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FINDING A BETTER WAY

Congestion and scarcity in scheduled transport modes

Draft text for chapter x in Handbook on Research Methods in Transport Economics and Policy

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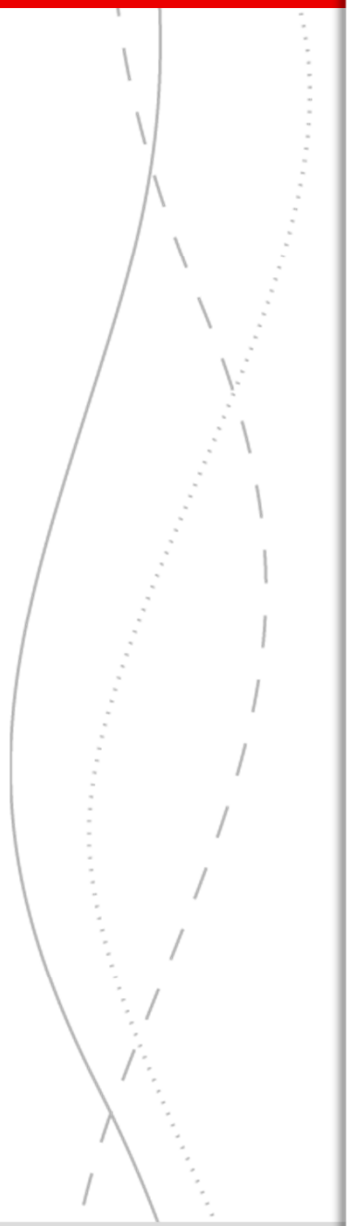
Definitions

Congestion differs across different parts of the transport sector:

In the road sector, congestion materializes by vehicles lining up in slow moving traffic;

This is not seen in railways

- The establishment of a railway time table is a means for prioritization of conflicting demand and solves the scarcity challenge long before traffic is initiated.
- Once traffic is initiated, disturbances can occur; this is defined to be congestion in scheduled transport modes



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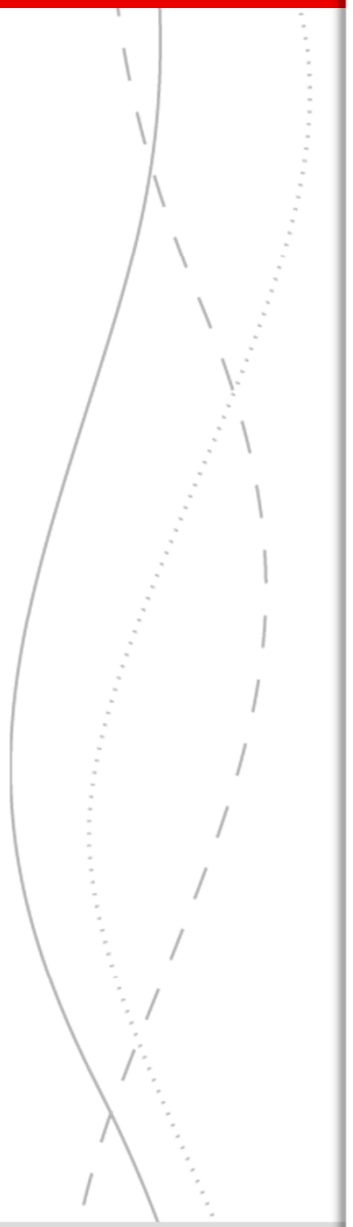
Purpose of presentation

To characterise the scarcity problem and describe how it is and could be handled

Specifically: In which way should the demand from some operators be given priority over the demand from others in order to sort out the conflicts generated by scarcity?



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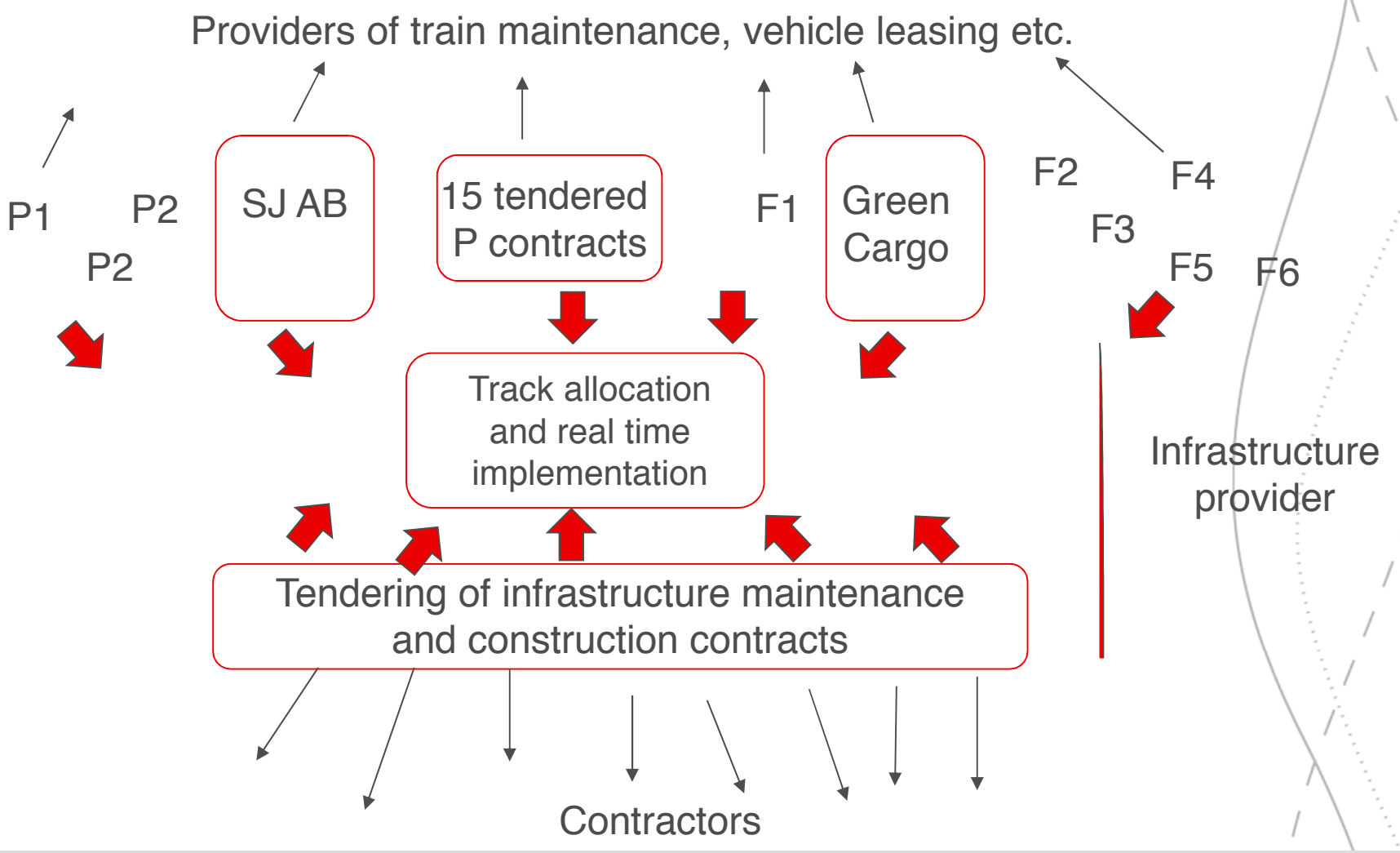
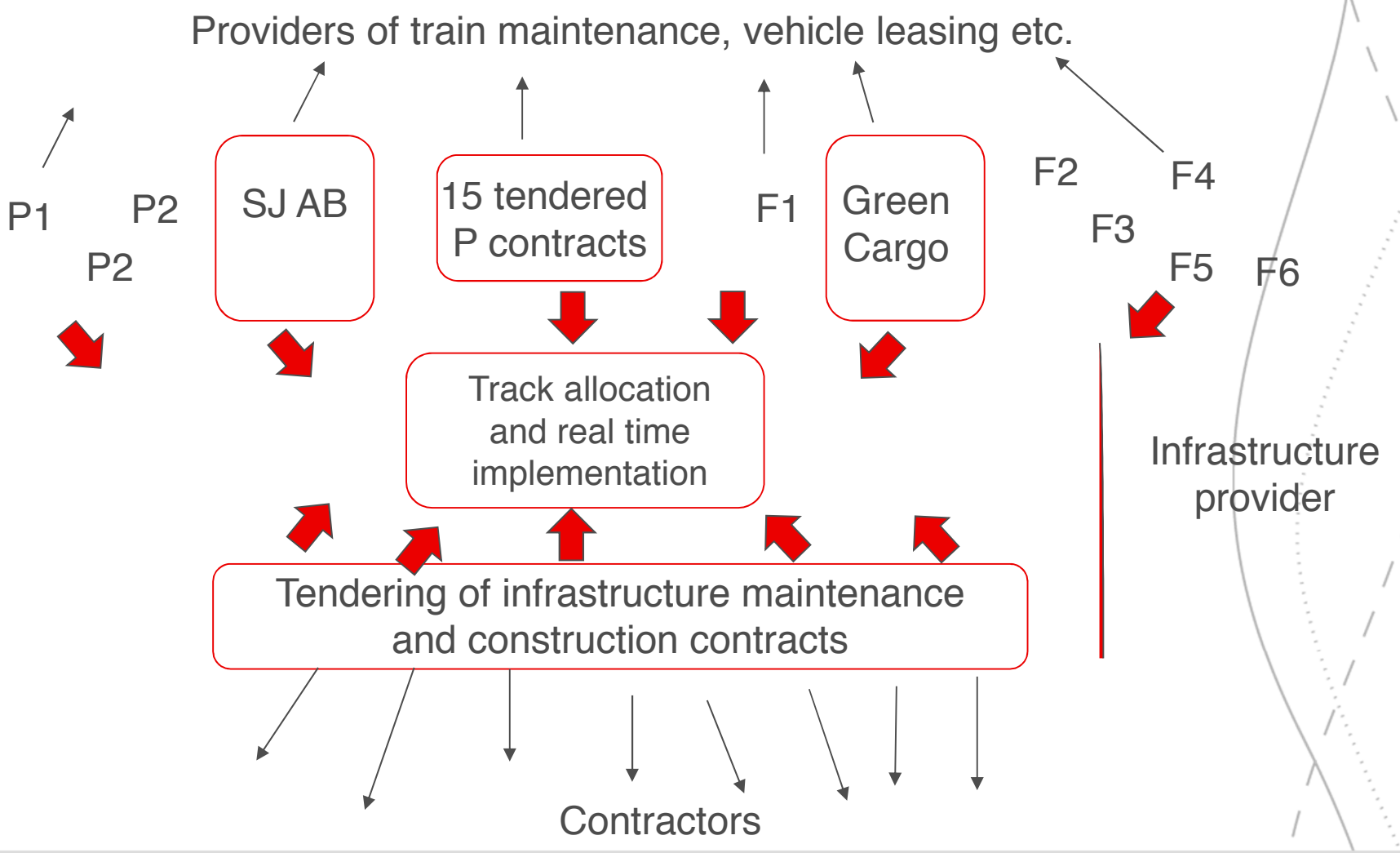
Sweden’s railway sector in 1988

SJ

… and in 2013


Providers of train maintenance, vehicle leasing etc.
P1
P2
P2
SJ AB
15 tendered P contracts
F1
Green Cargo
F2
F3
F4
F5
F6
Track allocation and real time implementation
Infrastructure provider
Tendering of infrastructure maintenance and construction contracts
Contractors

… and in 2013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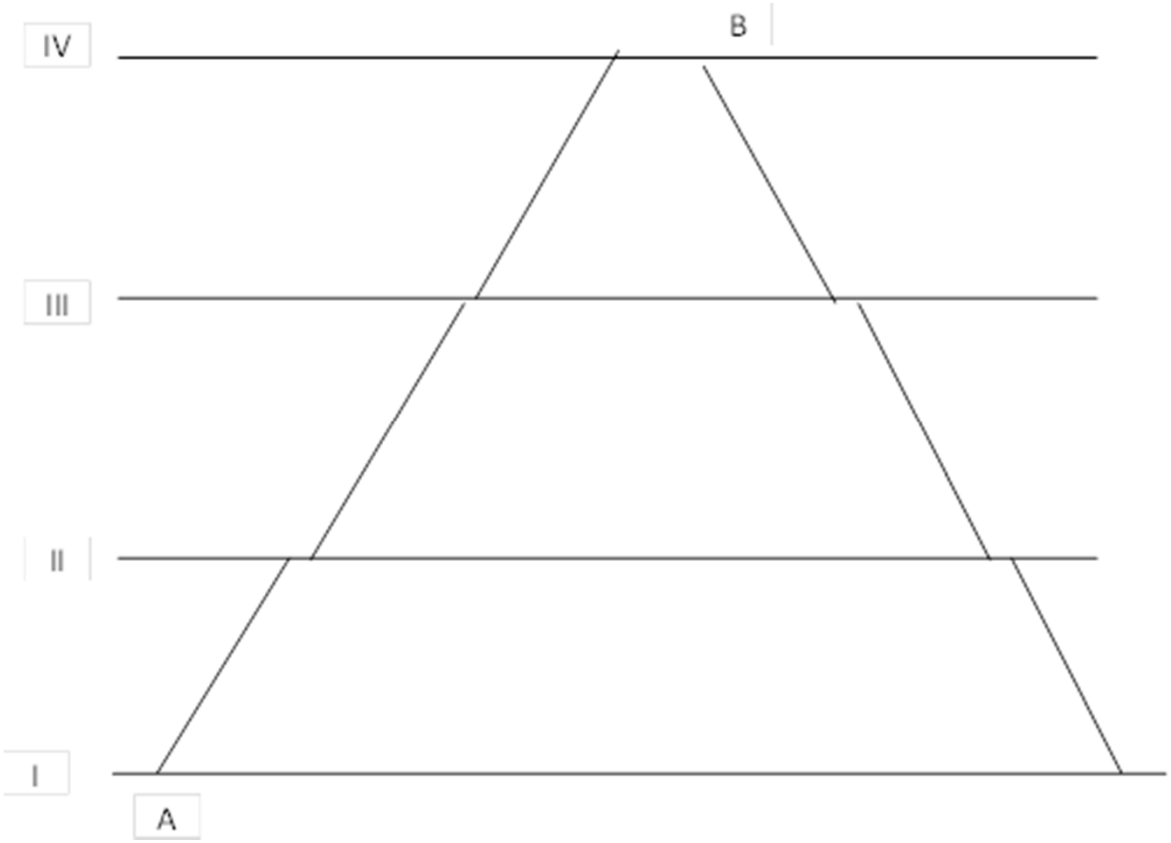
The nature of the problem



Features of track capacity supply

- When one train makes use of a block, others cannot use it at the same time; there can be zero or one train at a time on each block.
- A block is much longer than the train. Even if demand for access to a common infrastructure emanates from a fairly small number of train operators, a capacity shortage may occur.
- Once built, supply-adjustments to accommodate higher demand are lumpy, costly and take a long time before being operational.

Features of track access demand

Demand for track access is derived from the operator's demand which is derived from passenger and freight customer demand for travel or to dispatch freight loads between nodes in the network.

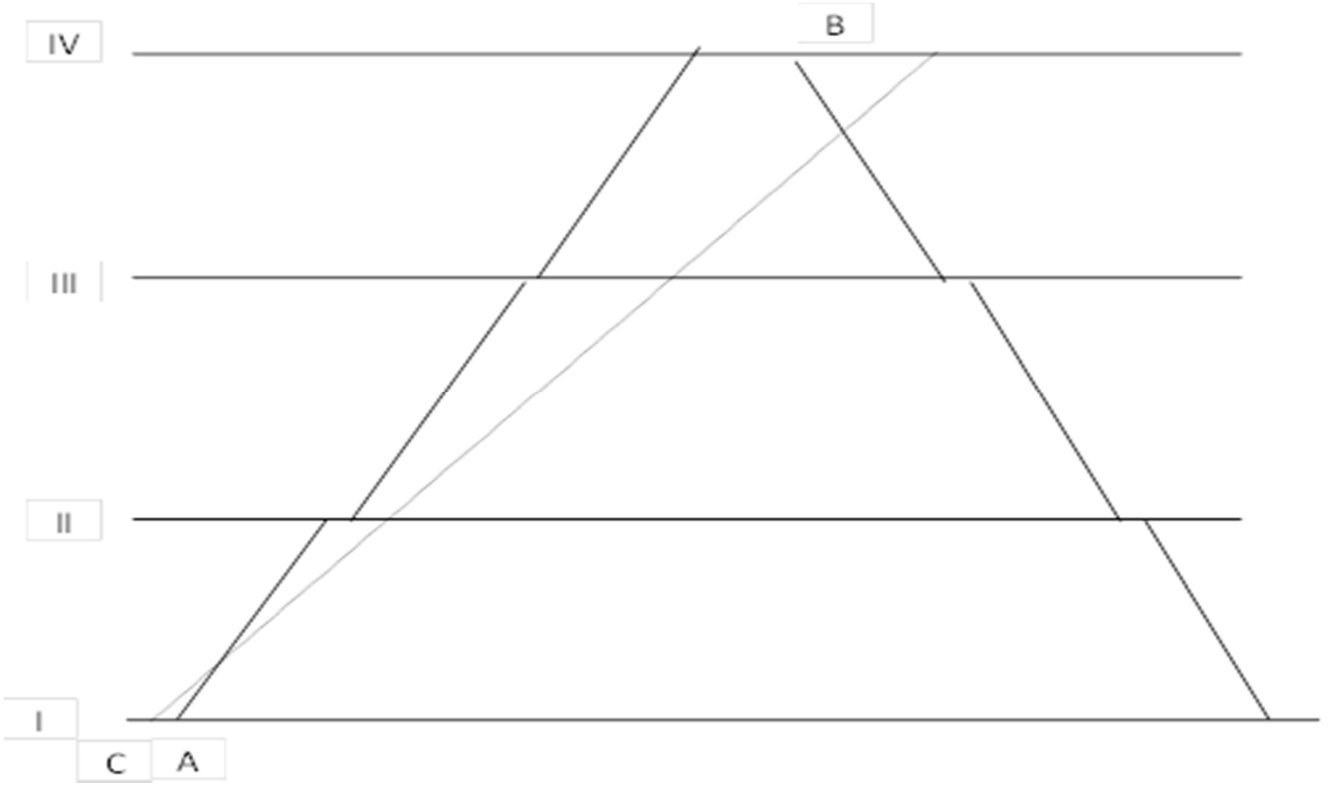
- Each departure time typically has (a large number of) substitutes, but each of these may have a different economic value: While a passenger service operator prefers to leave at 7:00 it may be feasible, although less valuable, to leave at 6:45 or 7:15 or at some time in-between. Since train operators have to meet customer demand there are strict boundaries on this flexibility; passengers are simply not interested to leave earlier than, say, 6:30
- There may be cyclical variations in demand. This creates peak periods where available capacity is insufficient and slack periods with under-utilised capacity.

Features of track access demand (cont.)

- There may be complementarities in the demand for track access. Going from Here to There could be valuable only if it is possible to proceed to Elsewhere at an appropriate point of time.
- Services of different operators may also be each other's substitutes. Two firms running the same type of train over a section of the network may value track access differently depending on how close to each other the respective routes over the network are laid.

These aspects must be accounted for when a time table is established;

Should C or A/B be given priority or should they all have to adjust their demand?



3. Objectives

- Efficiency
  - More profitable/valuable services should be allowed to expand at the cost of less profitable/valuable services.
  - Operators with more flexibility in their demand should be asked to move their departures more than those with less flexibility.
  - Interdependencies must be accounted for so that it is the efficiency of the system as a whole which is maximised.
  - The allocation system should provide safeguards against collusion and monopoly behavior.
  - The system should be reasonably simple to operate for the parties.
  - The system should provide information about additional slots in order to support long term system growth.
- Equity concerns must be spelled out by policy makers.

4. The treatment of scarcity today

- A 12 month planning period:
  - Network statement in November
  - Operators specify their demand in April
  - A first schedule is communicated in June,
  - … and a final is established in September,
  - … with traffic commencing in December.
- Priority principles
  - According to socio-economic principles (which have never been operationalised)
  - Priority principles; high speed trains before inter city before…
  - Existing time tables
  - Skill with the time tabling staff.
- At delays
  - Give priority to those which are not already delayed.

5. Shortcomings of today's approach

- The underlying optimisation problem

Max $B = \sum_i \quad \sum_r v_i(x^r)$

S.t. $\sum x_{s,t}^r \leq 1 \quad all\ s,t$

$$x^r \in X\ for\ all\ r$$

- B – social welfare; *i=1,…,I* independent train operators.
- $v_i(x^r)$ represents the value for operator *i* as a function of path *r* passing over consecutive blocks *x.*
- Challenge 1: The number of feasible solutions grows very fast.
- Challenge 2: Binary restriction on the objective function
  - => NP complete problem
- Challenge 3: The value function is un-known.

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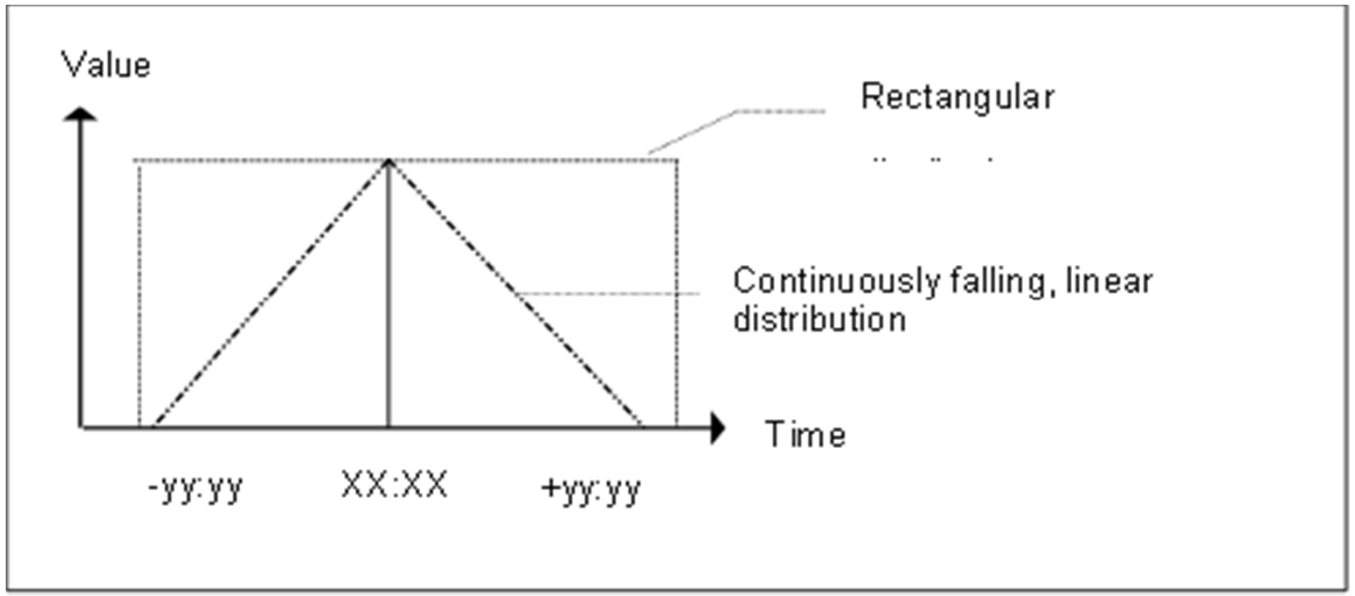
So,…

- No optimisation mechanism exists which – given some values of the value function – could report about a global optimum.
  - A small literature, starting with Brännlund et al (1998), have however looked into the possibility to handle the assignment by looking at different parts of the network at a time.
- The information about relative priorities is low.
  - Even in the old monopoly mechanism this may have provided problems,
  - … but the inclination to argue in favour of the own services is even much higher in competitive situations.
  - Rules-of-thumb may work as a first proxy but the marginal services of each class could be very difficult to priorities in a value maximising way.

6. Towards a more efficient solution

- Charges
  - The higher the cost for using infrastructure, the lower will demand be and the easier will it be to sort out conflicts.
  - P=mc is the (first best) pricing rule-of-thumb
  - Costs include externalities etc.
  - Scarcity is a social cost and should be included in the charge.
  - In a system with posted prices it should be more expensive to operate trains during peak than off peak.
  - A tatonnement process with price adjustment upwards and downwards could establish a solution.
- Auctions
  - An alternative way to handle the problem would be to establish a bidding process.
  - Think of a bid by one operator for a slot at time XX.xx…

The core component of a bidding contest



Conclusions

- Excess demand provides a signal that prices don't clear the market and that higher/more differentiated prices should be implemented.
- The substantial complexity of the market, the heterogeneity of demand and the blend of time and railway lines with both inappropriate and excess capacity, indicates that the potential loss of value is high in the railway industry.
- The most important step forward is to develop optimisation mechanisms in order to assess in a more systematic way how capacity problems may be dealt with.
- Even with crude relative weights this may take the system a long way towards establishing more efficient capacity allocations.
- Auctioning provides an elegant means for deriving appropriate relative weights of different trains.

Thank you for your attention

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Recalling the meaning of scarcity

- The scarcity cost in the railway network is the deviation from individually ideal timetables and its subsequent loss of revenue caused by insufficient availability of infrastructure capacity.
- The ideal timetable is thus the departure-arrival pattern that would prevail if everyone could run their services in the way they want, without obstacles in the form of other operators' services.
- Scarcity is manifested either in that trains have to depart at other times than they would prefer or in that they are completely closed off from operation.