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How Should Business Travel Time Savings be Valued?

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Abstract

This paper provides the most extensive appraisal yet of the methods for valuing business travel time savings. From both theoretical and empirical perspectives, we review the traditional Cost Savings Approach (CSA), which has long been dominant in appraisal practice worldwide, alongside its main rivals, namely the Hensher Equation (HE) and the Willingness-To-Pay (WTP) approach.

We conclude that the CSA does not provide a suitable basis for valuing business travel time savings. The HE and WTP approach do not tell the same story in terms of absolute values or variations in values according to key factors, but it is not clear which is the more appropriate. Further detailed exploratory research is needed into how employers value the benefits of employees' time savings. We recommend a carefully controlled triangulation of the CSA, HE, employers' WTP and employees' WTP, not seen since the pioneering work of Fowkes, Marks and Nash in 1986.

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1. INTRODUCTION

The value of travel time savings (VTTS) is one of the most important parameters in transport planning, with a long history of estimation and application to project appraisal. It is widely acknowledged that the value of *business* travel[1] time savings (VBTTS) will differ from that for private travel. The former will be influenced by the benefits to the company on whose behalf the journey is being made, whilst the latter will be a matter of personal willingness-to-pay. Estimates of VBTTS for use in appraisal are typically three to five times those for VTTS, and therefore are crucial to appraisal outcomes, especially for projects with a high business travel component (Mackie and Worsley, 2013). For example, in the UK, the car VBTTS[2] is currently between three and four times larger than the VTTS, so the 13% of car and van mileage which is for business purpose other than professional driving forms around a third of the total travel time benefits to cars and vans when roads are improved.

Whereas estimates of VTTS are derived from empirical studies, either official so-called national value of time studies or bespoke project related studies, the values used in appraisal for VBTTS are not generally based on empirical studies. Instead they tend to be elicited from a relatively simplistic theoretical approach based on the wage rate of the traveller, known as the Cost Saving Approach (CSA). There is therefore quite a significant disconnect between the evidence base supporting the valuation of commuting and leisure time in appraisal, and the evidence supporting the valuation of business travel time. Gradually, however, this position has been seen to be weak and a body of empirical evidence has come into existence.

This paper provides a comprehensive account of the substantial amount of evidence that now surrounds the VBTTS. Indeed a review of this evidence is long overdue. There have been many notable reviews of valuations of travel time savings (Hensher, 1976; Waters, 1992; de Jong et al., 1998, 2004; Shires and de Jong, 2009; Abrantes and Wardman, 2011; Small, 2012; Douglas and Wallis, 2013; Wardman et al., 2013a), but the emphasis has not been on business travel specifically. Quite aside from this gap in the literature, a review of VBTTS is warranted by the longstanding theoretical concerns surrounding the conventional CSA, and by the accumulating empirical evidence which indicates that for some business travel market segments, different approaches can yield different valuations.

Business travel includes those who are travelling to transact business as well as the work done by professional drivers of cars, taxis, buses, commercial vehicles and trains. The appraisal convention that travel time changes for professional drivers can be valued according to their gross wages plus staff-related overhead costs is generally accepted as reasonable. This paper will focus upon so-called 'briefcase' travellers who are transacting business, which is a significant market segment, and will consider the valuation of time savings for these travellers using the Hensher Equation (HE) and Willingness-To-Pay (WTP) approach as alternatives to the CSA. Through examining a large body of existing empirical evidence, backed up with theoretical considerations, we provide important insights

[1] By business travel, we refer to travel undertaken by employees as a representative of their employers or by the self-employed in the course of their work.

[2] Business travel by car is as a driver in this paper. Whilst taxi, car hire and lifts can be important market segments, there is a dearth of evidence in these areas and research into them is warranted.

in the controversial area of the most appropriate basis for VBTTS and identify directions for future research.

The layout of the paper is as follows. Section 2 discusses the HE and the WTP approach alongside the CSA as rival approaches to VBTTS estimation. Sections 3 and 4 summarise and evaluate empirical evidence concerning the HE and WTP approach respectively. The concluding section synthesises the insights from these reviews and provides recommendations.

2. THE RIVAL APPROACHES TO VBTTS

The CSA dominates official appraisal practice. Building upon the review of Odgaard et al. (2005), we identified that it is used in all but two of the 16 countries and organisations where guidelines on VBTTS are provided[3]. A 'restricted' version of the HE is currently used in the Netherlands and Sweden. In Sweden, a restricted case of the HE (see equation 5) was adopted in the mid-1990s, before replacing with the CSA in 2008 and then reverting to a different restriction of the HE (equation 4) in 2012. The latter had the effect of reducing the VBTTS for train relative to the CSA by 15% to account for productive use of travel time. In the Netherlands, the restricted HE (equation 5) has been used for some time, whilst Norway used a restricted HE (equation 3) until 2010 when it reverted to the CSA. Switzerland is unique in eliciting VBTTS by factoring up the VTTS using evidence from international studies (Bickel *et al*., 2005). As far as we are aware, for purposes of valuing business travel time savings, no country uses either a full HE (equation 2) or values derived from direct elicitation of WTP.

2.1 The Cost Savings Approach (CSA)

Although the theoretical origins of Cost Benefit Analysis (CBA) date back at least to Dupuit's celebrated 1844 paper, in a transport context it was first applied in Britain to the emerging motorway programme (Coburn et al., 1960) and the extension of the London Underground (Foster and Beesley, 1963). At this early stage, the VBTTS was one of many issues to be resolved, and the CSA emerged as a reasonable and practicable solution. By the 1970s, CBA theory and practice had been developed to a satisfactory state-of-the-art. The CSA was widely accepted as part of this, and has since proved remarkably resilient as the predominant approach in much of the world where transport appraisal is actively practised.

According to the CSA, the time of the employee while on business is owned by the employer. The value of a unit of time transferred between travelling and working is equal to the marginal gross cost of labour (or, given competitive conditions in the labour and product markets, the value of the marginal product of labour [*MPL*]), thus:

$$VBTTS = MPL = w + c \tag{1}$$

where:

w is the gross wage rate (inclusive of tax etc.)
c is the marginal non-wage cost per unit time of employing labour

To arrive at this, a number of well documented assumptions need to be made (e.g. Harrison, 1974). The key ones are that all released time goes into work not leisure, and that travel time *changes* do not

[3] Australia, Denmark, European Investment Bank, European Commission, Finland, France, Germany, Ireland, Netherlands, New Zealand, Norway, Sweden, Switzerland, UK, USA, and World Bank.

displace work done during travel. It is unlikely that these assumptions will be always and everywhere satisfied, and the CSA has been the subject of recurrent debate over the years. The overriding questions are firstly whether the CSA is a reasonable approximation to reality and secondly whether there are feasible alternatives. On the first question, one of the earliest and indeed few comparative studies (Fowkes et al., 1986) found little difference between the CSA values and those of competing approaches, and hence reinforced the CSA's position. With regards to the second question, our view is that there is a general preference among officials for a simple theory over the complexities and costs of acquiring empirical evidence unless theory is shown to be inadequate. Such defences of the CSA continue to hold sway in official recommendations in many countries.

Nonetheless, there are at least three visible trends which make the CSA more open to challenge now than when it was invented. First, over time the digital and mobile communications revolution has increased the usability of travel time for working. Second, changes in economic structure and work occupations have promoted the advancement of the so-called 'knowledge economy', such that the proportion of business travellers in occupations and roles which enable them to use travel time productively has risen. Third, there has been a perceptible move to more flexible working contracts, whereby work may take place in or out of the office and not necessarily between nine and five. Since appraisal needs to cover a lengthy forward period such as sixty years, this raises the question of how we can best predict the future evolution of these trends which, it would seem, will make the CSA increasingly untenable for briefcase travellers.

2.2 The Hensher Equation (HE)

In contrast to the CSA, the HE combines the perspectives of both the employer and the employee, whilst also accounting for the productivity of travel time and the allocation of time savings to work or leisure. The substantive theory and concepts behind the HE were outlined by Carruthers and Hensher (1976), before being developed more fully by Hensher (1977). Building upon Carruthers and Hensher (1976, pp169-171), Fowkes et al. (1986) proposed an alternative formulation that is now the conventional representation of the HE[4]:

$$VBTTS = (1 - r - pq)MPL + MPF + (1 - r)VW + rVL \quad (2)$$

where:

r is the proportion of travel time saved that is used for leisure
p is the proportion of travel time saved that is at the expense of work done while travelling
q is the relative productivity of work done while travelling relative to at the workplace
MPL is the value of the marginal product of labour
MPF is the value of extra output due to reduced (travel) fatigue
VW is the difference between the employee's valuations of 'contracted' work time and travel time
VL is the difference between the employee's valuations of leisure time (i.e. the residual time given the work contract) and travel time [5]

[4] With the caveat that we have reinterpreted the VW and VL terms in accordance with Batley (2015).

[5] *VL* is the behavioural value of non-work time for the relevant labour. Note that this is expected to be higher than the standard value of non-working time across the whole population on the grounds that business travellers have above average incomes. Adjustments from behavioural to appraisal values are not considered in this paper.

It should be noted that many of these parameters are specific to the individual trip being undertaken. Thus one might expect that for a particularly onerous trip the values of say *MPF*, *VW* and *VL* will be relatively high. Similarly *p*, *q* and *r* may vary with the characteristics of the trip. Populating the HE with robust empirically obtained values is immediately seen to be demanding.

As Mackie et al. (2003; p6) noted, "*In practice, Hensher (1977) omitted MPF from his calculations, no doubt because of the difficulty of obtaining suitable data, and this term has generally been ignored"*. Motivated by this assertion, and other uncertainties concerning the 'correct' specification of the HE, Batley (2015) has recently revisited the theoretical derivation of the HE from first principles. This involved solving a constrained optimisation problem, where the objective statement is one of maximising welfare, and where welfare is additive in profit generated by the employer (converted into utility units) and the utility of the employee, subject to a time resource constraint. This exercise exposed the following key properties of equation 2.

- The firm's output depends solely upon time contributed by the labour input, adjusted for the productivity of this time (hence the *p* and *q* terms), i.e. this is effectively a short run position subject to fixed capital. Productive time could, conceivably, include not only 'contracted' work time, but also a proportion of leisure time; this provokes the notion of 'effective' work time (i.e. the actual number of hours worked, which could be in excess of the contract).
- The employee's utility depends upon the quantities of 'effective' work time, 'effective' leisure time and business travel time.
- Business travel time may straddle 'contracted' work and leisure time (hence the *r* term, and the notion of 'effective' work time).
- Moreover, the *p*, *q* and *r* parameters are treated as fixed, reflecting the contract agreed between the employer and employee.

It is notable that the CSA is a restricted case of the HE where $p = r = 0$ and $VW = 0$.

Arguably the HE potentially excludes a number of benefits to the employer. Journey time savings might mean more can be accomplished in a single day than the additional time at one's desk may imply, with for example more time with clients and colleagues (the sorts of interactions that agglomeration theory asserts are important for productivity), or business travellers avoid either the cost of a night away that might be needed to spend the same amount of time in meetings or the travel time and cost of having to travel more frequently. Batley (2015) shows how the HE can be extended to include some of these potential benefits, although as far as we are aware this extension has not been implemented in practice and it relates more to long distance than local trips.

Reflecting the uncertainties concerning the 'correct' specification of the HE, it is important to acknowledge significant differences in how the HE has been specified in different contexts. With reference to the 'standard' HE of equation 2, it has generally been argued that either *MPF* is negligible or is too difficult to estimate precisely[6] and hence it is ignored (which is the position we take in this paper). We find in the literature three common restricted form variants of the HE which we have termed HE1, HE2 and HE3.

HE1

[6] Batley's (2015) derivation of the HE focusses on the case where $MPF=0$, whilst Kato's (2013) derivation considers the case where $MPF\neq0$. It might be argued that a WTP approach automatically picks up any *MPF* effect.

One view, advanced strongly by Fowkes (2001) and employed for a time in Norway, is that business travellers are on average indifferent between travelling in the course of employment and working at their normal workplace, so that $VW = 0$ and we have:

$$VBTTS = (1 - pq - r)MPL + rVL \quad (3)$$

HE2

Another view is that $r = 0$ in addition to $VW = 0$. This would seem most applicable where the vast majority of the travelling workforce are on fixed hours contracts with paid overtime or work flexi-time (i.e. receive time off in-lieu for overtime). It would also be applicable where the majority of business travel is undertaken during the 'standard' working day (e.g.. between nine and five) irrespective of the form of contract between the employee and the employer. Even where these conditions do not apply in the short run, there is an argument that in the long run all time savings accrue to the employer as employment contracts in the future will for example recognise the need for less travel in unsocial hours or the employee's time. This then gives the reduced form of the HE that underpins official recommendations for rail in Sweden:

$$VBTTS = (1 - pq)MPL \quad (4)$$

HE3

Hensher (2011, p140) stated: "*It is common in many applications to not differentiate the value of travel time savings to the employee by whether the time saved would be spent at work or on leisure, thus implicitly assuming that the private VTTS (VP) is the same in both cases, or that VW equals VL*". This assumption has been implemented in national studies in the Netherlands (Hague Consulting Group, 1990a, 1998; Significance et al., 2012) and Sweden (Algers et al., 1995), and adopted in current (previous) Dutch (Swedish) official recommendations, giving rise to the form:

$$VBTTS = (1 - pq - r)MPL + VP \quad (5)$$

where VP is a personal value for time saved on a business trip without distinguishing between whether the time saved is used for work purposes or leisure.

A rationale for this approach, apparent in the first Swedish national study (Algers et al., 1995), could be an interpretation that the estimated employee value of time savings is effectively a 'blended' value covering a mix of transferring time into leisure (VL) and work (VW). It seems though that this is a *post hoc* justification for not making any distinction, since Algers et al. (1995, p10) stated: "….. *the value of time to the employee was not differentiated depending on whether the time saved would be spent at work or on leisure and it was thus implicitly assumed that the private VoT (VP) is the same in both cases*".

In contrast, the first Dutch national study (Hague Consulting Group, 1990a) commented: *"…business travellers were asked to give their own evaluation of time losses or gain, for their own satisfaction*", which seems to point to VL, whilst in the second UK national study (Hague Consulting Group et al., 1999) the estimated private value VL has clearly been applied. Both studies used VL without weighting by r, whilst the latter study's models segmented by whether time saved went to work or leisure, which would have enabled the use of VW estimates in the HE.

Summary

Given that *VL* is expected to be somewhat less than *MPL*, and that *VP* is at most *VL*, then the VBTTS generated by the HE is expected to be less than that of the CSA, and possibly considerably so.

With regard to the *HE* relativities, HE2 will exceed HE1 given that *MPL* can be expected to be greater than *VL*. HE2 is the largest if *r.MPL* exceeds *VP*, which would be most likely to hold if *VP* is a blend of *VL* and *VW* but depends upon the value of r if, as has been the case in practice, *VP* is taken to be *VL*.

Of the three commonly used restricted HE forms, conceptually our preference is for HE1. This is on the grounds that it is least restrictive, albeit with the most significant challenges of parameter estimation. HE3 is only valid where it can be demonstrated that *VW* = *VL*.

2.3 The Cost Saving Approach (CSA), the Hensher Equation (HE) and the Marginal Product of Labour

The *MPL* is central to both the CSA and the HE, although not to the WTP approach discussed in the next section. Typically, the value of the *MPL* is taken to be the wage plus on-costs (equation 1), such as pensions, paid annual leave and maternity pay, but four main arguments have been levelled against this in the literature which are worth re-visiting.

- *Imperfect competition in the market* would lead to divergence between the value of the *MPL* and wages. However, for the higher-than-average earning section of the workforce that travels, an imperfect labour market is unlikely to exist. This is because such workers are relatively mobile and able to shift jobs to maximise their wage, thereby reducing the ability of employers to pay a wage less than the value of the *MPL*.
- *Imperfect competition in the product market* can lead to a divergence between the value of the *MPL* and the wage plus on-costs. In an imperfectly competitive goods market the wage plus on costs would equal the marginal revenue product of labour which is less than the value of the *MPL*.
- *High total product of labour at destination.* Given the costs and effort required to travel, we would expect the total product of labour at the destination for long distance trips to be higher (on average) than it is for short distance trips. From a valuation perspective, however, we are not interested in the total product of labour at the destination, but are instead interested in what alternative uses the labour would be put to given a travel time saving en route to the destination. Under conditions of perfect competition (where all alternative uses have equal value) the value for these alternative uses of labour would be valued at their marginal product (i.e. the value of the *MPL*).
- *Mis-specification of on-costs.* Typically, on-costs are taken from ongoing or periodic national labour cost surveys which include non-wage costs/benefits such as annual leave, pensions and maternity pay. These national surveys do not usually include the costs of office space and support staff, which would require bespoke surveys, and on-costs are therefore effectively short run (i.e. capital and other costs are taken as fixed). Overnight stays at destinations by employees travelling for business are also another form of on-cost. Arguably, medium or long run estimates of on-costs should be adopted.

Thus of the four main arguments against the use of the MPL we consider only two have any foundation – imperfect competition in the product market and a mis-specification of on-costs. Whether either of these two hold is of course dependent on the local economic conditions. In the UK,

the Department for Transport considers product markets to be imperfect (DfT, 2014), therefore one would expect some divergences between the MPL and wages plus on costs.

2.4 The Willingness-to-Pay (WTP) approach

The WTP approach invites the relevant economic agents, in this case the employer, to declare/reveal how much they are prepared to pay to save time in the course of business trips, that is:

$$VBTTS = WTP \tag{6}$$

In a competitive labour market, changes in the employee's disutility of travel will on average be offset by changes in the remuneration package, and this justifies the focus on employer's WTP. If however lags in adjustment mean that in the short run the benefits only accrue to the employee, who might then be prepared to pay for a time saving, the WTP will tend to be lower. This has practical significance if experimental methods tend to elicit short run rather than long run responses.

The WTP approach is intuitively simple; in principle, it captures all of the relevant benefits of saving travel time, and avoids the complications of estimating the HE parameters and the assumptions relating to *MPL*. Even if we believe that the wage rate plus on-costs reflects the *MPL* on average, this must surely vary with time of day and how the time is spent, amongst other things, and staff are usually hired as a package with employers not being able to pick and choose which hours to pay for.

Ideally, the employer's (rather than employee's) WTP should be elicited. This is by no means straightforward however; identifying appropriate people within the company to interview and the high costs of data collection represent significant problems. An alternative approach is to approximate the employer's WTP through employee-based surveys. These might take the form of an RP exercise around suitable trade-off contexts where the choices have been sanctioned by the company, or SP experiments where the focus is upon what the company would permit. Whichever approach is adopted, there exist significant challenges in eliciting the true willingness-to-pay, and these are discussed below.

3. REVIEW OF HENSHER EQUATION EVIDENCE

A reviewer of this paper remarked on the relative dearth of implementations of the HE in official national VBTTS studies, and questioned why this is the case. Our view is that the HE has seen little usage because of:

- The practical difficulty of estimating the p (or p^*), q and r (or r^*) parameters of the HE.
- Uncertainty about whether and how to populate the *VW* and *VL* terms of the HE.
- Lack of consensus about the HE's theoretical underpinnings and, therefore, uncertainty about its applicability to different practical contexts (as evidenced by the HE1, HE2, and HE3 variants above).
- Policy inertia, which has tended to weigh in favour of retaining the CSA.
- The out-turn HE VBTTS usually being relatively low, at least when compared to the CSA (a comparison which we will conduct ourselves below).

Despite some limited implementation in official recommendations, there is nonetheless a significant body of HE parameter evidence that has not hitherto been fully assimilated and reviewed.

3.1 The Hensher Equation parameters

Turning to the now substantial evidence on the *p*, *q* and *r* parameters and *VL*, we note that whilst there has been a reasonable degree of consistency in how the relevant questions have been asked across studies, which makes the evidence broadly comparable[7], the obtaining of accurate responses has not always been straightforward[8].

Eleven studies, as far as we are aware[9], provide evidence on the parameters of the HE (Hensher, 1977 [Australia]; Fowkes et al., 1986 [UK]; Algers et al., 1995 [Sweden]; Hague Consulting Group, 1990a, 1998 [Netherlands]; Ramjerdi et al., 1997 [Norway]; Hague Consulting Group et al., 1999 [UK]; Beca Carter Hollings and Ferner et al., 2002 [New Zealand]; VSS, 2009 [Switzerland]; Mott Macdonald et al., 2009 [UK]; and Significance et al., 2012 [Netherlands]). All but three of these studies (Hensher, 1977; Beca Carter Hollings and Ferner et al., 2002; VSS, 2009) estimated *VL*[10] rather than relying on *VTTS* estimates from elsewhere. Notable features of the HE literature are:

- There is surprisingly little within-study comparison of VBTTS from the HE and WTP approaches.
- The parameter *p** tends to be collected rather than *p*, where *p** represents the *average* amount of time spent working while travelling as distinct from the *marginal* amount of working time displaced by a time saving, which is what is strictly relevant.
- The parameter *r*, representing the proportion of a time saving that is reallocated to leisure, tends to be collected, but some studies have instead collected *r**, representing the proportion of business travel that takes place in leisure time.
- We are unaware of any study that has aimed to explain the relationships between *p*, *q* and *r* and the extensive set of possible causal factors.

In the report to the Department of Transport, as part of the project that funded this research, we were meticulous in spelling out how the questions were asked in each study to elicit the HE parameters (Wardman et al., 2013c).

Intuitively, we might expect a degree of systematic variation in the HE parameters. For example, *p* and *p** might be expected to be: on average lower for modes which do not provide a work-like environment; lower for very short distance journeys, given the 'fixed' costs involved in starting up productive activities; lower for those on very long journeys, who might run out of things to do or the appetite to do them; and larger for those more involved in the 'knowledge economy'. We might expect $p < p^*$ as some travellers may have completed their tasks before the journey has completed, and

[7] Contributory factors here are repeat studies, the involvement of some 'key players' across studies, and the adoption of questions administered in previous studies. The exact questions asked, and hence the degree of consistency across studies, are set out in Wardman et al. (2013c).

[8] For example, Hensher (1977) in the original application recognised that a serious problem is that respondents are likely to exaggerate the amount of time spent working while travelling and its relative productivity. A greater challenge though is to obtain accurate estimates of the marginal amount of time that would have been spent working and indeed of the amount of saved time, in the long run, that would be returned to work time.

[9] Whilst most of these are official 'national' studies, we are not aware of other publically available evidence. In part this is because the HE seldom forms official guidance and because forecasting studies tend to use the CSA or an SP approach. We are aware that the HE has been used in other studies, such as toll roads, but the results are confidential.

[10] VL is obtained in SP exercises by instructing the business travellers to assume that they would be themselves paying for the time saving for their own benefit.

hence would not have to cut back on productive use of travel time in the event of a time saving (i.e. $p = 0$).

For some work related activities whilst travelling, we would expect $q = 1$ (e.g. using a mobile phone or reading), and reduced interruption whilst travelling may lead to some tasks being more productive during travel. Relative productivity however might fall on longer journeys, if weariness sets in quicker when travelling as opposed to when working in the office.

Finally, we would expect r^* (and r) values to be zero for those who are paid overtime, receive time off in lieu of overtime or who undertake business trips entirely within usual working hours (e.g. between nine and five), but greater than zero for those who undertake business trips which fall to some extent outside of usual working hours. In the case where some of the journey is made outside of normal work hours, it is to be expected that any saved time is claimed for leisure. Thus we would expect $r > r^*$. Over time, r and r^* could conceivably rise or fall, depending on the direction and strength of various forces at play, such as the renegotiation of employment contracts to accommodate less/more travel outside of working hours, and investment in less/more transport-intensive production processes.

3.2 Within-study comparison of VBTTS from the HE, CSA and WTP approaches

We are aware of only three studies that have directly compared values obtained from the HE, the WTP approach and the CSA. Fowkes et al. (1986) remains unique in considering two WTP methods, namely employees' Revealed Preference (RP) and employers' Stated Preference (SP), whilst Hensher (1977) considered employers' SP valuations, and Algers et al. (1995) considered employees' SP valuations where respondents were instructed to follow company policy.

Table 1 sets out the findings, which for the HE covers the three variants detailed in section 2.2. The values are expressed as ratios of the CSA. The WTP values closely approximate the CSA values, with the former being only 9% higher on average and never dissimilar for any specific study or segment. This contrasts with the relationship between the HE and CSA valuations; the HE1, HE2, and HE3 values are on average 64%, 84% and 93% those of the CSA. Indeed, for our preferred HE formulation of HE1, all values are somewhat less than the CSA. They remain less in HE2 where all time saving benefits accrue to employers. It is for HE3, about which we have expressed reservations, where the values approximate those of the CSA. This pattern of findings, admittedly from a limited evidence base, would suggest that the WTP and CSA approaches are broadly similar to each other but out of line with the HE.

Table 1: Within-study comparison of VBTTS from the HE, CSA and WTP approaches

	Year	Mode	WTP/CSA	HE1/CSA	HE2/CSA	HE3/CSA	Comments
Hensher[a11]	1977	Air	0.86	0.68	0.78	1.05	Employer SP for WTP
UK	1986	Car	1.17	0.87	0.97	1.33	Employer SP for WTP
Business		Rail	1.22	0.69	0.81	1.10	
Travel		Air	1.01	0.69	0.86	1.03	
Study[b,12]		Car	1.37				Employee RP for WTP
		Rail	1.28				
		Air	0.97				
Swedish	1995	Car	0.77	0.61	0.86	0.85	Employee SP "according to
VoT		Air	1.08	0.51	0.87	0.60	company guidelines and
Study[g]		Train	1.14	0.41	0.71	0.54	rules" for WTP

Note: WTP denotes willingness-to-pay, CSA is the Cost Savings Approach, and HE1, HE2 and HE3 are the three variants of the Hensher Equation set out in section 2.2. RP and SP denote Revealed and Stated Preference.

3.3 Within-study variation in the HE parameters

Some within-study insights, particularly by mode and distance, can be obtained from Table 2 which summarises the evidence relating to the p, p^*, q, r and r^* parameters.

In general, as noted earlier, it is p^* (as opposed to p) that has been presented. The Norwegian study found that p^* falls with distance for car, but there is no such effect for the UK study. In general, and unsurprisingly, it appears that the productive use of travel time is not a significant issue for car. The figures for air and bus also indicate that, in general, little productive use is made of travel time, although as expected the p and p^* values tend to be higher for rail where the travelling environment is more conducive to work. There is evidence from the UK that p for rail falls with distance, which is supported by the Norwegian p^* figures but not the Swedish.

As for q, the evidence strongly supports a value around one[13], but perhaps surprisingly there is little variation by mode. There is also some evidence of q values in excess of one, perhaps reflecting the possibility that employees can better perform some tasks (e.g. reading) without the distractions of the usual working environment (e.g. answering the phone). The q figures that do stand out are those for Norway. The question was here asked in the same manner as other studies yet the authors offered no explanation of q values much lower than would be expected and their contrast with then existing evidence.

The r values are invariably large. On average, air has the highest r values and this is presumably because relatively long air journeys will tend to extend beyond 'contracted' work time. This will also explain the distance effects apparent in the UK rail evidence, in Norway for all modes, and to a lesser extent in the UK car evidence. The r value for car is lowest throughout, and particularly low in the case of New Zealand where journeys tend to be relatively short. Data on the types of employment contract (e.g. fixed hours with paid overtime or time off in lieu of overtime) was not available to us, but

[11] The key studies are referenced alphabetically. Appendix 1 aligns these letters with the reference list.

[12] In passing, we note that in this (Fowkes et al. 1986) study the divergences between employees' RP and employers' SP values for the three modes lay within the very narrow range of 4% to 15%.

[13] Although capping of q at 1 when applying the HE is not uncommon and reduces the overall average slightly.

the relatively high *r* values would be commensurate with a significant proportion of business travellers undertaking trips outside of usual working hours and not receiving overtime. For the UK, our analysis of the National Travel Survey indicates that a significant proportion of business trips (just under 50%) have start times or finish times that are outside of nine to five. This would seem to suggest that *r* values approaching 0.5, as seen in Table 2, could be plausible in a UK context. Modes which serve long distance travel markets (air and rail), with their associated early starts and late finishes, would also be expected to have the higher *r* values, and this can be observed in the evidence. In the main though, the *r* values are broadly consistent with our a priori short run expectations.

We observe that in the two instances where both *p* and *p** are estimated (New Zealand and SPURT) $p < p^*$, as expected. We are unaware of any studies that compare *r* and *r**, with most studies focussing on the *r* term applicable to marginal effects.

Both *p* and *q* (and also *p**) might be expected to be influenced by crowding levels. As far as we are aware, only the SPURT research study (Mott MacDonald et al., 2009) provides insights into the influence of crowding on the HE parameters. However, it was only at load factors exceeding 90% with some standing that SPURT identified a detrimental influence on productivity. At this level, *q* falls from around 1 to around 0.9. We can only speculate that *q* would be very much lower when standing is involved. Even if we accept that *q* does not vary greatly with the load factor provided seating is available, we would expect the ability to work during the journey to fall with the load factor. SPURT indicated that at 75-90% load factor, 50% of the journey on average is spent working (i.e. $p^* = 0.5$), whilst at load factors over 90% (without standing) this reduces to 38%. For standing passengers, the evidence indicates that *p** is halved. Interesting and novel though this study was, Mott MacDonald et al. (2009, p73) concluded that *"the effect of crowding, and/or seating availability, needs…to be explored further"*.

Table 2: Summary of *p*, *p, *q*, *r* and *r** evidence**

Study	Year	Mode (Observations)	*p*	*p**	*q*	*r*	*r**
Hensher[a] [12](Australia)	1977	Air Domestic (89) Air International (56)		0.36 0.19	0.61 0.51		0.55 0.31
UK Business Travel Study[b]	1986	Car (69) Train (274) Air (96)		0.03 0.20 0.14	1.01 0.95 0.99		0.32 0.42 0.42
UK VoT Study[c]	1994	Car Overall (1364) Car 10-30min (328) Car 31-60min (321) Car 61-121min (355) Car > 120min (360)		0.04 0.03 0.04 0.05 0.05	1.02 1.11 1.01 1.00 1.01	0.46 0.47 0.41 0.43 0.54	
Dutch VoT Study[d]	1988	Car (390) Train (59) Bus (20)		0.02 0.11 0.03	0.90 0.89 0.93	0.34 0.53 0.48	
Dutch VoT Study[e]	1997	Car (866) Train (226) Bus (69)		0.04 0.16 0.03	0.93 0.90 0.89	0.45 0.63 0.65	
Dutch VoT Study[f]	2011	Car (246) Train (41) Bus (11) Air (26)		0.04 0.16 0.06 0.14	0.91 0.94 0.83 1.00	0.44 0.62 0.45 0.79	
Swedish VoT Study[g]	1995	Car (200)[14] Car Self Employed (200) Air (200) Air Self Employed (200) Train Inter Urban (200) Train Self Employed (200) Train X2000 (170) Train Urban (200) Bus InterUrban (200) Bus Suburban (200) Company Car		0.14 0.10 0.13 0.11 0.28 0.23 0.28 0.18 0.13 0.17 0.19	1.01 1.20 0.97 1.02 1.03 1.08 1.04 1.15 0.93 1.26 1.11	0.54 0.66 0.84 0.85 0.78 0.75 0.79 0.82 0.85 0.86 0.47	
Norwegian VoT Study[h]	1997	Car Inter (203) Air (367) Train Inter Urban (148) Bus Inter Urban (73) Ferry (203) Car Urban (138) PT Urban (37)		0.03 0.07 0.18 0.06 0.03 0.21 0.30	0.32 0.28 0.39 0.20 0.19 0.02 0.07		0.57 0.64 0.72 0.74 0.63 0.39 0.43
New Zealand VoT Study[i]	2002	Car (420)	0.03	0.22	0.93	0.28	
Swiss VoT Study[j]	2003	Car (62)	0.64		0.98	0.51	
UK Study of Productive Use of Rail Time (SPURT)[k]	2009	Train Overall (1660) Train < 45min (714) Train 45-89min (631) Train 90-149min (249) Train 150min+ (66)	0.41 0.60 0.35 0.28 0.22	0.46	0.97 0.98 0.97 0.98 0.96	0.52 0.48 0.51 0.56 0.65	

Note: Evidence relates to IVT. PT is a combination of bus and rail, including tram and metro, and X2000 is a fast train in Sweden. *p* is the proportion of travel time saved that is at the expense of work done while travelling and *p** is the proportion of time spent working while travelling. *r* is the proportion of time saved converted to leisure and *r** is the proportion of business travel that takes place in leisure time. *q* is the relative productivity of work done while travelling compared to the workplace.

[14] This study did not specify the exact sample size for each category. It stated that "around 200 interviews" were collected for each mode and also for the self-employed with "about 170" for the Gothenburg to Stockholm X2000 train. The number for company car was not given.

3.4 Cross-study variation in the HE parameters

With regards to p^*, the three sets of Dutch figures in Table 2 indicate that p^* for train increased slightly between 1988 and 1997, but this increase seems to have come to a halt in the 2011 study. A larger increase is evident from comparing the two p^* values for UK rail. Rather clearer is the evidence that the p^* values for car and bus remain very low over time in the Netherlands, and this is also the case for the two UK studies yielding p^* values for car. Nonetheless, analysis that explains within-study variations in p and p^*, which is noticeably lacking, would have helped to interpret cross-study variations.

The values of q vary little over studies and time, with the exception of the unexplained reductions in the case of Norway.

As far as r is concerned, evidence from the Netherlands suggests an increase over time for all modes between 1988 and 1997, before stabilising and indeed decreasing in the case of bus over the subsequent years. An increase in r is also apparent in UK evidence for rail and car. This effect might be explained by the shift towards a service sector economy with more flexible working practices.

3.5 Cross-study comparison of VBTTS from the HE and CSA approaches

The implications of the HE relative to the CSA are reported in Table 3 for each of the three variants of the HE set out in section 2.2 above, and using the reported p (or p^*), q, and r (or r^*) values as available.

As might be expected, HE1 almost always accounts for the largest reduction upon the CSA, with the largest (smallest) reductions generally for rail (car) due to the relative amount of productive travel time use. The results for air are bi-polar, with appreciable increases over the CSA driven by large personal values, and significant reductions on the CSA value where a large proportion of business travel is undertaken outside of usual working hours.

As noted earlier, the relationship between the HE2 and HE3 values depends upon the balance between $r.MPL$ and VP, and in 21 (57%) of the 37 cases HE2 provides the lower VBTTS. Here it is only really for train where there are any large reductions in the VBTTS below that implied by the CSA.

Table 3: Comparison of VBTTS estimates from the Hensher Equation and Cost Savings Approach

Study	Year and units	Mode	*MPL*	*VL*	HE1	HE2	HE3
Hensher[a 12] (Australia)	1977 ($/hr)	Air Domestic	5.10	4.20	3.49 (68%)	3.98 (78%)	5.38 (105%)
		Air International	6.64	4.20	5.24 (79%)	6.00 (90%)	8.14 (123%)
UK Business Travel Study[b]	1986 (£/hr)	Car	10.32	7.02	8.95 (87%)	10.01 (97%)	13.72 (133%)
		Train	9.89	7.02	6.81 (69%)	8.01 (81%)	10.88 (110%)
		Air	11.95	7.02	8.22 (69%)	10.29 (86%)	12.29 (103%)
UK VoT Study[c]	1994 (£/hr)	Car	17.93	4.02	10.80 (60%)	17.20 (96%)	12.97 (72%)
Dutch VoT Study[d]	1988 (f/hr)	Car	44.69	21.20	35.90 (80%)	43.89 (98%)	49.89 (112%)
		Train	36.52	14.00	21.00 (58%)	32.94 (90%)	27.59 (76%)
		Bus	28.46	11.30	19.43 (68%)	27.67 (97%)	25.31 (89%)
Dutch VoT Study[e]	1997 (f/hr)	Car	50.97	23.90	36.89 (73%)	49.07 (96%)	50.04 (98%)
		Train	51.41	19.20	23.71 (46%)	44.00 (86%)	30.82 (60%)
		Bus	37.57	11.60	19.69 (52%)	36.57 (97%)	23.75 (63%)
Dutch VoT Study[f]	2011 (€/hr)	Car	25.64	12.75	19.04 (74%)	24.71 (96%)	26.17 (102%)
		Train	18.40	15.50	13.83 (75%)	15.63 (85%)	19.72 (107%)
		Bus	17.17	10.50	13.31 (78%)	16.31 (95%)	19.08 (111%)
		Air	39.12	85.75	70.48 (180%)	33.64 (86%)	88.49 (226%)
Swedish VoT Study[g]	1995 (SEK/hr)	Car	195	104	118.29 (61%)	167.43 (86%)	166.13 (85%)
		Car Self Employed	138	104	99.00 (72%)	121.44 (88%)	134.36 (97%)
		Air	207	118	106.14 (51%)	180.89 (87%)	125.01 (60%)
		Air Self Employed	184	118	107.25 (58%)	163.36 (89%)	124.96 (68%)
		Train Inter	171	104	69.42 (41%)	121.68 (71%)	92.30 (54%)
		Train Self Employed	178	104	78.28 (44%)	133.78 (75%)	104.28 (59%)
		Train X2000	181	113	74.57 (41%)	128.29 (71%)	98.30 (54%)
		Train Regional	160	80	61.28 (38%)	126.88 (79%)	75.68 (47%)
		Bus Inter Urban	128	98	87.02 (68%)	112.52 (88%)	101.72 (79%)
		Bus Regional	129	80	59.23 (46%)	101.37 (79%)	70.43 (55%)
		Company Car	189	104	109.19 (58%)	149.14 (79%)	164.31 (87%)
Norwegian VoT Study[h]	1997 (NOK/hr)	Car Inter Urban	185	185	183.22 (99%)	183.22 (99%)	262.77 (142%)
		Air	201	313	268.74 (134%)	197.06 (98%)	381.42 (190%)
		Train Inter Urban	153	118	117.06 (77%)	142.26 (93%)	150.10 (98%)
		Bus Inter Urban	132	59	76.40 (58%)	130.42 (99%)	91.74 (69%)
		Ferry	161	102	122.91 (76%)	160.08 (99%)	160.65 (100%)
		Car Urban	170	87	136.92 (81%)	169.29 (100%)	189.99 (112%)
		PT Urban	131	80	106.32 (81%)	128.25 (98%)	151.92 (116%)
New Zealand VoT Study[i]	2002 ($/hr)	Car	23.40	10.69	19.19 (82%)	22.75 (97%)	26.89 (115%)
Swiss VoT Study[j]	2003 (CHF/hr)	Car, Rail, Bus	66.50	59.61	21.28 (32%)	24.79 (37%)	50.49 (76%)
SPURT (UK)[k]	2009 (£/hr)	Rail	39.09	17.80	12.47 (32%)	23.54 (60%)	21.02 (54%)

Note: *MPL* denotes the value of the marginal product of labour, *VL* is the employee's value of a personal time saving on a business trip, and HE1, HE2 and HE3 are the three Hensher Equation variants discussed in section 2.2. Figures in brackets represent the HE figures as a proportion of *MPL*. X2000 is a fast train in Sweden.

Table 4 summarises the estimates of VBTTS using the HE relative to those using the CSA, segmenting by mode. HE1 provides a significant challenge to the conventional CSA, with values that are on average, for all modes except air, somewhat less than *MPL*. Note however that the discrepancy would be reduced if estimates of p were available instead of p^*, all else equal. Turning to HE2, if in practice all time saving benefits accrue to the employer ($r = 0$), then it is only for train where there is a large difference between the VBTTS and CSA, and the figure supports the official Swedish practice of a 15% discount of rail VBTTS to account for productive use of time. HE3 seems to indicate that the CSA would be appropriate for car and air but not for the surface public transport modes, although we have expressed reservations about this formulation. Whilst based on only three observations, we note that the self-employed figures are somewhat less than one and we return to this below.

Turning to Table 4, where we collate the values from Table 3 and express the VBTTS for the HE as a proportion of that for the CSA, we note that the ratios for all modes are very similar to the within-study comparisons in Table 1, which were 0.64, 0.84 and 0.93 respectively for HE1, HE2 and HE3.

Table 4: VBTTS from the HE as a proportion of those from the CSA

	HE1	HE2	HE3
All	0.69 (0.05) [37]	0.87 (0.02) [37]	0.95 (0.06) [37]
Car	0.71 (0.05) [11]	0.89 (0.06) [11]	1.03 (0.07) [11]
Train	0.53 (0.06) [9]	0.80 (0.04) [9]	0.73 (0.08) [9]
Bus	0.64 (0.05) [7]	0.93 (0.03) [7]	0.83 (0.09) [7]
Air[15]	0.97 (0.20) [6]	0.88 (0.03) [6]	1.35 (0.25) [6]
Self-Employed	0.58 (0.08) [3]	0.84 (0.05) [3]	0.75 (0.11) [3]

Note: HE1, HE2 and HE3 are three variants of the Hensher Equation set out in section 2.2. The Figures are mean, (standard deviation of the mean), and [observations]

The 'battleground' here seems to centre on the choice between HE1 and HE2 and whether r is zero or not, although the evidence provides clear support for $r > 0$ at least in the short run and therefore for HE1 over HE2. Note from Table 2 that in around 30% of cases, $p + r$ is little different to or exceeds one with r being the main contributor. Whilst p can be expected to increase over time with technological developments, high levels of r effectively reduce the benefits of time savings to employers. The implications of the HE for VBTTS are not so much the productive use of time, particularly for train which seems to have dominated policy debate in the area, but longer distance journeys where r can be expected to be higher. On the other hand, if r is zero or very low in the long term , and given that the appropriate measure of p is less than the typically used value of p^*, then the HE-based VBTTS would not seem to diverge greatly from the CSA.

4. REVIEW OF EUROPEAN WILLINGNESS-TO-PAY EVIDENCE

We now turn to valuation evidence obtained entirely from revealed or stated willingness-to-pay for time savings in the context of briefcase business travel. We had at our disposal a dataset, accumulated over many years, of WTP-based UK value of time evidence (Abrantes and Wardman 2011) which had been supplemented with mainland European evidence (Wardman et al., 2013a). For purposes of the present analysis, we identified the subset of data which related to VBTTS specifically,

[15] When we remove the two observations with what might be regarded as suspect *VL*s for air travel, the respective means are much lower at 0.67, 0.85 and 0.98., somewhat nearer to but still larger than the figure for train.

giving rise to 330 employee-based monetary values from 122 studies and 17 European countries that reported between 1968 and 2011. This WTP dataset excludes valuations that are explicitly *VL* and does not include valuations obtained directly from employers[16]. Notable features of this WTP literature are:

- There are few direct comparisons of employee WTP values with those from the HE and CSA[17] and none, as far as we are aware, of employee RP and SP values.
- The WTP evidence distinguishes by mode, distance, type of time and year. There has been little consideration of whether the variation in WTP-based values according to these attributes is consistent with the CSA and HE.
- There has been no comprehensive review of the large amount of European WTP-based evidence.

4.1 Values of time and labour costs

According to the CSA, the VBTTS is equal to *MPL* and makes no distinction between in-vehicle time (IVT) and walk and wait (OVT) time. We here compare evidence on WTP values of IVT and OVT with labour costs. However, in contrast to the HE comparisons in section 3, where the *MPL* figures were derived from the actual incomes of those in the studies, here we are hampered by not having the income values for the samples upon which the WTP evidence was estimated[18]. Instead we compare study-specific WTP values with national averages. Moreover, we do this for the UK and mainland Europe separately since we have more robust evidence for the UK, where the labour costs are for travelling workers weighted by distance travelled (Department for Transport, 2013). The mainland European values are based on the EUROSTAT national average wages, and here we have made adjustments in an attempt to convert to business travellers' wages[19].

To put the WTP values on a consistent basis, they have been expressed in 2010 prices and adjusted to 2010 income levels using an elasticity of VBTTS with respect to income of one. Table 5 summarises the WTP evidence. The labour costs vary between IVT and OVT and between data type because they are drawn from different countries.

Table 5: RP and SP business values for UK and rest of Europe (2010 prices and incomes)

	UK £ per hour		**Europe € per hour**	
	RP	**SP**	**RP**	**SP**
In-vehicle time	34.7 (9.4) [6]	21.9 (1.7) [165]	36.2 (3.9) [34]	33.2 (2.5) [94]
Labour costs[17]	Car 22.74 Rail 26.86		38.7 (1.8) [34]	35.0 (1.6) [94]
Out-of-vehicle time	-	25.1 (4.1) [21]	48.8 (16.2) [4]	50.5 (3.8) [6]
Labour costs[17]	Car 22.74 Rail 26.86		40.7 (8.3) [4]	45.7 (3.8) [6]

[16] The emphasis here is therefore upon approximating employer valuations from employee-based RP and SP surveys; we are only aware of one employer-based WTP survey (Fowkes et al., 1986). Evidence that is explicitly *VL*, where business travellers were informed that they would have to pay for the time saving themselves, must clearly be removed.

[17] The limited evidence that exists was covered in section 3.

[18] The original review studies that assembled this data did not collect study specific income levels on the grounds that it would not have been possible to construct a complete and consistent income measure across studies. In any event, the income levels are often household related which are not the relevant basis for the *MPL* of VBTTS.

[19] In arriving at the mainland European figures, we have adjusted the EUROSTAT mean gross labour cost per country to better reflect the wages of the business travelling public. We have done this by using the ratio of the UK mean gross labour cost for business travellers relative to the national average. This implies a 32% uplift, which seems reasonable.

Note: RP and SP denote Revealed and Stated Preference values respectively. Figures are mean, (standard deviation of the mean), and [observations].

In 2010 prices and incomes, the official UK resource VBTTS is £22.74 per hour for car drivers and £26.86 per hour for rail travellers. These are distance-weighted and fall to £19.03 and £25.78 respectively on a trip basis. The average RP value of IVT is £34.7 per hour, which exceeds by some margin the official values, although admittedly based on only six observations. The UK-based SP values are somewhat lower than the RP values. Whilst they are only significantly different at the 24% level, and are slightly lower than the official CSA values, we return to the issue of SP values below. The OVT values from SP are a little higher (15%) than the IVT values, but not significantly different.

For the rest of Europe, the mean RP value of IVT of €36.2 per hour is similar to that for the UK[20] for broadly similar incomes[21], although there is here much less divergence between the RP and SP valuations. The mean RP and SP valuations approximate the mean gross labour costs, at 94% and 95% respectively.

Remaining with the rest of Europe, given that labour costs differ little between the OVT and IVT samples for the RP evidence, any difference in VBTTS can be attributed to whether there is a premium valuation for OVT. It turns out that the OVT values are 35% higher, somewhat less than is typically the case for non-business trips. Comparing the mean OVT and IVT valuations for the SP data, the former are 52% higher but this partly reflects 31% higher incomes in the relevant sample. This implies OVT values that are 16% higher after accounting for income differences, very much in line with the figure of 15% for the UK evidence.

The SP values, although lower than the RP for IVT, are sufficiently high, particularly when compared with the gross wage rate, that we conclude they must reflect a significant element of company policy, and in fact the SP OVT values exceed their RP equivalents. Indeed, we can point out that eight of the studies covered in section 3 provided a directly estimated *VL* alongside the *MPL,* and the ratio of the two averaged 0.58. There are, however, a number of concerns surrounding the employee-based RP and SP evidence.

The RP valuations can only be assumed to reflect company policy if either the company is driving purchase decisions or else individuals are making decisions as agents following company policy or acting in its best interests. However, SP exercises can place the respondent in somewhat different contexts where there is more uncertainty as to what is allowed. They may unrealistically assume that the company will pay whatever is needed, whilst others might bring personal preferences into account, such as claiming time savings for their own use, or else avoiding time savings if this would mean that work would have to be done elsewhere or that overtime payments would be reduced. Yet others might respond as though it is their own money being spent to save time.

Matters are not helped by the somewhat 'cavalier' attitude that typify SP exercises offered to business travellers; it is often not made explicit whether the company or individual is paying and who inherits

[20] Using an exchange rate of €1 = £0.88, the mean UK RP value is €39.4 per hour.

[21] RP business valuations, with the proportionate contribution per country in brackets, were obtained for Denmark (16%), France (10%), Germany (6%), Greece (6%), Netherlands (28%), Norway (6%), Poland (3%), Portugal (3%), Spain (13%) and Sweden (6%). The mean GDP per capita is €36700 compared to €30120 for the UK. The SP valuations follow a broadly similar pattern and imply a mean GDP per capita of €34,987.

the time savings[22]. Whilst SP values in general might be too low due to protest/strategic bias against (in favour of) cost increases (reductions), the incentive to such bias can be expected to be different for business travel. On the one hand, price variations will be less contentious when respondents are dealing with the company's money rather than their own. On the other hand, they may take the view that they are spending someone else's money and hence express an exaggerated willingness-to-pay, even to the extent of assuming the company will pay for a time saving 'come what may'. On balance, we think the former will be stronger so that for well-instructed respondents the incentive to protest response is less than for private travel.

Taken as a whole, the WTP values are broadly in line with the CSA values, and are therefore higher than the HE values. However, there is some evidence (albeit based on a small sample) that OVT attracts a premium for business travel, but not to the extent typically observed for non-business travel. This finding is not in line with the CSA.

4.2 Variations in VBTTS

Although we have surrounded the RP and SP methods with some caveats, such concerns can be expected to relate more to absolute values rather than to variations in values. On this basis, the WTP evidence can be analysed to identify variations in VBTTS which can then be compared with analogous properties under the CSA and indeed the HE.

Table 6 reports the results of a regression analysis of how the 330 IVT and OVT values vary across studies. The dependent variable was the logarithm of VBTTS in € per minute and 2010 prices. The independent variables were either dummy variables, whereupon the exponential of their coefficient estimate denotes proportionate effects on VBTTS, or continuous variables such as GDP per capita, which are entered in logarithmic form and their coefficient estimates are elasticities. Coefficient estimates significant at the 10% level have been retained.

Not reported in Table 6 are the study specific 'fixed effects'. Of the 122 studies, 19 had significant coefficients representing factors such as study quality or the approximations involved in placing valuations on a common basis. The adjusted R^2 goodness of fit was a respectable 0.57 given the diverse nature of the studies. The only significant country-specific effect, in line with the results in Table 5, was for UK-based SP values.

Table 6: Meta-Analysis Business Travel Values of In-Vehicle Time (IVT) and Out-of-Vehicle Time (OVT)

Variable	Coeff (t)	Effect
Constant	-7.833 (9.1)	
GDP per capita	0.656 (7.8)	
Air Used	0.384 (2.2)	+47%
Bus Used	-0.593 (3.4)	-45%
RP	0.174 (1.7)	+19%
Inter-urban-IVT	0.483 (6.2)	+62%
Inter-urban-OVT	0.768 (5.5)	+116%
FreeFlowTime	-0.394 (2.7)	-33%
Toll Numeraire	-0.467 (4.4)	-37%

[22] This is in stark contrast to the studies that specifically value *VL* in terms of who pays, although not always in terms of the use to which the time savings are put. These are typically the national value of time studies, as opposed to studies which incidentally deliver VBTTS.

Forecasting -SP	0.336 (4.2)	+40%
UK SP	-0.695 (8.5)	-50%

Note: The 'Effect' column denotes the proportionate effect relative to the base of a categorical variable.

GDP/capita and trend

A property of the CSA is that VBTTS should increase in line with income with no independent time trend. Our initial concern was that a time trend might be highly correlated with trend growth of GDP/capita. It emerged that the correlation between their coefficient estimates was only -0.33. The time trend turned out to be negligible, with a t-ratio of 0.1 and no discernible impact on the estimated GDP/capita elasticity, and is not therefore included in the reported model.

The GDP/capita elasticity is, though, significantly different to the CSA requirement that it increases in line with income (i.e. has an elasticity of one). This might be because as economic activity increases, there is tendency for lower income employees to enter the business travel market, whereupon the GDP variation will overstate the income variation. This is certainly the case in the UK where the recent update to official VBTTS found that business travellers' incomes have not increased in line with GDP/capita (Laird et al., 2013).

Distance

The CSA only permits differences in VBTTS by distance insofar as longer distance travellers have higher incomes, which tends to be the case. Our dataset contains a representative measure of distance for each study, but a better fit was achieved by simply distinguishing between urban and inter-urban journeys. We have recovered highly significant incremental inter-urban coefficients for the IVT values (*Inter-urban-IVT*) and the OVT values (*Inter-urban-OVT*), which indicate that they are 62% and 116% higher than their urban equivalents. We would suggest that such variations are higher than would be implied by income variations by distance, thereby challenging the CSA, and they certainly are in the UK context where average incomes for inter-urban business travellers are 40-50% larger than for urban business travellers (based on our analysis of the National Travel Survey).

Time attributes

The CSA treats all aspects of time the same, although the WTP results given in Table 5 do not lend support to this convention. We specified a dummy variable denoting OVT but its coefficient estimate was far from significant. However, the inter-urban effect is, as noted, far larger for OVT than for IVT, implying OVT values that are 33% higher than IVT values. At least in this market[23], the pattern of results is out of line with CSA expectations, as is the somewhat lower value attached to time spent in free flow (*FreeFlowTime*) compared to congested traffic.

Mode

The CSA only permits modal variations insofar as there are income differences. We distinguished between mode used, which tends to proxy for income, and mode valued, which is related more to variation in IVT valuations due to comfort-related factors. The main effects were for mode used. The two reported modal coefficients relate to air (*Air Used*) and bus (*Bus Used*). The lower (higher)

[23] 75% of the business OVT values are for inter-urban travel.

VBTTS for bus (air) users compared to car and train presumably reflect their lower (higher) incomes, and such variations are in line with the CSA.

Design issues

In line with the results reported in Table 5, the RP-based values were found to be higher than their SP equivalents, although only by 19%. Two further interesting and related findings emerged.

The VBTTS estimates expressed in equivalent units of toll (*Toll Numeraire*), as opposed to fuel costs or public transport/air fares, were found to be very much lower. This is not admissible under the CSA since money is money.

We have stated that there has been a cavalier attitude towards the instructions surrounding the SP exercises. Our impression is that where the purpose of the SP study was forecasting, as opposed to valuation, then there tended to be more emphasis on instructing respondents that company policy should be followed., Its coefficient (*Forecasting-SP*) turned out to be highly significant and implies a VBTTS that is 40% higher.

Implied VBTTS

In addition to examining variations in VBTTS, we can use the estimated model to provide absolute VBTTS estimates. By way of illustration, the implied VBTTS for a UK inter-urban rail trip based on RP data, given a GDP per capita of €30,119, would be €39.79 (£35.02) per hour, falling to €23.35 (£20.54) for SP data where the purpose of the study was forecasting. These would be the same for car trips in congested conditions, although a third lower in free flow traffic. As for urban trips, RP-based values would be €24.55 (£21.60) per hour for rail and for car in congested conditions and €16.55 (£14.57) per hour for car in free flow conditions. These values broadly align with those reported in Table 5 for the UK. If we take the RP values as more closely reflecting company WTP, they bound the gross labour costs and can be taken to be broadly in line with the overall CSA values.

4.3 Other WTP evidence

A meta-analysis of 436 worldwide VBTTS by Shires and de Jong (2009) included CSA observations. In contrast to our results, the RP values were found to be 38% lower than the CSA and the SP values 33% lower. However, no explanation was offered for these important findings.

In a broader review of evidence from which the present paper has been drawn (Wardman et al., 2013b), 11 high speed rail SP studies including three from outside Europe were reviewed, on the grounds that this mode is aimed at briefcase business travellers. These yielded 24 VBTTS observations. 15 of these values could be compared with official VBTTS recommendations and on average they were 20% larger. The remaining 9 VBTTS observations could be compared with the average national gross wage plus on-costs and were 116% larger.

4.4 Company Policy and Stated Preference WTP

We have discussed potential problems in obtaining both company and personal valuations from employees. In the former case we indisputably want company policy to influence SP responses, whilst in the latter case we most certainly do not.

With regards to company WTP, as we have shown earlier, this has been almost entirely drawn from employees and based upon SP. Not only has there been poor or no instruction regarding company policy, but also a dearth of exploratory investigation regarding the sorts of policies and purchasing procedures companies have, their employees' awareness of them, and how these work through into decisions and hence implied VBTTS when employees are faced with the opportunity to save time by spending money[24].

Accent et al. (1989) conducted two computer-assisted SP exercises amongst long distance rail business travellers. The first (SP1) offered pairwise choices between two options characterised by ticket type, ticket price and journey time, after which a large number of questions were asked about company travel policy, booking arrangements, reimbursement, awareness issues and the impact on actual decision making. The second exercise (SP2) then offered pairwise choices between rail and other modes of travel with respondents reminded of their company's travel policies. This had a clear impact, as is apparent in Table 7. In all but one case, the SP values were lower when there was a greater incentive to account for company policy[25]. The variation was larger than that attributable to conventional indicators such as income, profession, company size and type.

The expected impact of accounting for company policy is not clear. On the one hand, if respondents had generally assumed that they were spending their own money, then this instruction would have increased values. On the other hand, if they had assumed the company would pay 'come what may', reminding them of company policy would tend to reduce values. It seems that the latter might have prevailed here, but in any event we should note that the SP2 values with the company policy reminder were very much in line with the then official UK rail VBTTS of £12.1 per hour.

Table 7: VBTTS and company policy (£ per hour, 1989 prices and incomes)

Trips to/from London	SP1	SP2	SP2/SP1
First Class			
Swindon	31.2	13.8	0.44
Cardiff, Manchester, Newcastle	54.0	16.8	0.31
Standard Class			
Swindon	6.0	9.6	1.60
Cardiff	18.0	13.8	0.77
Manchester	18.0	12.0	0.67
Newcastle	18.0	12.0	0.67

Source: Accent et al. (1989)

Given the uncertainties surrounding the status of SP-based WTP values, a potentially fruitful avenue of research is to compare values for the self-employed with those for employees, given that in the former case issues surrounding company policy are internalised. Algers et al. (1995) used SP methods to estimate the 'private' VBTTS (i.e. *VL*), as an input to the HE, and separately what they

[24] At the very least, it would be informative to establish whether, for example, companies were more prepared to countenance expenditure when employees were making long journeys, particularly in their own time, for trips deemed to be more important and to avoid walking and waiting, all issues that challenge the CSA. Indeed, an enlightened approach might be simply to find out under what circumstances companies are prepared to pay differential amounts to save travel time.

[25] Given that two separate models were estimated, strictly speaking we should not compare coefficients across them, particularly given the choice contexts are different, and hence we cannot determine whether the cost coefficient was higher on account of respondents taking employers' costs more seriously.

termed a 'behavioural' VBTTS (i.e. *WTP*), where employees were instructed to follow company policy as opposed to paying for the time saving with their own money. In addition, a separate SP exercise was conducted on the self-employed (*Self)*. The three sets of values are reported in Table 8 along with an overall *MPL*.

What we observe is that for any income level, the VBTTS for *Self* falls somewhat short of *WTP*, to the extent that they are clearly not measuring the same thing. It may be that this category recognises that there is productive use of travel time and not all time saved converts to extra productivity. We note that the HE for the self-employed yields SEK per hour values of 99 for car, 77 for inter-city train, 108 for air and 75 for X2000 which, with the exception of the latter, correspond closely with the VBTTS for *Self.* The *Self* values are clearly somewhat lower than *MPL*, but remarkably consistent with *VL*.

These relationships imply that the *WTP*-based on company policy might be too high. Inspection of *WTP* relative to the *MPL* might also lead to the same conclusion for Air and particularly for the X2000 train.

Table 8: Self-Employed and Employed Values from Swedish 1995 National VoT Study(SEK/hr)[26]

Income	**Car**			**Inter City Train**			**Air**			**X2000 Train**		
(SEK k/pa)	*Self*	*VL*	*WTP*	*Self*	*VL*	*WTP*	*Self*	*VL*	*WTP*	*Self*	*VL*	*WTP*
-100	80	81		74	83		89	91		126	90	
101-200	73	94	161	67	97	147	81	106	227	115	104	296
201-300	112	101	182	103	104	166	124	113	258	176	112	336
301-400	138	139	213	128	143	195	154	156	303	218	154	395
401-		144	206		148	189		161	293		159	381
MPL	138	195		178	171		184	207		(a)	181	

Note: *Self* denotes values for the self-employed, *VL* is an employee's personal value of time saved during a business trip for own use and *WTP* denotes willingness-to-pay. This figure (a) was not reported in the paper. X2000 is a fast train in Sweden. Source: Algers et al. (1995).

Turning now briefly to private values (*VL*) and the subject of company policy, here a respondent is instructed that they must pay for the time saving with their own money or else they have a fixed reimbursement. Company policy is therefore irrelevant and should be ignored. As with approximating company policy for company-based values, matters are not always straightforward in this context. The first Dutch study (Hague Consulting Group, 1990b) found the cost sensitivity for public transport business travellers to be 37% lower where the employer reimbursed some or all of the cost, even though respondents were told to assume that they would themselves have to pay for all costs directly. Hague Consulting Group (1990a, p25) commented that: *"Although we asked business travellers to respond as if they were spending their own money, it is inevitable that there will be some influence from the fact that such trips are often paid for by the employer"*.

5. CONCLUSIONS

5.1 Summary

[26] The ratios of WTP to CSA in Table 1 are lower because they include the self-employed values.

We have here reviewed a large amount of international evidence relevant to the value of business travel time savings (VBTTS), covering the traditional cost savings approach (CSA), the Hensher equation (HE), and the willingness-to-pay (WTP) approach. Indeed, this is the most extensive review ever undertaken of the VBTTS literature. We have demonstrated theoretical and empirical relationships between the different approaches and summarised evidence on the key parameters.

Whilst the CSA and HE have both been used to underpin official VBTTS recommendations, albeit with the former dominating, the WTP approach has not achieved such status; this is despite a view that the CSA and HE are simply special cases of WTP, since if either the CSA or the HE are 'true' representations of the VBTTS then the company, or hopefully its agents, can express a WTP that reflects that valuation.

An attraction of the WTP approach is its basis in real-world decision making, reflecting companies' revealed VBTTS from the decisions they make or allow, and avoiding the need to estimate the value of the marginal product of labour (*MPL*) directly. It is free from restrictive assumptions as to how companies do or should value savings in its employees' travel time. In practice though, analysis of such choices is far from straightforward, as evidenced in the very few, and now dated, studies that have covered employer's WTP. We are instead reliant on VBTTS obtained from the Revealed Preference (RP) and Stated Preference (SP) choices of employees which, despite being an extensive evidence base, do not necessarily reflect employer valuations.

The HE is intuitively appealing, providing a contrasting 'bottom-up' compositional approach that can be argued more readily supports spatial and temporal transferability. But there are significant challenges and uncertainties surrounding the estimation of its wide range of parameters. Nor can we be sure that this is how companies actually value their employees' time savings, and indeed this is an area where we recommend that detailed exploratory research is long overdue.

The CSA has the attraction of simplicity in application but its underlying assumptions seem increasingly tenuous.

We therefore have to accept that there is no empirical 'Gold Standard' against which to assess other approaches. Nonetheless, our review and critical appraisal provides important insights in the following key areas:

- What actually are the differences between the VBTTS of the different approaches?
- Given its dominance in official appraisal practice, is the CSA empirically justified?
- How do the empirically-based WTP and HE variations compare?
- How should business travel time savings be valued?

5.2 Summary of VBTTS from different approaches

Across the three studies that directly compare the WTP, CSA and HE approaches, the findings suggest that the WTP and CSA values are broadly similar, with some support for rail WTP values exceeding the CSA, whilst the HE values are lower than the CSA, with the largest discrepancy being for rail. When we compare evidence across different studies, the pattern of results is broadly similar to this, whilst evidence for high speed rail also suggests rail VBTTS in excess of the CSA.

This contrasting evidence means that we do not have any firm basis on the back of the overall findings for preferring one method over the other. Indeed, a number of factors will have 'muddied' the relationships, such as uncertainties regarding the legitimacy of the often large *r* values in the HE, the

accuracy of the *MPL* estimates and mixed evidence on the impacts of company policy, amongst other issues. Indeed, such a 'stalemate' lends a degree of support to the retention of the 'status quo' CSA in official appraisal guidance, much as did the similarities in values across methods apparent in the pioneering Fowkes et al. (1986) study.

5.3 Is the CSA empirically justified?

Recognising the concerns surrounding the absolute values provided by the HE and WTP approaches, we might reasonably expect their evidence on variations in VBTTS to be more reliable. We can exploit this evidence in assessing several key properties (*in italics below*) of the CSA.

The CSA regards all types of time to be the same. The WTP evidence covered here indicates that business travel time spent walking, waiting and in congested driving conditions is of premium value[27].

The CSA only distinguishes distance effects insofar as they are driven by income variations. There is WTP evidence that the VBTTS varies more by distance than would be implied by income variations alone.

The CSA only distinguishes modal effects insofar as they are driven by income variations. The WTP evidence is consistent with this but the HE evidence implies quite large variations by mode independent of income variations.

The CSA requires the VBTTS to increase over time in line with income growth. Whilst there is WTP evidence that the VBTTS growth is less than income growth, this may be due to lower income business travellers entering the market. Nonetheless, there was no trend effect in the WTP evidence independent of income.

Given the theoretical concerns over the CSA, the differences in absolute values across methods and the evidence on variations in valuations, we conclude that the CSA does not provide an appropriate basis for VBTTS for briefcase travellers and alternative approaches need to be identified. We therefore attribute the similarity between some CSA values and WTP values to coincidence.

5.4 How do the WTP approach and HE compare?

If we accept the view that the CSA approach is not justified, we inevitably have to compare the merits of the two alternative approaches. The values from the WTP approach exceed, sometimes by a large margin, the HE values. It might be possible to reconcile the two if, key amongst other things, the *MPL* is significantly larger than the wage rate plus on-costs, if the proportion of travel time saved that is used for leisure (*r*) in the HE is near to zero, or if there are biases in the employee WTP values. So we again turn to the variations in VBTTS to compare the two approaches.

Whilst there is little evidence, it is hard to believe that the proportion of travel time saved that is at the expense of work done while travelling (*p)* and the relative productivity of work done while travelling relative to at the workplace (*q)* in the HE would not be relatively low for walking and waiting time whilst

[27] In principle, the HE could provide insights here (for example, because the opportunities to spend walking and waiting time productively are likely to be less) but we are not aware of its application other than to travel time. Similarly, there is limited systematic evidence on how the various HE parameters vary with distance or crowding levels. Wardman and Whelan (2011) reported WTP crowding multipliers for business travellers in excess of one.

VL would be relatively high. On balance, we would expect VBTTS for walking and waiting time to have a premium value and this is in line with the WTP evidence.

The WTP evidence indicates that the VBTTS is larger for longer distances. Matters are less clear for the HE; *p* is unlikely to be maintained for longer distances, for which there is some empirical support, and *VL* may well increase with distance as might *MPL*. In contrast, there is evidence that *r* is somewhat larger for longer distance journeys, where there is a greater tendency to be making journeys out of normal hours, but then there is the question of how *r* will vary in the long run.

The WTP evidence across modes suggests that values follow income, being relatively high for rail and air. In contrast, the HE evidence is quite clear; its lowest values by some margin are for rail (due to productivity issues) with some support for air being low.

Independent of income variations, the HE would imply falling VBTTS over time with the expected and observed increases in *p* and *r*. The WTP evidence does not indicate any inter-temporal variations apart from income.

In summary, the HE and WTP approaches are not telling the same story with regard to variations in VBTTS. As in principle we would expect a fully specified HE to give similar results to WTP, this would suggest either the HE is not specified sufficiently well or there exists a bias in the WTP data. Our review indicates that both are possible.

5.5 How should the value of business travel time savings be estimated for briefcase travellers?

We have concluded that the CSA is not a suitable basis for VBTTS. As for the other two candidate approaches, the evidence is clear in being unclear! The HE and WTP approaches provide both somewhat different VBTTS and variations in them. We do not feel that the existing evidence, extensive as it is, provides a clear basis for how the VBTTS should be estimated, particularly since both the HE and WTP approaches face significant difficulties. Indeed, both approaches have their advocates within the profession. So this naturally leads us onto some recommendations for further research in this area, and much of this we believe to be long overdue. We make five key recommendations.

First of all, this area is in desperate need of detailed exploratory research, using focus groups, in-depth interviews and other qualitative techniques, to determine within the broader context of company decision making and policy how companies value their employees' travel time savings. In particular, we must recognise that one size might not fit all, with some companies taking a cost savings approach, others being more 'sophisticated' in considering the productive use of travel time and the use to which the time saved is put, and yet others taking a WTP approach based around issues such as the importance of the business trip, the unsocial hours involved or even things like keeping employees happy. How employees perceive and conform to company policy, company purchasing procedures and how these work through into actual behaviour are all important issues that warrant detailed investigation.

Secondly, there is a clear need to obtain a better, explicitly quantified, understanding of how the HE's *p*, *q* and *r* parameters vary across a wide range of different contexts. It is also essential that accurate values are obtained for these parameters given the numerous challenges faced in estimation. Research into whether on average *r* is lower or indeed near to zero in the long run is absolutely critical to this approach, as is identifying how *p* might vary over time.

Thirdly, we note that few studies have attempted to obtain employers' WTP valuations, and those that did (Hensher, 1977; Fowkes et al., 1986) are dated. Whilst this is admittedly not a straightforward approach, not least from a data collection perspective, the use of SP for freight value of time encounters very similar challenges but now seems quite common and perhaps VBTTS studies could learn from their experiences. In addition to what would be challenging research into employers' WTP, employee-based SP studies, which in many ways are a more feasible way forward, need to ensure that company policy is properly accounted for and are based on the insights obtained from the detailed exploratory research suggested above. That might in itself not be enough, however, and such studies would be usefully complemented by well-defined and familiar RP time-cost trade-off contexts. Without doubt, self-employed business travellers merit separate attention.

Fourthly, there has been little research into whether the *MPL* is in the long run significantly different from the short run *MPL* of the observed wage rate plus the classical on-costs of annual leave and pensions. Potentially the mis-specification of the on-costs may contribute to at least part of the difference between HE and WTP derived values.

Fifthly, there is little evidence on VBTTS for journeys made by taxi, car hire or as a car passenger. These can be important market segments and are sometimes somewhat different in nature, such as being multi-modal, replacing walking time or having relatively low or high costs, Further research in this area is warranted.

Finally, not since Fowkes et al., (1986), in the very early days of empirical investigation, have we had a 'triangulation' of different methods covering the CSA, the HE, employers' WTP and employees' WTP. A controlled comparison of the different methods discussed here is long overdue.

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Appendix 1: Key Studies Cited Alphabetically in Text

a	Hensher (1977)
b	Fowkes et al. (1986)
c	Hague Consulting Group et al. (1999)
d	Hague Consulting Group (1990a, 1990b)
e	Hague Consulting Group (1998)
f	Significance et al. (2012)
g	Algers et al. (1995)
h	Ramjerdi et al. (1997)
i	Beca Carter Hollings and Ferner et al. (2002)
j	VSS (2009)
k	Mott MacDonald et al. (2009)