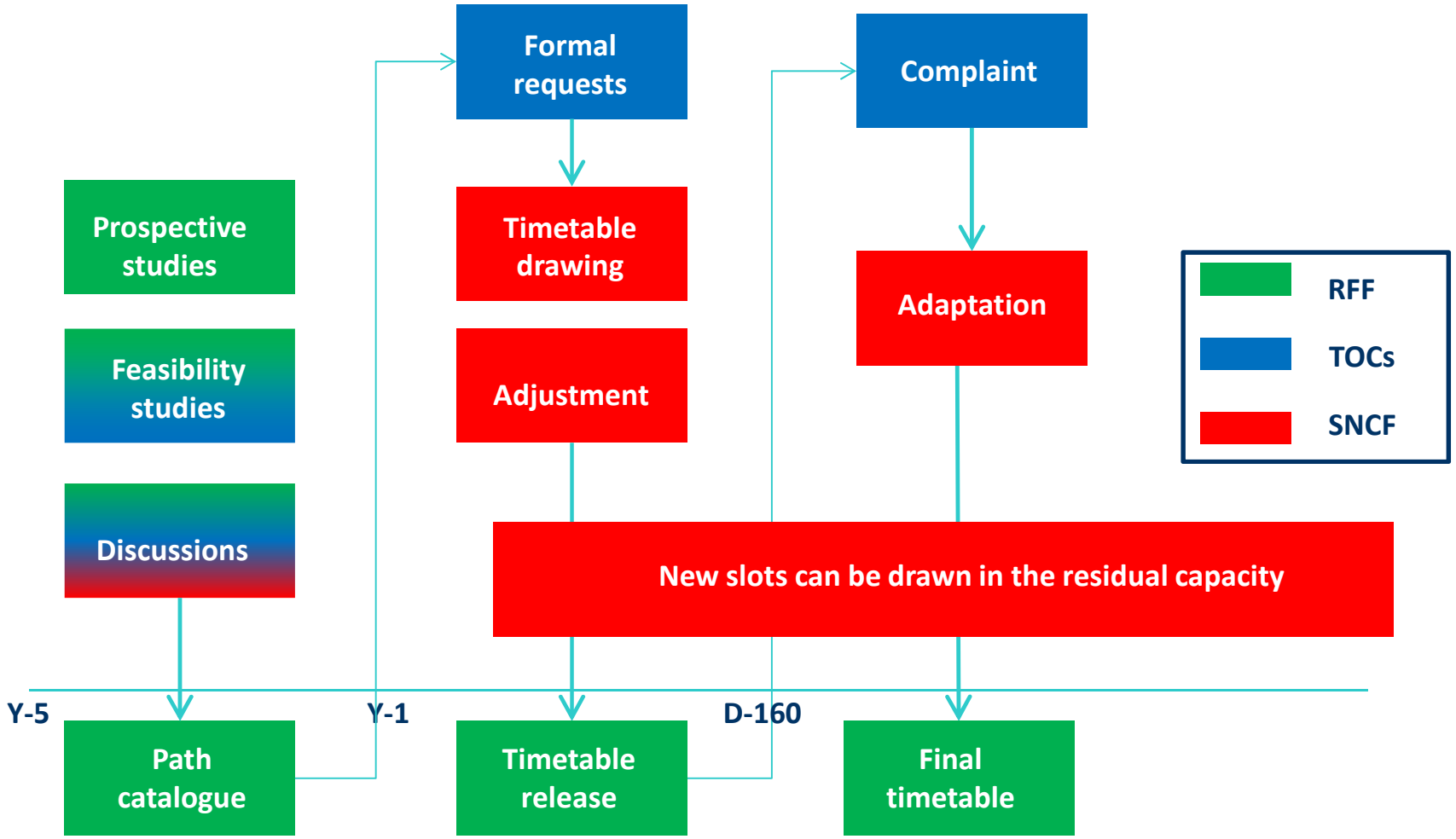
Introduction (2/2)

- This article focuses on capacity allocation
- Liberalization and vertical separation will lead to a potential increase of demand for rail capacity. Currently:
  - the former vertically integrated incumbent does not ask for all the capacity it can use
  - Very few competitors, mostly on freight
- Capacity is hard to increase in the short term
- Solution: allocate capacity by market mechanisms?

What is “capacity” in the railroad? industry



An example of allocation process



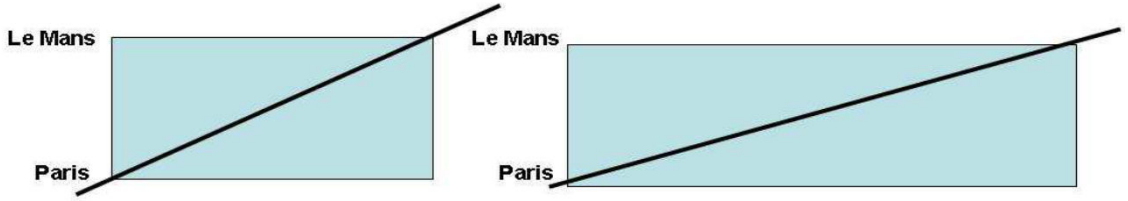
+ Prices are administratively set

Specificities of rail capacities (1/2)

- Two key features:
  a) The value of one train path is contingent to the overall pattern of service
  b) slots are not homogenous goods and have an exclusionary property
- Property a) → slots may be substitutes OR complements → require to use combinatorial auctions
- Property b) → to fully optimize its capacity, the IM has to subdivide slots

Specificities of rail capacities (2/2)

- To optimize the revenue of its network, the IM has to maximize the revenue of each block it sells.



High speed train

Regular speed train

- Formally:

$$\max \sum_{i \in I} \sum_{a \in A_H} p_a^i x_a^i$$

$$s.t. \sum_{a \in A_H} x_a^i \leq 1 \quad and \quad x_a^i \in \{0,1\}$$

$\rightarrow$ NP hard problem

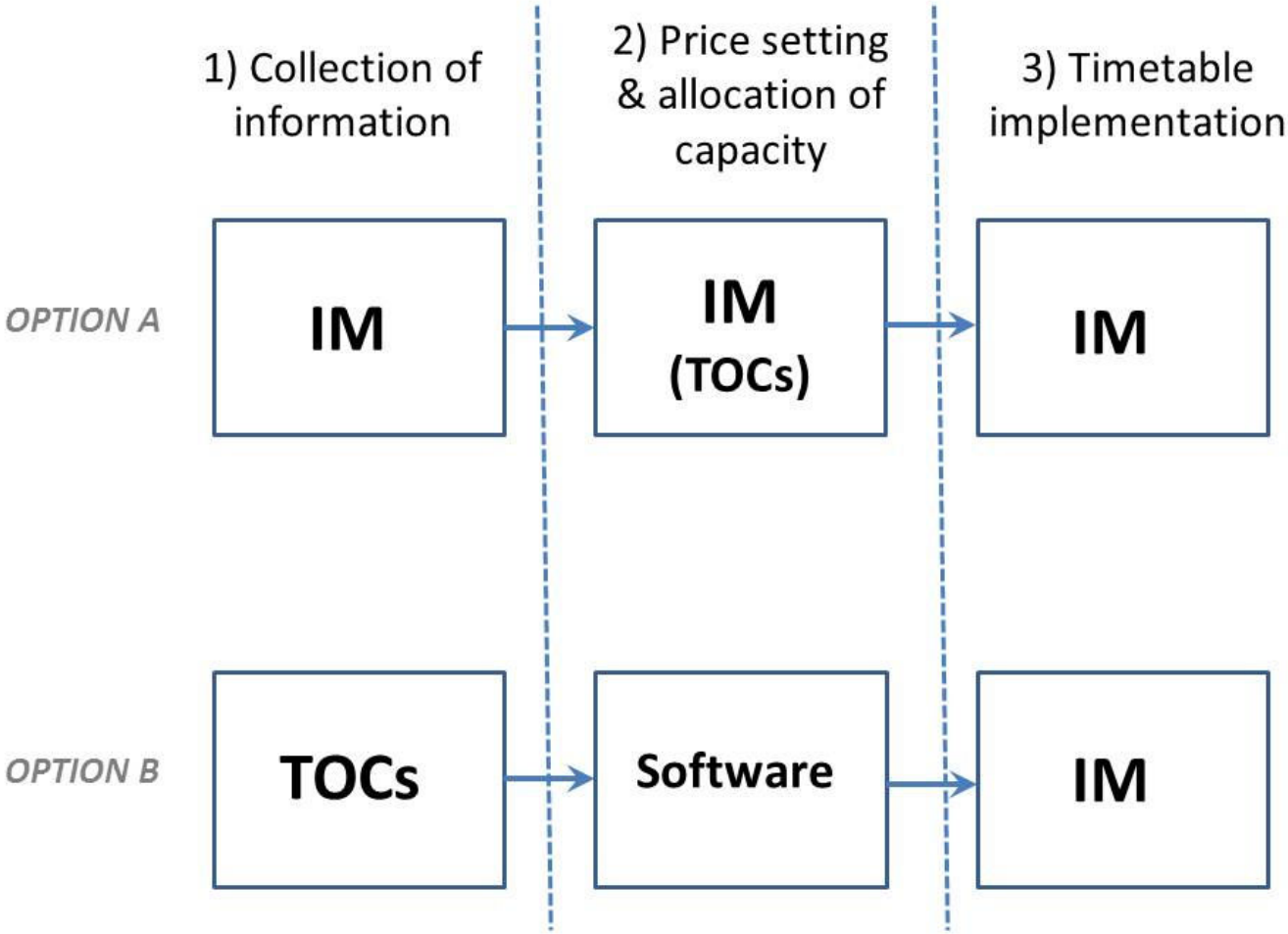
Literature insight : rail literature

- Inspired by the liberalization process taking place in Sweden
- Coopers and Lybrand (1993): auctions are impossible because of the properties of rail capacity
- Brewer and Plott (1996): combinatorial auctions are possible (testbed environment)
- More complex network and techniques: Nilsson (2002), Borndörfer (2005), etc.
- But still some oppositions: Gibson (2003), Quinet (2003)

Literature insight : CA literature

- Combinatorial auctions (CA) are doomed by early literature to be impossible to manage (winner determination is not trivial)
- Mid-1990s: CA are concretely used by the FCC to sale radio frequency
- New auctions designs to reduce the information burden to allow manageability (Rothkopf et al. 1998)
- **Nisan and Segal (2006) Blumrosen and Nisan (2010): to optimally sell *n* goods, one needs to know the price of the 2^n-1 possible bundles. To allow a good approximation, the information burden still grows exponentially.**

Two ways to allocate capacity

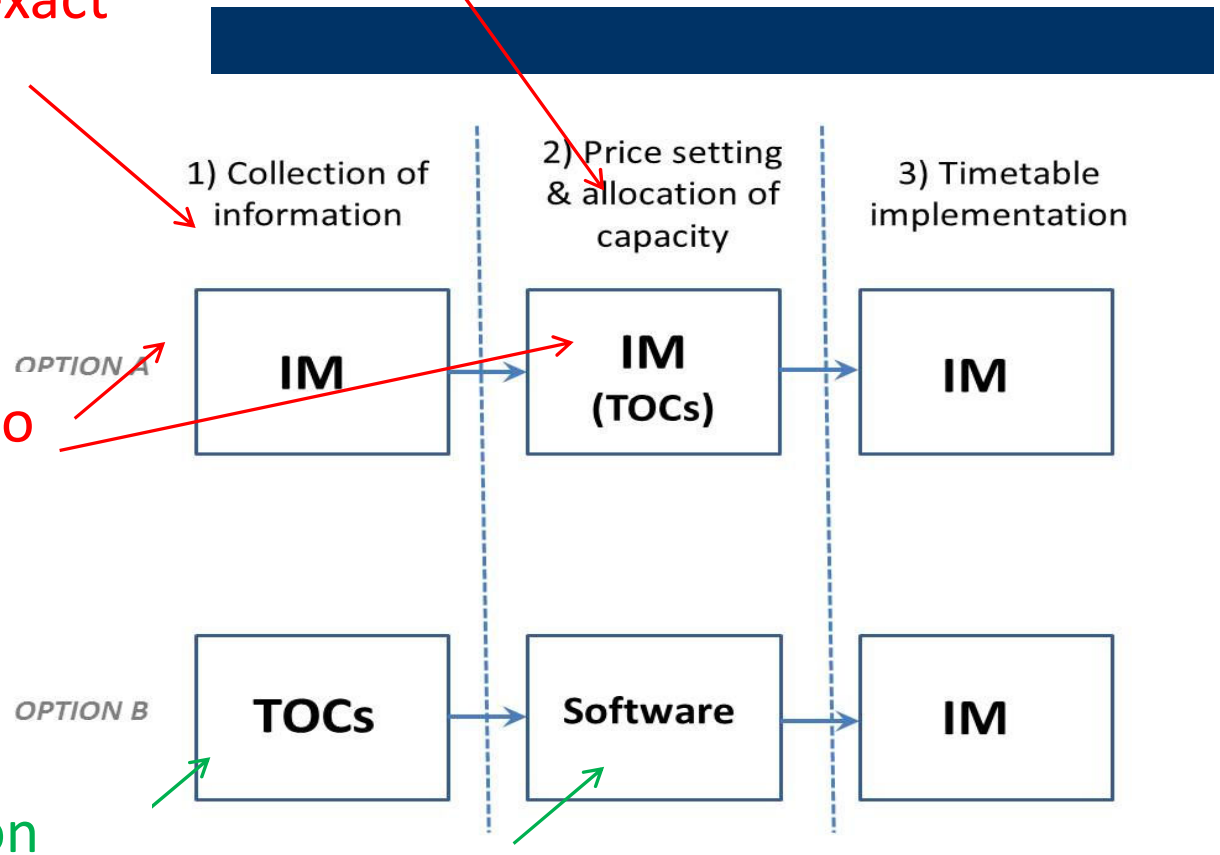


Most efficient way?

Efficiency

No direct access to TOCs real valuation

No access to exact final demand



No incitation to be efficient

Competition lead to efficiency

Price depends on TOCs bids

Transaction costs

- Costs in option A

$$C_{A,1}(M_i, I) = aI + \sum_{i \in I} b_i M_i \qquad C_{A,2}(I, X, n) = eI + fX + gn$$

- Costs in option B

$$C_{B,1}(n) = \alpha\left(2^n - 1\right) \qquad C_{B,2}(X, R) = \beta X + \gamma R$$

I: numbers of market, Mi: Size of market i, X: Complexity, n: number of slots, R: Numbers of rounds

- Exponential vs. linear evolution

Conclusions

- Are auctions impossible to use to sell railroad capacity? NO
- Keep in mind manageability: a centralized entity draw the graph, but some of the slots can be auctions
- **The invisible hand cannot draw the (entire) timetable**
- Consequences for the current liberalization?
  - Competition for/on the network
  - Organization of information transparency?

Thanks