Regulating congestion and scarcity in rail transport

Chris Nash, Daniel Johnson and John Haith
Institute for Transport Studies
University of Leeds

The Issue

- how to give appropriate incentives to Train Operating Companies (and subsidy providers) re how many trains to run and when and where to run them?
- how to give appropriate incentives to infrastructure managers re timetabling and expansion or contraction of capacity?

Note.

Congestion leads to delays caused by trains of one train operator to trains of another

Scarcity leads to the inability of train operators to get the slots they want.

Alternative approaches

- Long run marginal cost pricing
- Short run marginal cost pricing
- Slot auctions
- Administrative decisions (based on cost-benefit analysis)

Outline

1. Alternative approaches to dealing with the problem
2. Congestion costs
3. Scarcity costs
4. Conclusions

Long run marginal cost

UNIVERSITY OF LEEDS

- Incremental cost of additional capacity
- Problems due to
  - Investment cost a sunk cost
  - Stepped cost function with major indivisibilities
  - Charging average incremental cost may discourage use of spare capacity or fail to ration demand to capacity available
  - A long run contract with a two part tariff would be better (although joint costs might still cause problems) but seen as anti competitive and not permitted

ITS

Short run marginal cost

- gives incentives to Train Operators to make best use of existing capacity
- Includes congestion or scarcity charge

BUT

- Does nothing to incentivise infrastructure manager
- Relies on the regulator to do that ('meeting reasonable needs')

Auctioning

UNIVERSITY OF LEEDS

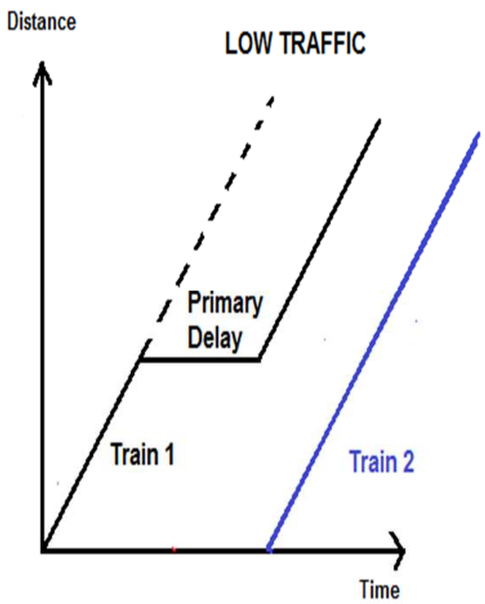
- Complicated to organise (bidding for each individual slot? Each link or node may be used in a lot of different ways. Is it slots through a single bottleneck that matter?)
- Value of a slot depends on:
  - what other slots the Train Operator gets
  - what slots other Train Operators get
- Need for an iterative process based on willingness to pay to avoid retiming
- Does not deal with congestion costs, only scarcity
- But may reveal information the regulator cannot otherwise obtain

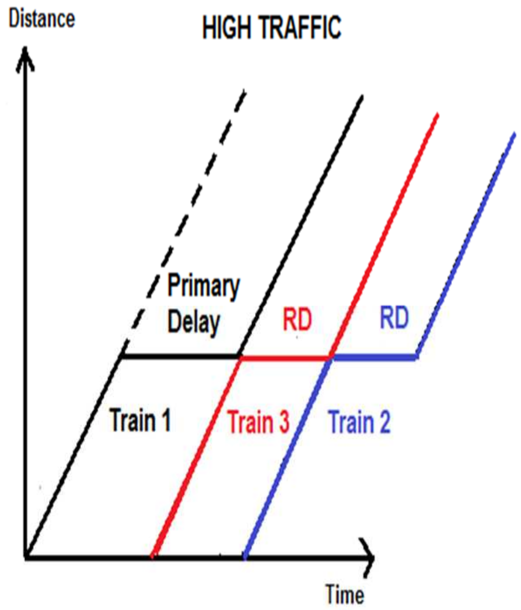
ITS

Congestion charges

- Apply where an additional train can be accommodated but will reduce punctuality
- Delays directly caused by that train charged for by the performance regime
- But there is still a further externality in that an additional train may add to reactionary delay even when not the direct cause of delays itself

Reactionary delay





Adapted from diagram in : Network Rail (2012) Periodic Review 2013 – Consultation on the Capacity Charge

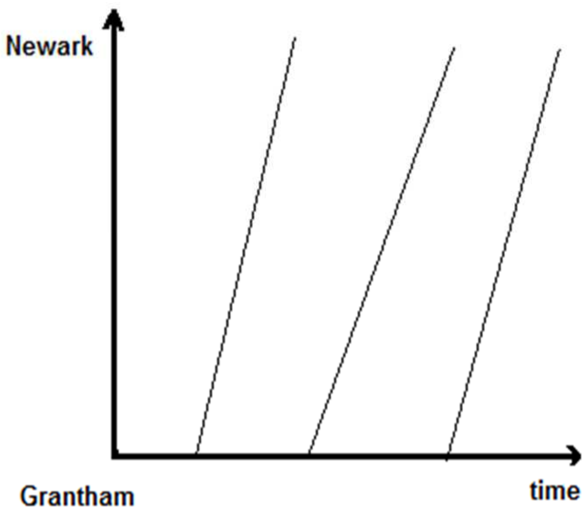
UNIVERSITY OF LEEDS

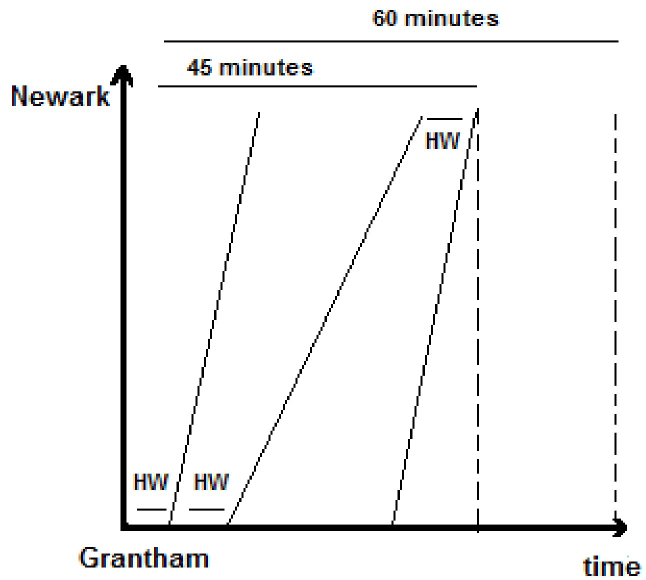
- Capacity usage was calculated (CUI).
- Regression Analysis was carried out with the measure of capacity usage (CUI) as the explanatory variable and observed reactionary delay per train mile as the dependent variable.
- The exponential form was chosen as providing the ‘best’ relationship between capacity usage and reactionary delay.
- The calculated impact on reactionary delay of additional capacity use provided the basis for calculating the Capacity Charge.
- The charge varies by time band and location.

ITS

How CUI is calculated

UNIVERSITY OF LEEDS





The ‘compressed’ timetable compared to the actual gives the CUI. In this example 75%.

ITS

An Alternative to CUI ...

UNIVERSITY OF LEEDS

- Vromans, Dekker and Kroon (2006) described the link between heterogeneity and reliability in a paper on a Dutch Rail study.
- To measure heterogeneity they suggested that the minimum gap between successive trains is calculated (1/X).
- This concept has been used as a basis for developing a new measure of capacity usage - **HET**.
- The over-riding principle is that :-

IT IS <u>NOT HOW MUCH</u> CAPACITY IS USED BUT <u>HOW</u> IT IS USED THAT DETERMINES THE LEVEL OF REACTIONARY DELAY.

ITS

In our regression analysis for sample sections of the East Coast Main Line

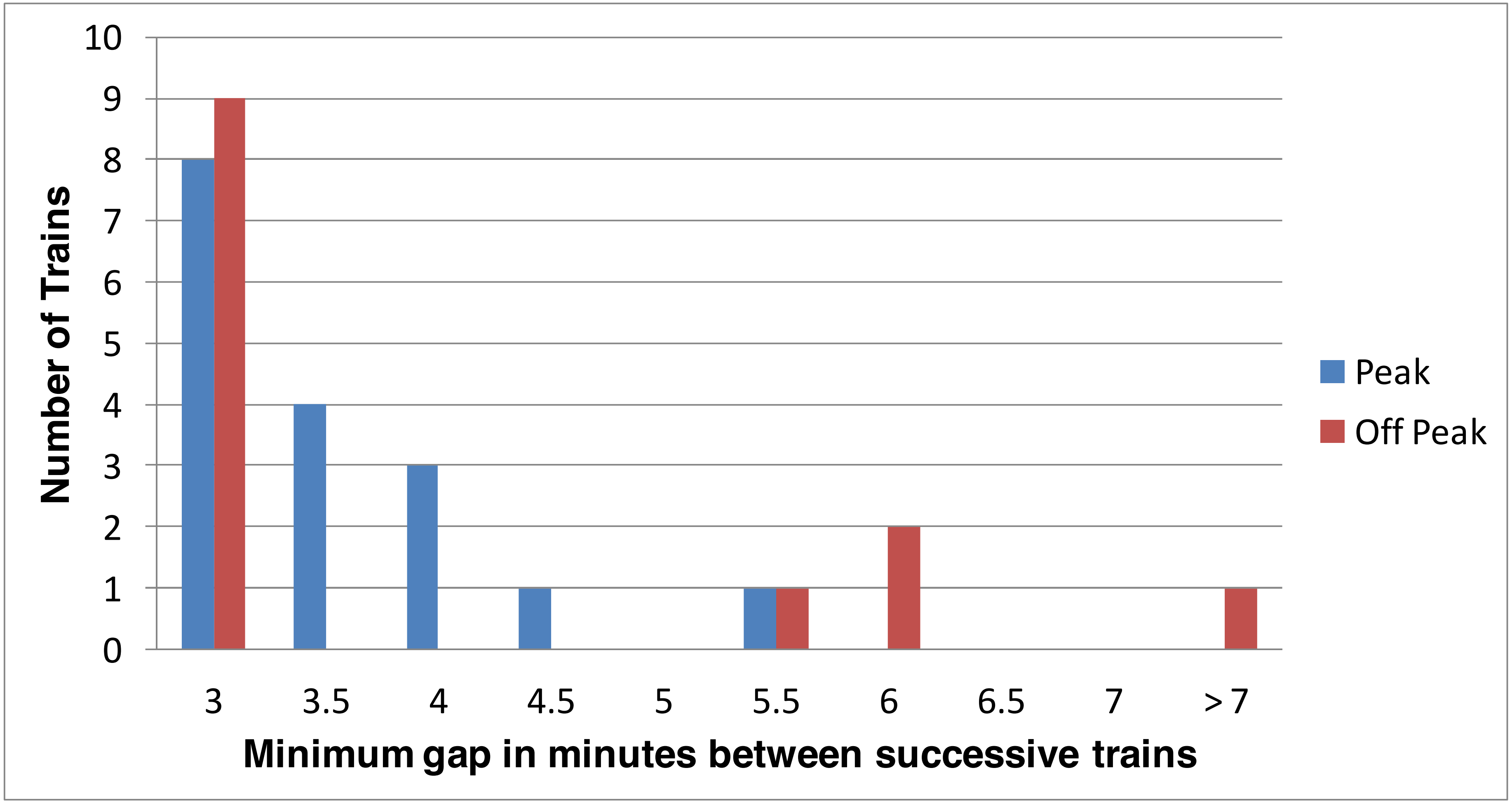
HET consistently out-performs CUI.

(T-Stat scores for Route Coefficient &

R-Squared values for individual areas/sections)

Peak & Off Peak Spacing (Welwyn Viaduct –Up Direction)

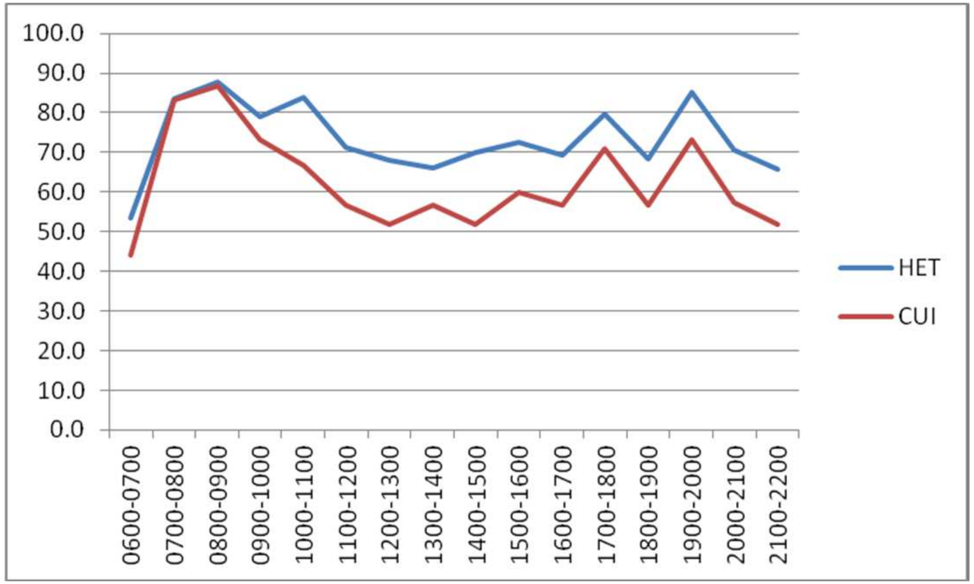
UNIVERSITY OF LEEDS



ITS

HET and CUI measures for Welwyn

UNIVERSITY OF LEEDS



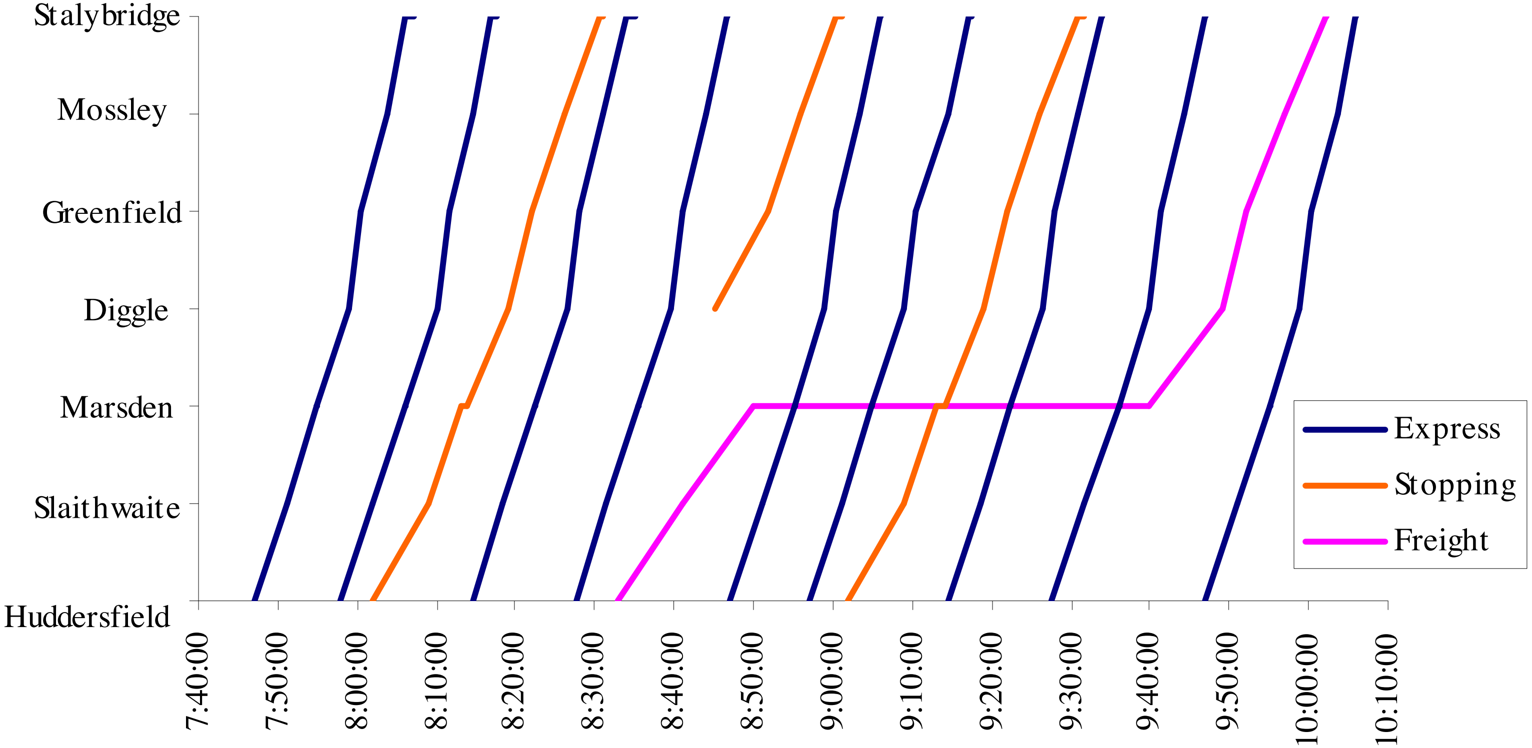
ITS

Capacity charges

- Capacity depends on mix and order of trains
- For most routes there is a dominant train type, and measure paths in terms of multiples of paths of dominant train type, eg freight train may take 3 Inter-City paths
- If same train types run in flights, pathing problems can be reduced

Actual allocation of track capacity between Huddersfield and Stalybridge in busiest two hour period
Source: Summer 2002 Working Timetable

UNIVERSITY OF LEEDS



ITS

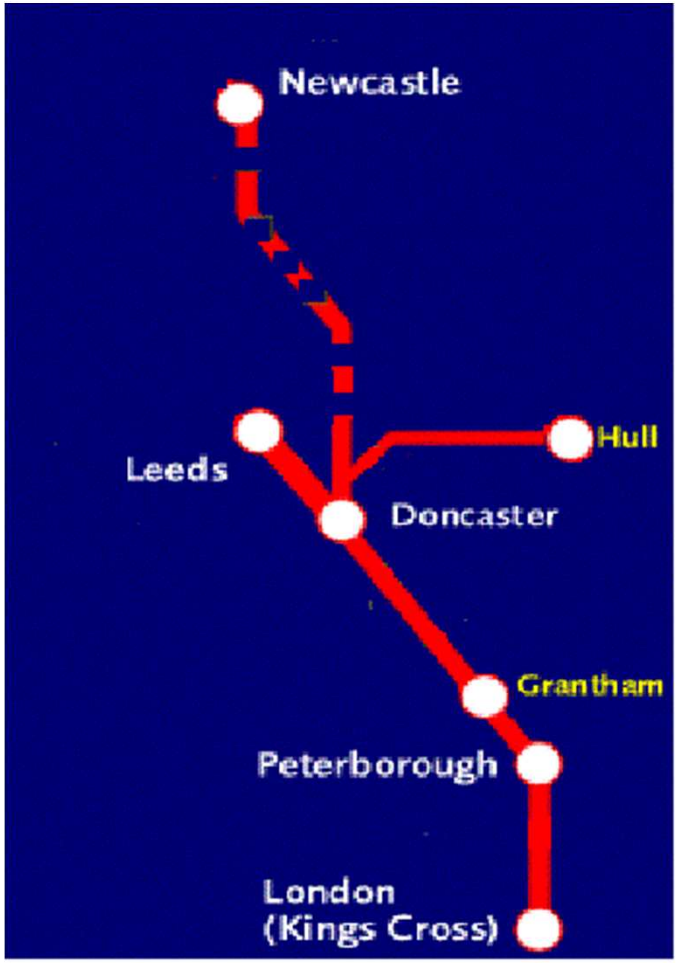
Opportunity cost of slots

Change in rail revenue <u>plus</u>

- Change in generalised cost (allowing for impact on crowding) for rail passengers <u>plus</u>
- Difference between marginal external cost and price on other modes to which passengers diverted <u>less</u>
- Marginal rail operating, infrastructure and external costs

Case Study Network- East Coast Mainline

UNIVERSITY OF LEEDS



- Principal trunk route from London to Leeds, York, Newcastle and Edinburgh
- Heavily used between London and Doncaster where main lines branch off
- Connects London with Stevenage and Peterborough commuter belts
- 6 peak, 4 off-peak trains per hour from KX
  - Main operator is East Coast Trains
  - 2 Open access operators
- Up to 40 freight train movements per day on busiest section

ITS

PRAISE Rail Operations Model

UNIVERSITY OF LEEDS

- Developed at University of Leeds in mid-1990s to look at potential for on-track competition.
- Applied in UK and Sweden
- Simulates choice of whether to travel, choice of ticket type and train for a sample of travellers (allowing for crowding)
- Includes three elements
    1. Demand Model
    2. Cost Model
    3. Evaluation Model

ITS

Methodology

UNIVERSITY OF LEEDS

Use PRAISE to remove existing franchised services one by one

i.e. assume opportunity cost is given by the value of a franchised passenger train

ITS

Results Summary

	Operators' Profit	Net social benefits
5.05	953	1829
6.05	823	2361
7.00	-432	310
8.05	756	3363
9.05	-852	3550
10.05	296	1495

Conclusions

UNIVERSITY OF LEEDS

- Congestion costs are determined by the number of trains and the gaps between them
- Arise in off peak as well as peak
- But heavily influenced by exact timetable as well as number of trains, so difficult to derive a tariff
- Opportunity cost of slots may also vary from zero to a large number over the day
- So optimal tariffs likely to be complex
- Large differences between private and social profitability so scarcity pricing (or auctioning) without appropriate subsidies would not give socially optimal outcome

ITS