Review of the value of time assumptions for business travellers on HS2

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1. Introduction

The modelling and appraisal of HS2 is to be conducted by and for DfT, so as to provide Ministers with the best possible assessment of the social Value for Money of the scheme as one input to the decision within the five business case model. In general, DfT has sought to do this by ensuring that the appraisal is WebTAG compliant. However, the consultation responses have shone a light on the appraisal guidance for changes in travel time in the course of employer's business (EB). As a result, DfT has produced a paper which it has asked us to peer review.

The paper and this peer review relate particularly to the HS2 scheme and the applicability of the appraisal guidelines to the HS2 appraisal. There is a sense in which HS2 is *sui generis*

- It is a rail scheme with large time savings so the issue of working while travelling is particularly relevant.
- Most EB travel on HS2 will be white collar travellers for whom the productive use of travel time is more of an issue than for blue collar.
- It is a long distance scheme which will tend to be used by EB travellers on relatively high incomes, so the issue arises of the appropriate income level to use, irrespective of the productive use of travel time.
- These points apply less strongly to the capacity relief benefits (Watford-London etc) on the WCML than to the HS2 line benefits.

Before proceeding with our peer review of the Department's paper, we feel that it is appropriate to state our understanding of the terms of reference for this task, thus:

- In what follows, we endeavour to provide an academic review of the Department's paper within the three day time budget specified.
- In reviewing the Department's paper, we have drawn upon our experience of the ITS & Bates (2003) study, which contributed towards the Department's current guidance on the valuation of business travel time savings (see especially pp10-14 of ITS & Bates).
- Whilst we have some level of appreciation of the ongoing appraisal of HS2, we have reviewed the Department's paper without the benefit of detailed knowledge of the relevant demand model.
- We shall proceed on the basis that the appraisal of HS2 is compliant with the guidance; we understand that it is the guidance which is being challenged and that the Department's paper is motivated by this challenge to the guidance, in the context of the application to HS2.

2. Theory

As the Department's paper notes, two principal approaches have been proposed in the literature for the valuation of travel time savings for business travellers, namely the 'cost savings' approach and the so-called 'Hensher' approach as codified by Fowkes, Marks and Nash (1986).

The paper rightly observes that standard UK practice, as detailed in WebTAG unit 3.5.6, is to adopt the 'cost savings' approach. The 'cost savings' approach is also sometimes referred to in the literature as 'wage plus', reflecting the fact that the costs to the employer will typically consist of both direct compensation/reward to the employee, plus additional costs (notably employer NI and pension contributions) of employing staff. This is explained in WebTAG 3.5.6.

A focus of the paper is to contrast the 'cost savings' approach with the 'Hensher' approach, in the context of potential business travel on HS2. Motivating this focus are two propositions emerging from the HS2 consultation, specifically:

'' 1) It is unrealistic to assume time spent on a train is unproductive''.

''2) The value of business traveller time on rail is too high''.

Turning to the theory, two key distinctions can be drawn between the 'cost savings' and 'Hensher' approaches:

- The Hensher approach considers the potential for different levels of productivity of working on the train relative to working at the workplace. The cost-savings approach makes no such distinction.
- The cost savings approach assumes that the employer derives all of the benefits of travel time savings. As well as employer benefits, the Hensher approach considers the potential for benefits to the employee, from increased leisure and/or reduced travel fatigue.

The practical implications of these distinctions are that the Hensher approach, unlike the cost savings approach, divides the time savings into two components:

- Some of the time savings are devoted to work, valued at the wage rate (which would be the value of marginal product in perfectly functioning labour markets, itself a crucial simplifying assumption).
- Some of the time savings are devoted to leisure, valued at the value of non-working time.

Irrespective of the validity (or otherwise) of propositions 1) and 2) above, it is vital to set them in context by noting that the interest of appraisal is in valuing the benefits of travel time *savings*, rather than travel time *per se*. Thus, the question is, how much travel time will HS2 potentially save, and how will this saving be used.

We need not concern ourselves with how travellers use their time for the majority of the journey except to the following extent:

- If business travellers work the whole time they are on the train at 100% normal productivity, then we can infer that any saving in travel time would have been fully productive relative to productivity in the workplace (i.e. p=1.0 and q=1.0 in the Hensher equation).

- If business travellers stare out of the window and consume coffee while travelling, none of the saving in travel time would have been used productively (i.e. p =0 in the Hensher equation).
- If on average business travel on train is spent partly working and partly not working (i.e. $0<p<1$), then it is not possible to say *a priori* whether the portion of time saved would have been used productively. Yet this marginal question is what we need to answer.

Furthermore, there is the question of whether the travel time saved is devoted to work or to leisure:

- If, having experienced a travel time saving, the business traveller goes directly home at the end of his/her journey then, provided the employee's salary reflects this feature, the employee will substitute work for leisure (i.e. r=1.0).
- If, on the other hand, the saving in travel time means that the time released is used to perform additional work then r=0.
- If the travel time saving is shared between work and leisure then $0<r<1$. This is what we need to know.

3. What assumptions distinguish the cost saving approach from the Hensher approach?

We think it is useful to identify specific practical contexts which place particular challenge on the cost savings approach and/or motivate the adoption of a broader framework such as Hensher's. In this regard, a recent paper by Karlström et al. (2007) is helpful (and authoritative), since it couches both the cost savings and Hensher approaches within a common theoretical framework, yielding each approach as a special case, and explicating the assumptions applying to each such case.

Broadly speaking, the Hensher approach to valuing business travel time savings collapses to the cost saving approach where the following assumptions hold:

- Travel time savings are devoted entirely to work (as opposed to leisure).
- The frequency of business trips is independent of total business travel time.
- The marginal (dis)utilities of work and travel are equal.
- The wage rate including on costs is equal to the marginal product of the relevant class of labour
- Travel time is not productive.

Another recent paper, by Pawlak et al. (2011), is motivated by an interest in challenging the proposition (implicit in the classic works of Becker (1965) and de Serpa (1971) that time can be devoted only to a single activity, as opposed to simultaneous activities. More specifically, Pawlak et al. develop an extended version of the goods-leisure framework (drawing especially from the presentation by Train & McFadden (1978)) that allows travel time to be combined with other activities, namely work and leisure. If travel can be combined with work or leisure, then this brings the potential for a reduction in the value of travel time savings. The authors illustrate the empirical workings of their framework using a simulation-based exercise; this reveals the potential for variation in the VTTS under different assumptions concerning the productivity of travel time. Whilst it is difficult, from reading Pawlak et al., to draw explicit results on the magnitude of such variation

which could be applied to HS2, a simulation exercise of this kind could help to formalise the scenarios developed in Table 3 of the Department's note.

In the context of the HS2 document, the most significant of the above assumptions is number 5, concerning the productivity of business travel time. An important point to acknowledge is that, whilst concerns regarding the legitimacy of assumption 5 would provide grounds to explore alternatives to the 'standard' cost saving approach (as detailed in WebTAG 3.5.6), it does not necessarily follow that one should dispense altogether with the cost saving approach and defer to the Hensher approach instead. The Hensher approach is motivated by a broader set of considerations than simply the productivity of travel time, and it would be possible to move towards an 'adjusted' cost saving approach without embracing the Hensher approach in its most complete form.

Regarding the work/leisure trade off, we think the Department's guidance and the HS2 appraisal should adopt a relatively long-run stance. Our view is that over a period, lots of things happen to the business environment such as flexible working hours, new markets overseas requiring international travel, increases in motorway congestion, improved driver comfort etc. We hypothesise that employees and employers make a deal about what is acceptable and that the neutral assumption is that hours of employed time for white collar workers are not affected by particular changes in travel conditions. We are therefore inclined to regard the argument that EB travel time savings accrue partly as leisure as too short term in focus. We note this is also the view of Karlstrom et al. (2007) in the Swedish context.

Furthermore, making the constant total working time assumption (r=0) would avoid opening up an additional set of issues. An issue of particular significance to policy with variable total working time would be the tax regime, since the valuations emanating from this approach will vary depending on the balance between income, corporation and value-added tax (see Karlstrom et al.)

Overall, we have grave doubts about the practical feasibility of robustly implementing the full Hensher model including the taxation effects. We think robust estimation of the terms p, q and r in the Hensher equation as they relate to travel time *changes* is too demanding. But we would recommend in the particular case of HS2, and possibly more generally, that the DfT give consideration to an 'adjusted cost saving approach' to take account of the marginal productivity of travel time savings. This adjustment addresses the proposition 'Faster journeys mean less time available—and used-- to work on the train'.

4. Evidence

In order to reconsider the 'zero productivity of travel time' assumption, the Department might have regard to two broad sources of empirical evidence. First, what evidence is there about what business travellers do while travelling by train, morning and evening, to and from their business and what they would do if their journey was shorter? Secondly, what evidence is there about willingness to pay for travel time savings for journeys on employers' business and in particular is there evidence that the value of EB travel time is lower by train than by other modes which is consistent with more productive use of travel time in the former?

With regard to the use of travel time. one strand of evidence is of course from the SPURT and other studies which have been conducted on the question at hand. We have not been asked to review those studies and so cannot comment on the weight which should be attached to them. We concur with the DfT's cautionary note about their literal interpretation while believing they are telling us something about a real phenomenon. Our impression however is that these studies are more about how travel time in general is used than how *savings* in travel time are used; they do not answer the questions:

- How are *savings* in travel time used, *ceteris paribus*?
- Relaxing *ceteris paribus*, do reductions in travel time give cause for passengers to use travel time differently for the entire journey?

A second strand of evidence is from observation of EB traveller choices. In the past it has often been argued that interpretation of Stated Preference and Revealed Preference observations of traveller behaviour on EB are compromised by the difficulty of establishing whether the employee behaves or responds to the SP questions on their own account or in the joint employer/employee interest. This needs to be borne in mind, but we think bears less on the relative values of saving rail and car time and more on the absolute value of EB time savings.

If travel time on rail is relatively productive, then we would expect the marginal utility of travel time savings (all else equal) on rail to be relatively low in absolute terms and the value of travel time savings (i.e. the ratio of the marginal utilities of travel time savings and travel cost) to be relatively low. In practice, however, estimates of these marginal utilities and the value of time may be confounded with mode specific constants, which could reflect a range of factors such as comfort and crowding. We are aware of four relevant[1] Stated Preference studies. The high speed study for SRA (Atkins, 2002) reports SP values of time across the sample of business travellers of 51.2 pence per minute for rail and 61.6 pence per minute for air. Whilst at face value this indicates a higher value for air as a mode, the same model reports that the high speed rail value of time was also 61.6 pence per minute. Indeed, a model which estimated separate time coefficients for air, car, rail and high speed rail implies values of time relative to conventional rail of 1.08 for air, 0.76 for car and 1.30 for high speed rail The higher coefficient values for high speed rail could have been because the larger time savings offered were more worthwhile, but generally this pattern of results does not support more productive use of rail time.

In a recent study for Network Rail, Steer Davies Gleave (2009) offered air users choices between existing rail, high speed rail and air. For the preferred air-rail model, mode specific time parameters are estimated. The business values of time are £39.6 per hour for classic rail, £30.2 per hour for high speed rail and £36.1 per hour for air. No alternative specific constants were entered. Whilst the air coefficient is larger than for high speed rail, it is lower than for conventional rail. This could reflect air users' preferences for air, all else equal. Nonetheless, the mode specific time coefficients were not significantly different from each other.

[1] Although there are more studies of rail versus air mode choice, the SP exercises used do not vary the air journey time against rail and hence it is not possible to distinguish the relative disutility of time spent in train and on planes. Similarly, RP models estimate generic time valuations. There are numerous studies of conventional rail versus car but reviewing these was beyond the scope of this report.

The same study reports a model based on car users' choices between rail, high speed rail and car. The respective values of time for business travellers were £24 per hour, £19 per hour and £23 per hour, although again these values would not be significantly different from each other.

Burge et al. (2010) offered existing travellers SP choices between rail, car and air and separately these three with the addition of high speed rail. High speed and conventional rail were constrained to have the same time coefficients. The values of travel time savings vary by mode due to the logarithmic specification of cost, but in terms of marginal utility of travel time that for car was 22% larger than for air and rail which had the same marginal utilities. Note, however, that the model specified alternative mode specific constants which indicated that air users prefer high speed rail over air to the tune of 233 minutes whilst the figure is 45 minutes for current rail users. The removal of these constants would be expected to lead to a large difference between air and rail specific time coefficients. We understand that values derived from this model are available in the Long Distance Model Report which is not currently in the public domain.

In work for Eurostar UK, Wardman and Murphy (1999) offered air and rail users SP choices between the two modes for trips between London and Brussels/Paris. The rail scenarios reflected the time savings that would be achieved by the high speed link to the channel tunnel. Only in the air users' SP exercise did air journey time vary. For business travellers, the value of time would be 7% larger for rail than air, although not significantly different from each other.

These comparisons control for income and distance because the mode specific values are reported for the same set of individuals. The pattern of evidence is not clearcut; it would be difficult to assign a figure to lower disutility of time for rail on the basis of these results.

Wardman has undertaken several meta-analyses of values of time over the past 15 years. These provide some insights. Abrantes and Wardman (2011) suggests a distinction can be made between the mode to which the value relates (as distinct from the mode used). So for a car user providing a valuation of rail journey time savings, mode used is car and mode valued is rail. They found air to have a value 81% larger than car whereas rail had a value 13% less. However, given the relatively few air valuations in the data set, it may well be that this mode valued effect for air is confounded with air users who will have higher valuations because of their higher incomes.

We recommend that the Department considers the evidence from these (and other including European) studies more systematically than we have been able to do and compares the pattern of behavioural values from SP studies with the appraisal values. Our impression is that the evidence from these studies is quite clouded, for example by the need to interpret modal constants but that there is some uncertainty as to how much lower rail EB values are than air or car, *ceteris paribus*, if indeed they are lower at all.

5. Treatment of crowding relief and modal shift

It is important to recognise another aspect of the current guidance. By assuming that travel time on EB is essentially the property of the employer and is unproductive, the corollary is that the guidance disregards any differences in valuation between walking, waiting and in-vehicle time and between different levels of crowding for EB travellers. If DfT were to move away from the zero productivity of travel time assumption, we think this aspect of appraisal would have to be reconsidered since one would expect productivity during travel to be affected by levels of crowding.

Our appreciation is that crowding relief effects are included within the HS2 Planet Long Distance model where appropriate. Clearly if in the do minimum, EB travellers tend to travel first class and/or to reserve seats, there is an empirical question about the size of the crowding relief benefits for them, but conceptually, if HS2 changes the probability of getting a seat from 0.97 to 1, this should be taken into account in modelling and forecasting through crowding values for the EB purpose as in the PDFH guidance. Again, the model values for short/medium distance on WCML might be different from those on HS2 proper.

The DfT's other point is on the treatment of benefits to EB travellers switching from other modes. This seems to us the most dubious point in the paper. We have a base case in which there is available to the business traveller classic rail (one or more routes and stations), air, car and not travel. We introduce high speed rail as an additional choice. When evaluating the benefits, it is crucial to maintain the logical integrity of the rule-of-a-half formula. If someone chooses car in the base case and high speed rail in the do something, the bounds of the benefit are zero for the marginal person and [GC HS2- GC CLASSIC RAIL][2]. This is on the assumption that classic rail and high speed rail are a single rail mode which is the assumption of the HS2 model. The benefit triangle applies to the modal transfers from air and car and to the generated traffic which in this case is large relative to the modal transfers.

The exception to the above would be if the assumption were to be made that the employee balances their travel choices purely on their own utility so the employer gets an external benefit when the employee transfers from car to rail. But as argued above, that is not our preferred model of how the business travel market actually works. The point about unrealistically high values of transferring traffic in the DfT paper is particularly germane.

[2] The traveller who is on the margin between using car and classic rail ex ante gets a benefit of the difference between the generalised cost of classic rail and the generalised cost of high speed rail. The traveller who is on the margin between choosing car and high speed rail ex post gets a benefit of zero. Assuming a linear demand curve over the relevant arc, the average user benefit to modal transfers and generated traffic is half the change in generalised cost.

6. Other evidence

We draw the Department's attention to an international meta-analysis of European values of travel time savings undertaken for the EU (Shires and de Jong, 2006). For the countries in northern Europe with a serious track record on the valuation of travel time, which certainly includes Sweden, Denmark and the Netherlands, the UK official values of non-working time are very comparable with the official values in those countries. However the official values of EB time in the UK are 20-50% above the other three and indeed are 20% higher than any of the other ten countries in the analysis (see Table A26 col 9). This proves nothing in itself but is food for thought.

7. Income levels of EB travellers in the long distance rail market

Separately from the rest of the paper there is the issue of whether £70k average income for the market segment of interest is or is not 'a high number'. The Department has promised a note on the provenance of this number and its meaning. For example, is it the individual income of the EB travellers (as opposed to their household income) and does it include or exclude the 21.2% of employee related overheads? Sources such as the National Travel Survey and the National Rail Travel Survey should be used to provide evidence on this point. A slightly broader question is whether or not the Department should stick with its general appraisal guidance of a single average value of EB travel time for rail travellers in the context of a scheme which is not oriented to the average rail traveller.

8. Summary and Conclusion

- The cost saving approach assumes zero productivity of travel time savings. So, we are interested in how travellers use travel time *savings* rather than travel time *per se*; the fact that travellers are observed to be productive for some part of their journey is not in itself sufficient to dispense with the zero productivity assumption.
- That said, there is an intuitive case (supported by anecdotal and empirical evidence) to reassess the robustness of the zero productivity assumption as a simplified representation of the reality. The case for reassessment applies to all modes and journey lengths but is particularly strong in the context of long distance rail travel.
- The Hensher approach relaxes this assumption, but also introduces other theoretical issues and practical complications so that we doubt the feasibility and robustness of implementing the full Hensher approach.
- The Department should consider an 'adjusted' cost saving approach that appeals to the productivity argument, but does not go as far as the Hensher approach. In doing so it should consider both theory and evidence including time use studies and studies of willingness to pay for rail travel attributes.
- If the Department changes its position on the central case assumption regarding the productivity of travel time savings, benefits from changes in crowding levels for EB travellers would need to be incorporated in the appraisal and walking and waiting time changes handled separately from in-vehicle time.

- We are not convinced that the treatment of modal transfers for EB traffic should be any different from the Department's standard rule-of-a-half guidance. This element of the sensitivity tests in the Department's Table 3 should be isolated so that its separate effect is transparent.
- In the immediate term, we think the Department's sensitivity analysis proposal is the only feasible approach. In the medium term, we think it is desirable to implement either revised WebTAG guidance or exceptional treatment of HS2 business travel time savings and crowding relief so as to enable revision of the business case.

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