Institution: University of Leeds

Unit of Assessment: 14 Civil and Construction Engineering

Title of Case Study: Case Study 1: Providing the evidence base for UK and international transport demand forecasting and appraisal

1. Summary of the impact (indicative maximum 100 words)

Research undertaken by the Institute for Transport Studies (ITS) at the University of Leeds from 1997 to 2013 has played a key role in developing the methods and evidence base for demand forecasting and economic appraisal in transport. The primary impact of this research has been changes to official guidance Manuals, which are prescribed to scheme promoters, operators, consultants and other agents. In applying these Manuals, a secondary research impact has been to improve the quality of transport decision-making and Value for Money (VfM) of public expenditure.

Against this background, ITS Leeds research has achieved the following impacts throughout the period 2008 to 2013 (and ongoing):

- The UK Department for Transport's WebTAG appraisal guidelines have specified monetary valuations of travel time savings and traffic noise directly from our research.
- The UK rail sector's Passenger Demand Forecasting Handbook, which is the industry Manual, has specified key parameter values directly from our econometric and review work.
- Extending the reach of the impacts from the UK to worldwide, the ITS Leeds research has also been exploited in the appraisal processes of the World Bank and European Commission.

2. Underpinning research (indicative maximum 500 words)

Government, infrastructure providers, regulators and operators, and their respective agents, require evidence to inform their decision-making processes. For example:

- strategic business planning is critically dependent upon evidence concerning the responsiveness (or elasticity) of demand to economic activity and other external factors;
- routine transport planning is reliant upon estimates of market responsiveness to attributes such as price, journey time and service quality;
- project appraisal requires not only demand forecasts, but also valuations of time and other service attributes, to allow economic evaluation and help determine the social value for money;
- environmental assessment requires values of impacts based on evidence of willingness to pay.

Through the period 1997 to 2013, ITS Leeds has made notable contributions to the evidence base on what drives changes to travel demand, and on the valuation of travel and environmental attributes.

The value of travel time

The single most important parameter in transport appraisal is the value of travel time savings. In 1998, Wardman was the first academic worldwide to employ meta-analysis to synthesise and re-evaluate Stated Preference (SP) and Revealed Preference (RP) valuations of travel times from hundreds of UK studies; he has systematically updated this analysis as new valuations have emerged [1; i]. Wardman has also extended the scope of the meta-analysis work to cover time elasticities as distinct from valuations [2], and to derive values of other aspects of service quality such as punctuality and crowding [iv]. Wardman's results were central to the 2003 ITS Leeds report by Mackie et al. for the Department for Transport [3; ii], which derived functional relationships between values of time and the size and sign of time savings, distance and income, and provided the Department with revised values of time, waiting time multipliers and GDP elasticities.

As part of the EU-funded HEATCO project (2004-06), ITS Leeds led the analysis of data and the development of methods to calculate the value of time savings at a European level. This work was conducted by Shires and de Jong [4; v], and extended the meta-analysis approach of Wardman from a UK to a European context. The estimated regression equations were applied to provide values of travel time for each EU country, by travel purpose and mode. Such values can be used as best-estimate values for countries where evidence on values of travel time is lacking; for example, they have been used in project assessments for Romania and Bulgaria.

Understanding the demand for rail services

ITS Leeds has employed two research methods – namely major reviews and econometric analysis – in the search for better understanding of the determinants of rail passenger demand. With regards to the first method, Wardman has delivered the largest ever meta-analysis of fare elasticities (2011), as well as reviews of rolling stock (2001) and crowding (2011) valuations. With regards to the second method, Wardman (2006) estimated the effect of GDP and other external factors on rail demand [5; iii, iv] – the GB railway industry had hitherto struggled to understand the growth in railway demand – whilst Batley (2011) remains the only published study that has directly estimated the impact of punctuality on rail demand [6; iv].

The environmental value of transport investments

Research led by Nellthorp in 2005 extended the scope of transport appraisals to include the valuation of environmental impacts from transport, in the form of road and rail noise. This was collaborative research involving the Universities of East Anglia (Day) and Loughborough (Bristow). Nellthorp used a technique called the 'benefit transfer method' which allowed time- and location-specific data from a model of house prices in Birmingham (provided by Day) to be 'generalised' for any location in the UK at any time. Nellthorp's explicit methods showed that traffic noise valuations could be incorporated into the economic appraisal of transport schemes [7; i].

Research team with current title/grade and period of employment

Professor Peter Mackie (L 1970-87; SL 1987-96; Prof 1996-date).
Professor Mark Wardman (RF 1987-88; SRF 1988-97; PRF 1997-99; R 1999-2004; Prof 2004-date).
Dr Richard Batley (RO 2000; RF 2000-02; SRF 2002-07; PRF 2007-date).
Dr John Nellthorp (RO 1996-99; RF 1999-2001; SRF 2001-date).
Professor Gerard de Jong (Visiting Prof 2004-date).
Jeremy Shires (RA 1993-95; RO 1995-99; RF 1999-2007; SRF, 2007-date).

Note: RA, RO & RF = Research Assistant, Officer and Fellow; SRF & PRF = Senior and Principal Research Fellow; L & SL = Lecturer and Senior Lecturer; R = Reader; Prof = Professor.

Key grants and funding

i. 1997-2011: DETR/DfT, PI **Mackie**, Call-off contracts with DETR/DfT for research and consultancy on traffic appraisal. £750k over 15 years, e.g. RG.TRAN. 442579, 473959, 473245.
ii. 2000-2: DETR, PI **Mackie**, 'Revising the values of work and non-working time used for transport appraisal and modelling'. £110k, RG.TRAN. 444383.
iii. 2002, 2005, 2009 and 2013: Association of Train Operating Companies (ATOC), PI **Wardman**, 'Updating the Passenger Demand Forecasting Handbook'. £80k, e.g. RG.TRAN. 445021, 448215, 101196.
iv. Multiple grants from ATOC, DfT, NAO, RSSB and EPSRC on aspects of travel quality modelling, PIs **Wardman** and **Batley**. £400k, e.g. RG.TRAN. 474208, 482729, 483748, 485581, 485461, 471902, 480033, 484855, 485440, 478162, 481352, 446958, 460920, 472980.
v. Grants from the EU (2004-6: HEATCO Framework 6 (€110k to Leeds of €1.3m budget, RG.TRAN. 447876)) and World Bank (2003) (£65k, RG.TRAN. 445963), PI **Mackie**.

3. References to the research (indicative maximum of six references)

1. **Wardman,** M.R. (2004) 'Public transport values of time'. *Transport Policy*, **11** (4), pp363-77. doi:10.1016/j.tranpol.2004.05.001
2. **Wardman**, M.R. (2012) 'Review and meta-analysis of UK time elasticities of travel demand'. *Transportation*, **39** (3), pp465-490. doi:10.1007/s11116-011-9369-2
3. **Mackie**, P.J., **Wardman**, M.R., **Fowkes**, A.S., **Whelan**, G.A., **Nellthorp**, J., and Bates, J.J. (2003) *Value of Travel Time Savings in the UK.* Report to Department for Transport. Available at: http://eprints.whiterose.ac.uk/2079/2/Value_of_travel_time_savings_in_the_UK_protected.pdf
4. **Shires**, J.D. and **de Jong**, G.C. (2009) 'An international meta-analysis of values of travel time savings'. *Evaluation and Program Planning*, **32** (4), pp315-325. doi:10.1016/j.evalprogplan.2009.06.010
5. **Wardman,** M.R. (2006) 'Demand for rail travel and the effects of external factors'. *Transportation Research Part E*, **42** (3), pp129-148. doi:10.1016/j.tre.2004.07.003

6. **Batley**, R.P., **Dargay**, J.M., and **Wardman**, M.R. (2011) 'The impact of lateness and reliability on passenger rail demand'. *Transportation Research Part E*, **47** (1), pp61-72. doi:10.1016/j.tre.2010.07.004
7. **Nellthorp**, J., Bristow, A.L., and Day, B. (2007) 'Introducing willingness to pay for noise changes into transport appraisal: an application of benefit transfer'. *Transport Reviews*, **27** (3), pp327-383. doi:10.1080/01441640601062621

Note: ITS Leeds researchers in **bold**. References [1], [2] and [6] should be judged for research quality; that said, all except [3] have been published in international journals with rigorous peer review processes, whilst [3] was subject to peer review commissioned by the DfT and has been widely cited in the other 'national' value of time studies (e.g. Netherlands, Norway and USA).

4. Details of the impact (indicative maximum 750 words)

The primary impact of this research is official (government and operator) guidance and policies on transport forecasting and appraisal, both in the UK and internationally. Consequently, through adoption of these processes, the ITS Leeds research has contributed to the underlying evidence base and analysis framework for many high profile practical applications since 2008. The table below is a list of official guidance documents which contain specific contributions made by ITS Leeds based on the underpinning research described in Section 2 above.

User/Beneficiary	Reach	Guidance Manual
The World Bank	Global	Economic Evaluation of Transport Projects Toolkit [A]
European Commission	EU	Guide to Cost-Benefit Analysis of Investment Projects [B]
Association of Train Operating Companies	UK	Passenger Demand Forecasting Handbook (PDFH) [C]
Department for Transport	UK	WebTAG [D]

WebTAG

WebTAG is the Manual which the appraisal of all UK publicly funded transport projects is required to follow. Explicit references to the research cited here are found in Units 3.3.2 and 3.5.6 of WebTAG, and have been retained in all updates of these units since 2008 [D]. Unit 3.3.2, regarding appraisal of noise, refers to work by Nellthorp et al. [7] as the basis for calculating official values of traffic noise. Mackie et al.'s report [3] led directly to the re-setting of official UK appraisal values for changes in travel time which are still used today; Unit 3.5.6 on the value of travel time refers directly to [3] stating: *"Values for non-working time are....based on research conducted by ITS for DfT reported in 2003"*. Since compliance with WebTAG is mandatory for major scheme appraisals, the ITS Leeds work has influenced the appraisal of all major road and transport schemes submitted for funding approval to/by DfT since 2008; this impact is corroborated by the DfT [E]. When the DfT undertook the 'New Approach to Appraisal (NATA) Refresh' review in 2009, Mackie chaired the Peer Review panel of academics and practitioners.

PDFH and rail industry regulation

The PDFH [C] contains the officially recommended demand forecasting procedures of the rail industry in Great Britain. Research which leads to changes to its recommended parameters therefore impacts on real world decision making. ITS Leeds work on understanding the causes of trends in rail travel [5] has underpinned the recommended elasticities to GDP in the 2002, 2005, 2009 and 2013 versions of PDFH. The latest update of PDFH in 2013 also uses generalised journey time (GJT) elasticities from [2]. These GJT elasticities entail a significant departure from previous values, impacting upon demand forecasts of changes to not only journey time, service frequency and through-train provision, but also to other elasticities derived from the GJT elasticities, such as crowding, reliability, accessibility to stations and rolling stock. In addition, a recent ITS Leeds review informed by [6] has led to major changes in the parameters used to forecast changes in reliability; these updated parameters have been implemented within the Office of Rail Regulation's 2013 update to Schedule 8, affecting millions of pounds of compensation payments concerning train punctuality. Finally, ITS Leeds created the DfT's Strategic Fares Model, and updated it in 2010 and 2013; this is used to inform how rail fares in Britain are regulated and was subsequently a feature of PDFH [iv]. ATOC's letter of corroboration [F] states that: *"ITS has played a leading role in developing the body of evidence and the framework contained within the PDFH, which is a key component of*

the commercial and regulatory framework of the rail sector".

An Illustrative Example – High Speed 2 (HS2)

The valuation and forecasting strands described above come together in the economic appraisal of the HS2 rail project. The demand forecasting and economic appraisal of this project has been consciously set up to be compliant with PDFH and WebTAG. So, for example, the demand growth over time is influenced by Wardman's work on GDP elasticities [5], the modelling of reliability benefits and crowding relief on the West Coast Main Line by Batley et al. [6], the valuation of non-work travel time savings by Mackie et al. [3], and the valuation of noise by Nellthorp et al. [7]. These pieces of work undertaken at ITS Leeds all influence the assessment of value for money of HS2 [G], and research on the value of travel time is a particular focus of the strategic case for HS2 [H].

World Bank toolkit

The ITS Leeds work for UK government and industry has provided the foundation for more internationally-focused work which has extended the reach of the research impacts. In 2003, ITS was commissioned by the World Bank to develop a transport appraisal toolkit, which draws heavily on ITS research outputs. This toolkit has been available to consultants around the world from 2003 to date [A]. The responsible officer in the World Bank states that the toolkit "*...has been instrumental in improving the quality of economic evaluation in the transport sector in the World Bank. Over the period 2008-12 there were 261 investment projects financed by the World Bank either in the transport sector or with a substantial transport component. These Guidelines made a substantive contribution to improving the quality of the economic evaluation of these projects*' [I].

European Cost-Benefit Analysis

In 2008, the European Commission adopted its Guide to Cost-Benefit Analysis of Investment Projects [B], incorporating the methods and values developed by the HEATCO project. The ITS Leeds research has therefore served as a reference point for value of time calculations in appraisals of trans-European network projects. The same values are also recommended for calculating congestion costs in the 'Handbook on estimation of external costs in the transport sector' [J], co-financed by the European Commission.

5. Sources to corroborate the impact (indicative maximum of 10 references)

A. World Bank (2003) Toolkit for the Economic Evaluation of Transport Projects. Washington DC: World Bank. http://www.its.leeds.ac.uk/projects/WBToolkit/index.htm
B. European Commission, Directorate General Regional Policy (2008). Guide to Cost-Benefit Analysis of Investment Projects. (see especially Table 3.1, p80). http://ec.europa.eu/regional_policy/sources/docgener/guides/cost/guide2008_en.pdf
C. Association of Train Operating Companies, Passenger Demand Forecasting Handbook (PDFH, latest version 5.1, 2013). Commercial in confidence.
D. DfT Transport Analysis Guidance (WebTAG) https://www.gov.uk/transport-analysis-guidance-webtag; see specifically unit 3.3.2 on the noise sub-objective and unit 3.5.6 on the values of time and vehicle operating costs.
E. Letter of corroboration from the Deputy Director, Transport Appraisal & Strategic Modelling, DfT.
F. Letter of corroboration from the Manager, Strategy and Franchising Policy, ATOC.
G. HS2 Ltd (2012) The Economic Case for HS2: Value for Money Statement. http://assets.dft.gov.uk/publications/hs2-economic-case-value-for-money/hs2-economic-case-value-for-money.pdf (e.g. reference to ITS Leeds research on page 40).
H. HS2 Ltd (2013) The Strategic Case for HS2. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/254360/strategic-case.pdf (e.g. references to ITS Leeds research on pages 34, 112 and 113).
I. Letter of corroboration from the Lead Transport Economist, Sustainable Development Unit, World Bank.
J. Infras, CE Delft, Fraunhofer Gesellschaft and University of Gdansk (2008) Handbook on estimation of external costs in the transport sector. Report for the European Commission. http://ec.europa.eu/transport/themes/sustainable/doc/2008_costs_handbook.pdf (e.g. references to ITS Leeds research on pages 128, 129 and 133).