Institute for Transport Studies
FACULTY OF EARTH AND ENVIRONMENT

UNIVERSITY OF LEEDS

When can HSR attract adequate ridership to justify its cost?

Chris Nash (University of Leeds and Masaryk University)
C.A.Nash@its.leeds.ac.uk

New Mobility - High-Speed Transport Systems and Transport-Related Human Behaviour (CZ.02.1.01/0.0/0.0/16_026/0008430)

EUROPEAN UNION
European Structural and Investment Funds
Operational Programme Research,
Development and Education

MINISTRY OF EDUCATION,
YOUTH AND SPORTS

ITS

Outline

UNIVERSITY OF LEEDS

1. Introduction
2. Costs and demand
3. British case studies

-HS1 (London-Channel Tunnel)

-HS2 London-Birmingham-Manchester/Leeds

4. Conclusions

ITS

High Speed Rail (HSR)

UNIVERSITY OF LEEDS

- A high-speed train is a train capable of reaching speeds of over 200 km/h on upgraded conventional lines and of over 250 km/h on new lines designed specifically for high speeds

(European Commission)

I will talk largely about new lines

ITS

Cost per route km of HSR projects

UNIVERSITY OF LEEDS

- Mean £31m
- Range £11m – 79m
- Simple rural routes £11-20m
- Urban routes £43-61m

High proportion of tunnel up to £79m

Source: PWC (2016) *High speed rail international benchmarking study. HS2 Ltd*

ITS

Costs and capacity

UNIVERSITY OF LEEDS

- So HSR inevitably very expensive
- But enormous capacity
- If all trains identical, capacity of up to 18 trains per hour with 1000 seats per train.

ITS

HSR operating costs

UNIVERSITY OF LEEDS

Depend mainly on

- Rolling stock requirements
- Staff requirements
- Energy consumption
- Maintenance costs

Very high utilisation of assets and staff may more than offset high energy and maintenance costs (Civity, 2013)

ITS

Values of Time for rail travellers £ per hour (2010 prices) DfT Britain 2015

UNIVERSITY OF LEEDS

commuting	10.01
other leisure	4.57
business (>100km)	36.19

ITS

Why do businesses value time savings so highly?

UNIVERSITY OF LEEDS

Ability to work effectively on the train should reduce value

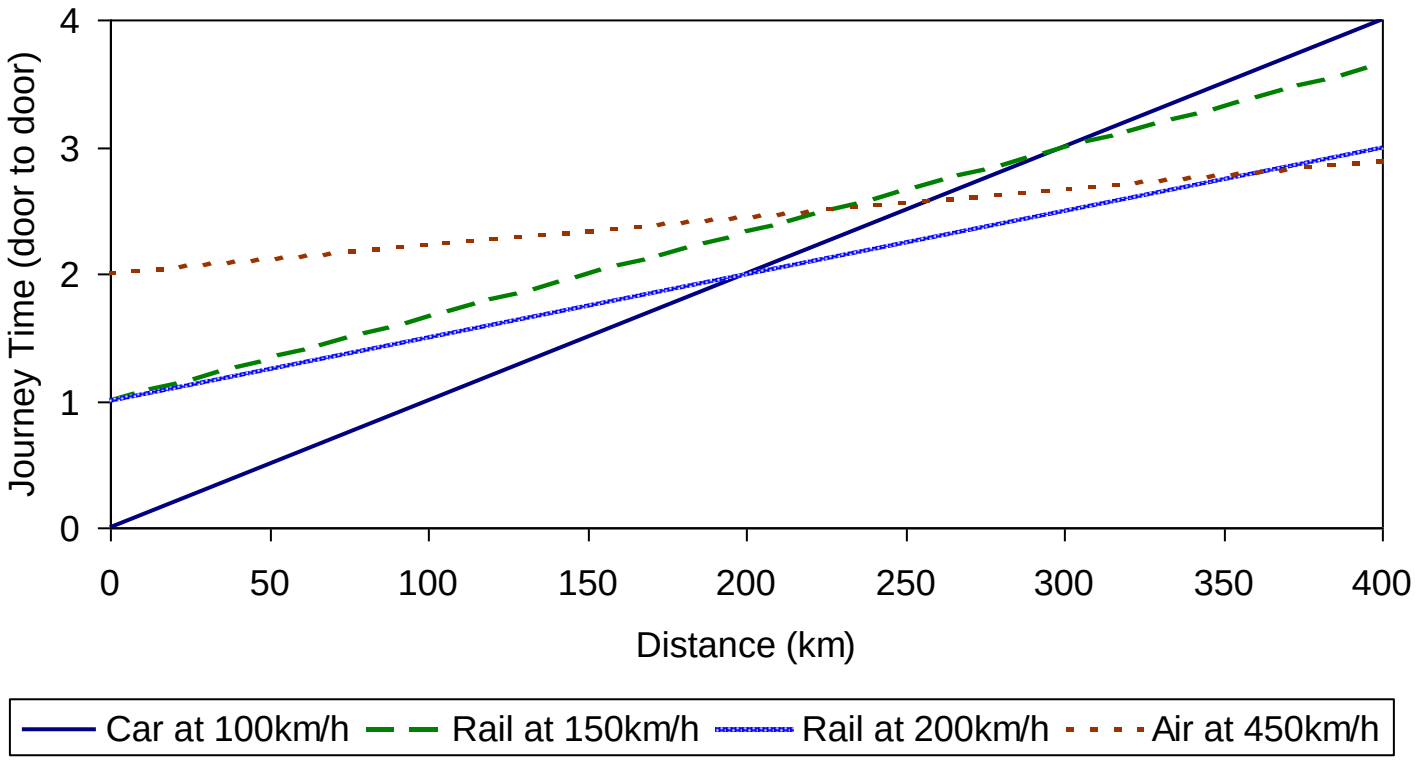
But:

- Ability to fit more meetings into a day
- Reduced travel in unsocial hours
- Better productivity at destination

ITS

Comparative Journey times

UNIVERSITY OF LEEDS



ITS

Source of High Speed Rail Traffic (%)
(Preston, 2017)

UNIVERSITY OF LEEDS

	Paris-Lyons	Paris-Brussels	Madrid-Barcelona	London-Paris/ Brussels
Plane	20	8	60	49
Train	40	47	10	12
Road	11	34	10	19
Induced	29	11	20	20

ITS

Rail Share of the rail/air market and rail station to station journey times (source Nash, 2015)

UNIVERSITY OF LEEDS

Corridor	Year	Travel time	Rail share (%)
Paris–Brussels	2006	1 h 25 min	100
Paris–Lyons	1985	2 h 15 min	91
Madrid–Seville	2003	2 h 20 min	83
Brussels–London	2005	2 h 20 min	60
Tokyo–Osaka	2005	2 h 30 min	81
Madrid–Barcelona	2009	2 h 38 min	47
Paris–London	2005	2 h 40 min	66
Tokyo–Okayama	2005	3 h 16 min	57
Paris–Geneva	2003	3 h 30 min	35
Tokyo–Hiroshima	2005	3 h 51 min	47
Paris–Amsterdam	2004	4 h 10 min	45
Paris–Marseilles	2000	4 h 20 min	45
London–Edinburgh	1999	4 h 25 min	29
London–Edinburgh	2004	4 h 30 min	18
Tokyo–Fukuoka	2005	4 h 59 min	9

ITS

Ex post appraisal of French high speed line construction

UNIVERSITY OF LEEDS

	Sud Est	Atlant-ique	Nord	Inter Connec-tion	Alpes	Mediter-ranean
Passengers in first year (m)	15.8	26.7	19.2	16.6	18.6	19.2
Social rate of return (%), IRR	30	12	5	13.8	10.6	8.1

Source: Conseil Général des Pont et Chaussées (2006) Annex 1 updated from Crozet (2013)

ITS

Ex post appraisal of Spanish high speed line construction (Betancor and Llobet, 2017)

UNIVERSITY OF LEEDS

	Madrid-Andalusia	Madrid-Barcelona
Passengers in 2013 (m)	5.5	8.0
Social return % (50 year life)	0.15	2.55

ITS

Determinants of demand for HSR

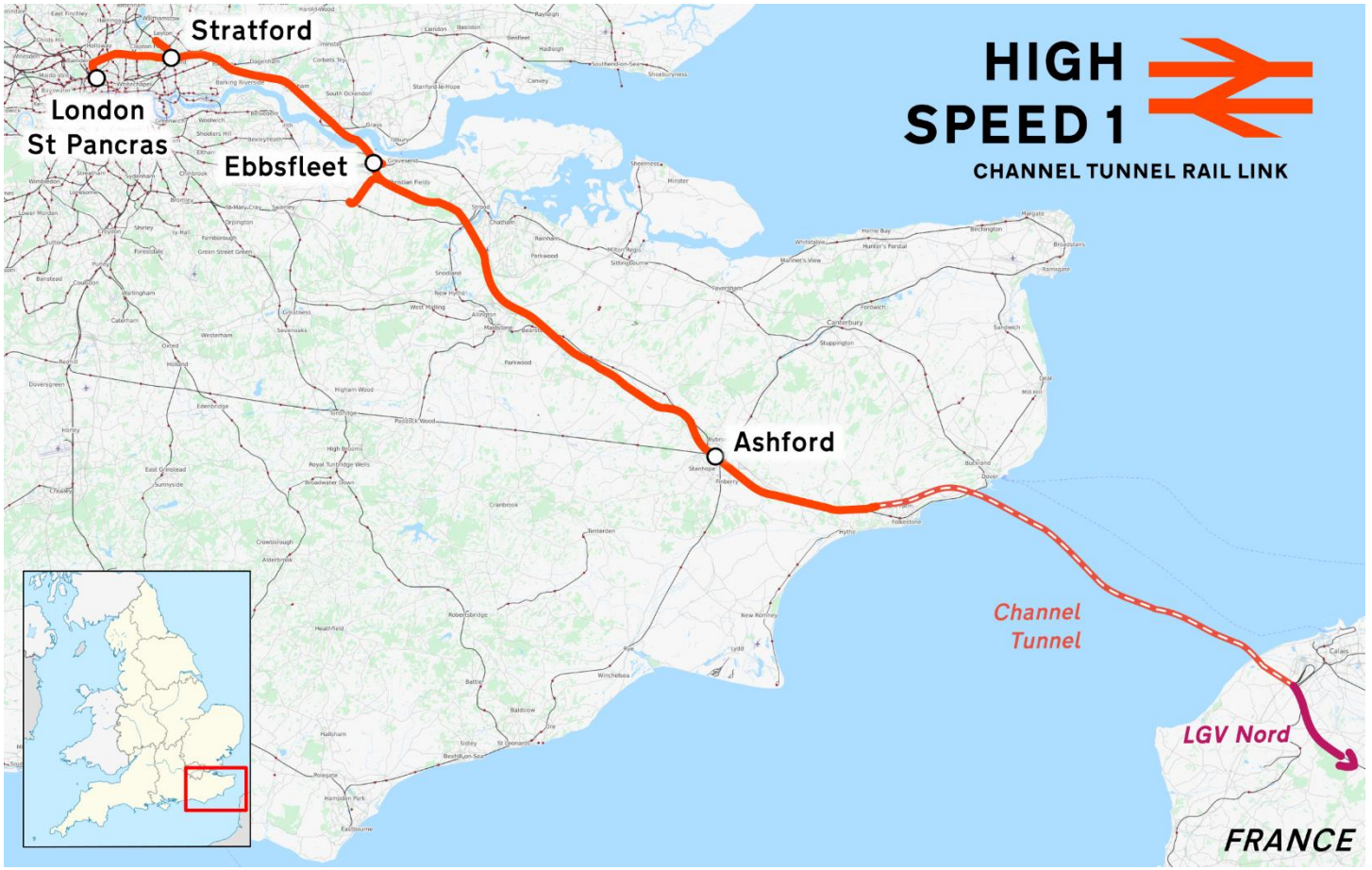
UNIVERSITY OF LEEDS

- Population
- Density
- Corridors (‘string of pearls’ in Japan generates over 200m trips p.a.)
- Competitive position with air and car

ITS

High Speed 1

UNIVERSITY OF LEEDS



ITS

UNIVERSITY OF LEEDS

Passenger traffic on HS1 2018 (m passenger trips)

Eurostar (London –Paris/Brussels)	11m
Javelin domestic services	10m
Total	21m

ITS

Ex ante appraisal of HS1 (London to Channel Tunnel) (£millionPV)

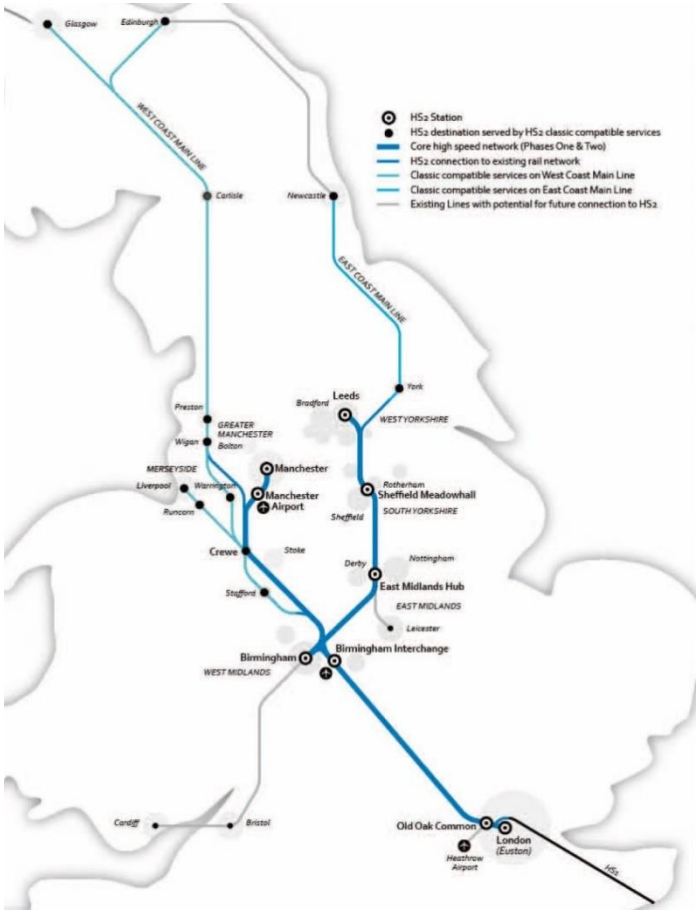
UNIVERSITY OF LEEDS

	1998 Appraisal
Benefits	
User benefits - International Services	1,800
User benefits - Domestic Services	1,000
Road Congestion	30
Environmental benefits	90
Regeneration	500
Total Benefit	**3,420**
Costs	**1,990**
NPV	**1,430**
BCR	**1.72**
(BCR excluding regeneration benefits)	**1.5**

ITS

HS2 Proposal – phases 1 and 2

UNIVERSITY OF LEEDS



ITS

Options examined

UNIVERSITY OF LEEDS

- East, West, Both or Y shaped network
- Sifting process looked at 60 London termini and 6 routes
- Stations included Old Oak Common (severe loss of user benefits compared with Central London)
- Routes including M1 corridor (closer to built up area so involved a lot of demolition and/or tunnelling)
- New orthodox line (200km p.a.)
- Upgrading existing lines

ITS

Journey times from London

UNIVERSITY OF LEEDS

	now	with HS2
Birmingham	1:21	0:49
Leeds	2.12	1:23
Manchester	2.08	1.08
Newcastle	2.52	2.19
Edinburgh	4.23	3.38
Glasgow	4.08	3.38

ITS

Passengers forecast to use HS2 (>40m p.a.)

UNIVERSITY OF LEEDS

Switch from classic rail	69%
New Trips	26%
Modal Shift from Air	1%
Modal Shift from Car	4%

- Rail already dominant except for London-Scotland
- So not much scope to reduce CO_2 by modal shift.

ITS

Pricing Policy assumed in the appraisal

UNIVERSITY OF LEEDS

- Rail fares rise by RPI +1% from 2020
- HS2 fares same as conventional rail
- Air fares continue to decline
- Motoring costs decline as efficiency improves but no rise in fuel tax or further use of road pricing

So by 2036 in real terms:

Rail	+25%
Air	−30%
Car	−40%

(HS2 forecasts)

ITS

Capacity benefits

UNIVERSITY OF LEEDS

- HSR route has huge capacity
- Relief of capacity problems on parallel routes leading to:
  - Reduced overcrowding
  - Improved reliability
  - More capacity for freight

  Particularly important between London and Rugby, but also approaches to Birmingham, Leeds and Manchester (part of Northern Powerhouse Rail?

  How best to use capacity on the Northern part of the route?

  What would happen without HS2?

ITS

Sensitivity tests and risk analysis

UNIVERSITY OF LEEDS

- Capital costs (NB 64% optimism bias already applied)
- Operating costs (41% optimism bias already applied)
- Value of business travel time/overcrowding
- Speed
- Capacity
- Demand growth

  Demand growth is the key issue

  But 99% certain BCR is above 1.5 and 75% certain above 2.0.

ITS

Forecasting demand

UNIVERSITY OF LEEDS

HS2 predicts long distance rail demand will grow at 2.2% p.a., roughly half the growth rate for the last 20 years; demand capped in 2036.

Possible threats to growth

1. Impact of improvements in telecommunications

   - will need for travel reduce?

2. Increased competitiveness of the car (autonomous cars)?
3. Long term impacts of covid19?

ITS

Examples of Network Rail forecast growth over 30 years for alternative scenarios

UNIVERSITY OF LEEDS

Demand growth, based on economic growth assumptions (0.5-2.25% p.a.) and different pricing of alternative modes:

	Range	'Prospering in isolation'
London to:		
Birmingham	33-87%	67%
Manchester	52-158%	115%
Leeds	41-145%	108%
Birmingham to:		
Leeds	39-117%	103%
Manchester	40-126%	95%

ITS

Wider economic benefits

UNIVERSITY OF LEEDS

Current appraisal method considers these only for major conurbations on the assumption of unchanged land-use :

- Agglomeration benefits
- Labour market benefits
- Imperfect competition

The figure of £14billion is on this basis.

Graham examined whether there were further agglomeration benefits from improving inter city rail business travel? Concluded very small (£0.1bn?) due to low share of all journeys in the course of work.

ITS

Wider economic benefits (cont'd)

UNIVERSITY OF LEEDS

Additional mechanisms (Venables, Laird and Overman, 2014).

- Increases in density and city size leading to further agglomeration effects
- Specialisation and economies of scale
- Attraction of additional private investment

KPMG estimate £15b p.a.; but much criticism of how they separate out rail accessibility from other factors.

ITS

Benefits and Costs of the full “Y” network PV, 2015 prices, £bn		(DfT, 2020)
1	Net transport benefits	74.2
2	Wider Economic Impacts (WEIs)	20.5
3	Net benefits including WEIs	94.7
4	Capital costs	78.2
5	Renewals	5.4
6	Operating costs	25.2
7	Total costs = (4) + (5) + (6)	108.9
8	Revenues	45.4
9	Net costs to Government = (7) – (8)	63.5
10	BCR without WEIs (ratio) = (1) / (9)	1.2
11	BCR with WEIs (ratio) = (3) / (9)	1.5

Breakdown of benefits for HS2 (full Y network) (PV, 2015 prices, £m) (DfT, 2020)

UNIVERSITY OF LEEDS

Rail user benefits		76670
Road user benefits		820
Wider Economic Impacts		20500
Reduced External Costs		810
Loss of indirect Tax		-4140
Net Benefits		94660

ITS

National Infrastructure Commission Report on rail needs in the Midlands and the North 2020

UNIVERSITY OF LEEDS

- Northern part of HS2 plus other aspirations (new line Leeds-Manchester; upgrading Sheffield-Manchester etc) not affordable
- Should examine the possibility of terminating the Eastern leg of HS2 in the East Midlands and upgrading the existing line from there north

ITS

Conclusions

UNIVERSITY OF LEEDS

1. HSR typically requires more than 10m passengers p.a. to be justified
2. HSR will largely take over from air where station to station journey times are less than 3 hours
3. Diversion from car depends on congestion and on pricing policy for car
4. Important to examine a wide range of alternatives, including upgrading existing lines or a mix of upgrading and new build
5. An important question is how to make best use of capacity created

EUROPEAN UNION
European Structural and Investment Funds
Operational Programme Research,
Development and Education

MINISTRY OF EDUCATION,
YOUTH AND SPORTS

ITS