The Digital Revolution and Worthwhile Use of Travel Time:

Implications for Appraisal and Forecasting

Mark Wardman

Institute for Transport Studies, University of Leeds

Glenn Lyons

Centre for Transport and Society, University of the West of England

CORRESPONDING AUTHOR

Mark Wardman

Institute for Transport Studies, University of Leeds

Leeds, LS2 9JT

United Kingdom

Telephone: +44 (0) 113 343 5349

Fax: +44 (0) 113 343 5334

E-mail: m.r.wardman@its.leeds.ac.uk

Abstract

Savings in travel time and more specifically their monetary value typically constitute the main benefit to justify major investment in transport schemes. However, worthwhile use of travel time is an increasingly prominent phenomenon of the digital age. Accordingly, questions are increasingly being asked regarding whether values of time used by countries around the world based on their appraisal approaches are too high. This paper offers the most comprehensive examination of our theoretical and empirical understandings of international appraisal approaches and how they account for worthwhile use of travel time. It combines the economics perspective with wider social science insight and reaches the conclusion that past revolutions in transport that have made longer and quicker journeys possible are now joined by a digital revolution that is reducing the disutility of travel time. This revolution offers potential economic benefit that comes at a fraction of the cost of major investments in transport that are predicated on saving travel time. The paper highlights the challenges faced in both current and indeed potential alternative future appraisal approaches. Such challenges are rooted in the difficulty of measuring time use and productivity with sufficient accuracy and over time to credibly account for how travel time factors into the economic outcomes from social and working practices in the knowledge economy. There is a need for further research to: establish how improvements in the opportunities for and the quality of worthwhile use of travel time impact on the valuation of travel time savings for non-business travel; improve our understanding of how productive use of time impacts on the valuation of time savings for business travellers; and estimate how these factors have impacted on the demand for different modes of travel.

Keywords

Value of Travel Time Savings, Travel Time Use, Productive Use of Travel Time, Hensher Equation, Business Travel, Digital Age.

Acknowledgements

We would like to thank to Richard Batley, Jonas Eliasson, James Laird, Peter Mackie and John Bates who have contributed to our understanding of issues discussed here. A Department for Transport funded scoping study into how travel time savings in the course of business trips might be valued provided an impetus to this paper, and we are grateful to

Dan Thomas and Jake Cartmell of the Department for insight and guidance as part of that project. All views expressed here though are those of the authors.

1. INTRODUCTION

This paper confronts a persistent issue in transport economics and in turn transport policy and planning: that transport scheme appraisal should account for the apparent growing preponderance of travellers to make worthwhile use of their journey time in the digital era of the knowledge economy. Our discussions address both business travellers, focussing upon professional employees who are sometimes referred to as 'briefcase travellers', and non-business travellers, since in both markets the benefits of time savings can be expected to be influenced by whether and to what extent travellers are making worthwhile use of their travel time.

It has long been acknowledged (Harrison, 1974; Hensher, 1977) that the ability to use travel time productively is critical to the appraisal of time savings that accrue to those travelling on company business, although surprisingly little account has actually been taken of this in official practice internationally. More recently, Lyons and Urry (2005) recognised that the changing travelling environments due to the digital age and how time on the move is being used with the support of mobile technologies heightens the need to give attention to this.

Travel time has always provided possibilities for thinking, relaxing, talking, eating and, additionally for public transport modes, reading, writing and sleeping. However, the onset of the digital revolution has significantly increased the scope of how time can be used. It is now commonplace while travelling to observe people using mobile devices to surf the web, listen to music, watch films, read books, play games, make and receive calls and messages, and undertake work activities[1]. Some of these are new opportunities whilst others must be,

[1] Indeed, on train journeys, for example, it can be rare to observe anyone not undertaking such activities!

due to their take-up, improvements on previous forms of essentially the same non-digital activity.

It is illuminating to provide some historical context to these recent developments. There have over the past century and a half been a number of personal travel revolutions: the emergence of the railways made long distance travel a possibility and suburban commuting a reality; the omnibus provided significant improvements in urban accessibility for the masses; the private car transformed enormously individual mobility, initially to a privileged few and then more widely; the air industry enabled international travel and foreign holidays inconceivable a few decades prior, whilst low cost airlines have recently brought regular air travel within the reach of many. Within these modes, there have been less revolutionary, but nonetheless steady, improvements in physical comfort and ambience over time.

In this paper we recognise that the current age is witnessing a revolution *within* the modes at our disposal. Whilst not associated with reductions in journeys times or longer distance journeys brought about by greater speeds, this revolution has instead taken the form of reductions in the unit disutility of travel time due to increasing possibilities for worthwhile use of this time and indeed increases in the quality of that worthwhile time. Moreover, this trend might reasonably be expected to continue for a number of reasons. Firstly, we can expect a cohort effect, where the propensity of a given age group to use digital technology increases over time. Secondly, existing technology will improve and thereby enhance the journey experience. Thirdly, there will be new opportunities for worthwhile use of time as new products emerge. Fourthly, digital technology is having effects on the very nature of business and social practices such that where and when activities are undertaken (including while travelling) could be becoming more flexible over time.

If we speculated that, on average, travellers are experiencing merely a 2% per annum reduction in their value of time due to being able to make more or improved worthwhile use of travel time, which is equivalent in economic terms to a 2% time reduction on all journeys, this makes the benefits from transport investment schemes modest by comparison. Indeed, one might then explore re-balancing resource allocation from time saving schemes (such as new road or rail capacity) towards measures that increase the opportunities for and the quality of worthwhile time use (such as improved design of vehicles that enhances the travelling environment itself).

This apparent revolution in travel time use poses important challenges for our consideration of how and in what ways travel time is worthwhile and in turn what value can be attached to savings in such time. The traditional assumption that travel time (saved or used) is directly related to journey purpose is arguably more questionable: flexibility in where and when knowledge-based activities take place means ownership of time (between an individual and an employer) is harder to attribute. Moreover, in relation to economically worthwhile use of time, there are as yet no effective means to accurately measure how productive an episode of someone's time use is and therefore accurately compare productivity on the move with that outside of travel.

The impact of the productive use of travel time on the valuation of business travel time savings has long been debated. The key assumption that has been troublesome for over 30 years is that travel time itself has no value or is economically worthless. This assumption has had an enormous influence on international appraisal practice (Wardman et al., 2013), yet if business travellers do make productive use of travel time then it would seem that official values over-estimate the monetary benefits of time savings.

Turning to non-business travel, the conventional approach to value of time estimation has, until recently, paid little attention to the worthwhile use of travel time. The view has been that journeys represent nothing more than a disutility of reaching destinations relative to spending time in other pursuits. Yet it is palpably the case that some people some of the time achieve positive outcomes from their use of their travel time. Again, official values are overstating the benefits of time savings to the extent that they do not account for the impact of worthwhile use of time and especially its potential increase over time.

The impact of travel time use is not only restricted to appraisal; it also has significance for travel demand and its estimation and forecasting. We address both in this paper.

In the context of step-changes in the worthwhile use of travel time, and the real-world significance that this has had and can be expected to have going forward, this paper has a number of objectives. As far as business travel is concerned, which is where the debate originated and has largely focussed, we provide what we believe to be the first comprehensive synthesis of available international evidence of productive use of travel time and consider the implications for the value of business travel time savings (VBTTS) and appraisal practice. Importantly, we extend this discussion in different ways. We explore the extent to which the worthwhile use of time has been addressed for non-business travel and its consequences for the valuation of travel time savings in this market (VTTS). We also consider the somewhat neglected issue of the effect on demand patterns. The paper pursues its objectives through the lens of both economics and a wider social science perspective – something we believe is core to informing the paradigm shift that may be required of international practice. After this evaluation of recent trends and future expectations, set against appraisal requirements, we identify avenues of future research that become necessary.

The paper is therefore structured as follows. Section 2 considers conceptual and methodological issues. It provides a critical evaluation of the range of possible methods by which time savings, for business and other trips, can be appraised and extends the appraisal discussion to a broader consideration of travel time use and its meaning. Section 3 provides a comprehensive review of available evidence on the worthwhile use of travel time for business travellers, including its potential impact on VBTTS. Section 4 focusses upon evidence for non-business travel where we contend that the examination of the worthwhile use of time and its impact on VTTS has been very much neglected. Section 5 considers the implications of the worthwhile use of travel time for travel demand and its forecasting. Section 6 provides our concluding remarks and recommendations.

2. BACKGROUND: THE CONTENTIOUS MATTER OF WORTHWHILE USE OF TRAVEL TIME

The worthwhile use of travel time can take different forms for journeys undertaken for different primary reasons. For journeys undertaken on behalf of the employer, spending time in a worthwhile fashion can most naturally be expected to be working while travelling, and its efficiency relative to the workplace will be an important consideration. However, other activities might be undertaken, particularly when such travel is outside contracted hours. In fact more broadly (as empirical evidence is revealing) there can be no firm presupposition that a journey's purpose also indicates how the travel time itself is used or how any saved travel time is redeployed (and valued). Yet conventional approaches to appraisal implicitly if not explicitly are founded to an extent on this presupposition. We return to this blurring of the attribution of time according to journey purpose below. However, to further set the paper's context we next need to discuss how time savings are conventionally appraised and the link to the worthwhile use of time.

2.1 Appraisal of the Value of Business Travel Time Savings (VBTTS)

The estimation of VBTTS essentially takes one of three forms, which vary according to the degree to which they incorporate the worthwhile use of travel time. These are the Cost Savings Approach (CSA), the Hensher Equation (HE), and the Willingness-to-Pay approach (WTP).

The Cost Savings Approach (CSA)

The CSA has been used in the appraisal of transport schemes since the 1960s (Coburn et al., 1960; Foster and Beesley, 1963). Under the CSA, the VBTTS is determined by the value of the marginal product of labour (MPL) which is made up of the gross wage (w) and the marginal non-wage cost of employing labour (c):

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

The central properties here are that "*[t]ime spent travelling during the working day is a cost to the employer's business. It is assumed that savings in travel time convert non-productive time to productive use and that, in a free labour market, the value of an individual's working time to the economy is reflected in the wage rate paid*" (Department for Transport, 2012a). The CSA does not differentiate by type of time; all are unproductive and savings in any are converted into productive use, whilst there are no indivisibilities in the use of time saved and the unit value of time is constant.

Critical reflection on the CSA dates back as far as Harrison (1974). The assumption that travel time is unproductive is clearly untrue at the level of some, and perhaps many, individuals. However, Fowkes (2001) pointed out that "*if business travellers on a two hour train journey spend one hour working, there is no reason that a half hour journey time saving need reduce the time spent working*" and hence the relevant question is whether the travel time saved would have been productive or not. Taking all the assumptions of the CSA together, it has previously been noted that *"[i]t is evidently the case in particular situations, one or more of these conditions will not hold. However, it is a reasonable basis for arguing that on average, and taking a long-run view, these effects are largely self-cancelling*" (Mackie et al., 2003). This is important because it reminds us that the purpose of appraisal is not to accurately depict human behaviour at the level of the individual but to establish a reasonable approximation *at the aggregate*. Whilst there is a persistent and now growing scepticism regarding whether the assumptions are holding true collectively and are fit for purpose, the CSA has proved remarkably resilient and remains the predominant approach to VBTTS in much of the world where transport appraisal is actively practised.

The Hensher Equation (HE)

The HE has a pedigree almost as long as the CSA (Hensher, 1977). It explicitly recognises that time spent travelling might be productive and that not all saved time is converted into productive use. In addition, and unlike the CSA, it allows for the benefits of time savings to the employee. The approach conceived of by Hensher was originally codified (to our knowledge) by Fowkes et al. (1986), and recently Batley (2014) has derived it from first principles. It takes the form:

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

where:

MPF = the value of extra output due to reduced (travel) fatigue

VW = the value to the employee of work time at the workplace relative to travel time

VL = the value to the employee of leisure time relative to travel time

p = proportion of travel time saved at the expense of productive work travel time[2]

q = relative productivity of work done whilst travelling relative to the workplace

r = proportion of saved travel time used for leisure

The first term [.....] represents the employer's benefit and the second term {.....} is the employee's benefit. Given the difficulties of estimation, MPF is invariably ignored in practice, although if technological developments mean that more work is done while travelling then we might be less comfortable with ignoring it.

This equation naturally allows for worthwhile use of time from the employer's perspective. However, the employee's values (VW and VL), based on their expressed or revealed WTP, can also be expected to depend on what they are doing while travelling.

[2] Fowkes et al. (1986) distinguished between p, which is the marginal amount of working time displaced by a time saving, and what they termed p*, which represents the average amount of time spent working while travelling.

Three variants of the HE have been applied. Fowkes et al. (1986) advocated the assumption that there is, on average, indifference between travelling in the course of employment and working at the normal workplace, whereupon VW = 0, and this was adopted for a time by the Norwegian authorities. Another view is that in the long run r = 0, since through contract re-negotiations and staff turnover the benefits of time savings will eventually accrue to the employer, and this is the current official Swedish approach. One other formulation, currently used in the Netherlands and for a time in Sweden, sets VW to VL apparently on the grounds that the private value does not distinguish between whether the saved time is used for work or leisure.

What is though common to all these three variants, and to the subject of this paper, is that they all contain the p and q terms relating to the productive use of time. Each HE variant can collapse to the CSA with a necessary case being that p=0. The approach can apply to walk time, waiting time and time spent in crowded conditions, although the p and q parameters would be expected to be different in each. We might also expect p and q to vary with factors such as journey length (since sometimes it is not worth starting work on a short journey or it is increasingly difficult to work for the entire journey as its duration increases), as well as direction of travel, seniority, mode, and the amount of time saved.

The Willingness-to-Pay Approach

In principle, the WTP approach involves inviting the relevant economic agents, in this case the employer (WTP_{er}) and employee (WTP_{ee}), to declare/reveal how much they are prepared to pay to save time in the course of business trips, that is:

$$VBTTS = WTP = WTP_{er} + WTP_{ee} \quad (3)$$

The approach is intuitively simple; 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* and its measurement. We would expect the employer to be primarily responsible for paying for time savings that can be achieved during their employees' business trips. However, there might be instances where the employee is prepared to pay, as with the HE, but care would have to be taken to avoid double counting.

The WTP approach also allows firms to express values that exceed the average wage rate in cases where the *MPL* of the specific activity is particularly high, such as being able to spend more high quality time at the destination, where there are concerns over impacts of travel on productivity, or where there are altruistic concerns particularly relating to business travel during unsocial hours. In principle, the WTP VBTTS should reflect productive use of travel time; companies can be expected to pay less and conceivably nothing for time savings to the extent that they reduce the productivity achieved while travelling. Although WTP approaches typically return constant unit values of time, there is no reason why in principle they cannot examine the non-linearities and thresholds that might be expected to exist in the business travel market.

The CSA might be seen as a restricted case of the employer's WTP (i.e. where WTP is taken to be the wage rate plus non-labour costs), and the HE might be seen as a weighted sum of the employee's and employer's WTP in another restricted case (i.e. where the employer's WTP is a function of *MPL* and *MPF*, and the employee's WTP is a function of *VW* and *VL*).

However, we are not aware of implementation of the WTP approach for official VBTTS recommendations anywhere in the world[3].

2.2 Appraisal of the Value of Non-Business Travel Time Savings (VTTS)

The estimation of VTTS is essentially a matter for personal preference and willingness-to-pay (WTP). Whilst WTP is clearly a function of income, there is no reason to suspect any particular dependency. The neo-classical theory of time allocation as set out by Bates (MVA et al., 1987), building upon contributions of DeSerpa (1971) and Bruzelius (1979), establishes the "fundamental property of time value" that the value of a time saving in activity i (VTS_i) is:

$$VTS_i = RVT - MVT_i \quad (4)$$

RVT is the resource value of time, defined as the benefit of an increase in the total time budget if such were possible, and MVT_i is the marginal valuation of time spent in activity i.

The MVT_i term is of direct relevance here, since the marginal valuation of time spent travelling will not only include comfort related issues, influenced by factors such as mode, class of travel, design features and degree of crowding, but it will also be strongly influenced by being able to undertake worthwhile activities whilst travelling either to alleviate boredom, to gain positive utility from travel time or to be able to beneficially transfer activities over time.

[3] By this we mean a full WTP basis for the official recommendations. However, the employee element of the Hensher Equation, employed in the Swedish and Dutch official values, is based on WTP.

It is customary in appraisal practice to increase the VTTS over time in direct proportion to income growth. This has an intuitive appeal when all other things are equal. However, to the extent that MVT_i is falling over time , as will happen as the opportunities for and quality of worthwhile use of travel time increase, there will be a dampening effect on the growth in VTTS.

2.3 Wider understandings of travel time use and meaning

While much consideration in transport economics has been given to the approaches above, another body of literature has sought to understand the meaning of travel time itself which further contributes to both the framing of the different approaches above but also to the complexity of the matter of values of time.

As well as being argued and revealed to have positive utility for the traveller (Mokhtarian and Salomon, 2001; Redmond and Mokhtarian, 2008), travel time has been conceptualised as a ‘gift’ to the traveller (Jain and Lyons, 2008) – it provides *time out* (interspace time for oneself to be selfishly consumed, away from the obligations of others) and *transition time* (time to wind down from and/or gear up to different roles and activities at a journey’s origin and destination). There is also a potentially important distinction to be made between clock time and *experienced* time in relation to any subjective assessment of the (dis)utility of travel time – such as is embodied in studies to empirically establish WTP values of time. Drawing upon ethnographic work, Watts (2008) explains how experienced travel time can be stretched or compressed depending upon a traveller’s state of mind and the use to which time is put (for example, in extreme, falling asleep on the train might provide both refreshment to the traveller and a sense of teleportation between one point on the journey and another). Hence a given journey time could be experienced in more than one way, affecting how it is judged.

Allied to our remarks at the start of Section 2, Holley et al. (2008) have challenged the separation in transport appraisal of travel time valuation according to travel during the course of work (employer 'owned' time) and commuting and other travel outside the course of work (employee 'owned' time). They suggest that in the knowledge economy, notions of time 'owned' by an employer (popularised by Ford in the mass production of cars) are becoming less relevant with "*a resurgence of the pre-industrial task-oriented concept of time*" (Holley et al., 2008). Knowledge workers are judged by the tasks they complete, irrespective of where and when the time is invested to complete them. Thus someone may read for leisure on a journey in the course of work, work on a laptop during a leisure journey or work in the evening at home having slept or watched a DVD on a return trip from a business meeting.

Thus there are a number of interpretations of time and its use which might cast doubt, or at least pose questions, regarding how establishing the value of travel time savings is approached in economic appraisal of transport schemes.

For manual work, principles stemming from the early work of Taylor (1911) have resulted in productivity measurements based on the quantity (and acceptable quality) of the output per unit time. Meanwhile "*it seems to be of common agreement that to date there are no effective and practical methods to measure KW [knowledge worker] productivity*" (Ramírez and Nembhard, 2004). Knowledge work, which is often non-sequential, is recognised as not being easy to observe or measure. The means of production (unlike that for manual work) is not tied to place of work but instead is owned by the knowledge workers: "*knowledge* *between their ears is a totally portable and enormous capital asset*" (Drucker, 1999). While such consideration relates to how productivity in the knowledge economy – once measured and understood - might ultimately be improved (something that would then likely be accounted for in wage rates), it highlights that we would be naïve to assume that for the purposes of travel time valuation we can easily judge the *extent* of productivity. Yet in the evidence we later synthesise in this paper, this may indeed be what has been done.

At this juncture we suggest that the matter of V(B)TTS *might* be considered a 'wicked problem'. This term, originally used in social planning, does not denote 'wicked' in the lay sense of the word. Rather, a wicked problem is one that cannot be definitively described and for which "*there are no "solutions" in the sense of definitive and objective answers*" (Rittel and Webber, 1973). We are in two minds as to whether this is indeed the case as opposed to V(B)TTS being a 'complex problem'. However, the span of decades over which the matter continues to be debated does question whether it is complexity alone that plagues the problem.

Regardless of whether wicked or complex, a key motivation of this joint paper from two authors from different academic constituencies aligns with the third of Roberts' (2000) three strategies for attempting to solve wicked (or, we suggest, also complex) problems: namely a *collaborative* strategy - enabling different constituencies and viewpoints to work together towards improved accomplishment. Meanwhile, addressing V(B)TTS has largely focused upon an *authoritative* strategy whereby, Roberts suggests, responsibility is put in the hands of a few stakeholders vested with the authority to come up with a solution (with the possibility of being (seen to be) wrong about the problem and wrong about the solution). A *competitive* strategy would have seen us as authors writing separately (and differently) on the matters addressed in this paper.

This section of the paper has outlined how worthwhile use of travel time has, or has not, been treated within the orthodox approaches to valuing travel time savings and the related assumptions that are made. It has also presented wider perspectives that could serve to challenge or complicate these assumptions. With this as a context, the next two sections of the paper turn to examine the empirical evidence concerning business travel time use and non-business travel time use respectively.

3. EMPIRICAL INSIGHTS INTO BUSINESS TRAVEL TIME USE

In this section, we first consider how worthwhile use of business travel time has been estimated through the lens of the Hensher Equation. We then add to this by introducing wider evidence from studies outside of those focused upon VBTTS. In both cases, our emphasis is upon briefcase travellers since this is where the assessment of the value of time savings is most contentious (Mackie et al. 2003).

3.1 Examining the Hensher Equation Parameters

We have identified 11 studies that provide evidence on the productivity related elements of the HE. The evidence relating to p (the marginal amount of working time displaced by a time saving), p^*(the average amount of time spent working while travelling) and q (the relative productivity of work done whilst travelling relative to the workplace) is summarised in Table 1. It is to be expected that p^* exceeds p and it can be observed that it has been p^* that has mainly been estimated.

For each mode, p* shows a range across studies but with notable within-mode differences in several studies. For car, the range is 0.02 to 0.22, with the higher values for company car in Sweden, urban car in Norway, and for New Zealand. Bus varies between 0.03 and 0.17, with the higher values only recorded in the Swedish study. For train, the range between 0.11 and 0.46 is larger, with the recent UK study notable for its much higher value. The range for air is 0.07 to 0.36 with the early figure from Australia for domestic air an outlier in terms of its much higher value.

Clear messages are hard to draw out when looking across studies and, by implication, over time. However, *within study* variation of p* across modes does show a broadly consistent picture in terms of the highest to lowest proportion of travel time spent working: train, air, bus and car. There is some evidence that productivity falls with journey duration, although more detailed investigation of this important dimension is clearly warranted. We observe that in the two instances where both *p* and *p** are estimated that *p* is less than *p**, as expected.

Little credible evidence exists concerning the critical dimension of how things may be changing *over time*, yet this is a significant consideration in terms of appraisal approaches that examine periods of 60 years into the future and ongoing developments in information technology and portable devices that support productivity. It is significant too for travel demand forecasting.

With regards to *p**, the three sets of Dutch figures 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 similar increase is evident from comparing the two *p** values for UK rail, although here we should note that the more recent 2009 study involved longer journeys. All things considered, the evidence on *p** from rail is unclear, and might indicate that confounding factors are at play. 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.

Table 1: Summary of *p*, *p and *q* evidence**

Reference	Study Date	Country	Mode	*p*	*p**	*q*
Hensher, 1977	1977	Australia	Air - Domestic	-	0.36	0.61
			Air - International	-	0.19	0.51
Fowkes et al, 1986	1986	UK	Car	-	0.03	1.01
			Train	-	0.20	0.95
			Air	-	0.14	0.99
Hague Consulting Group, 1990	1988	Netherlands	Car	-	0.02	0.90
			Train	-	0.11	0.89
			Bus	-	0.03	0.93
Hague Consulting Group et al, 1999	1994	UK	Car	-	0.04	1.02
			10-30 min	-	0.03	1.11
			31-60 min	-	0.04	1.01
			61-121 min	-	0.05	1.00
			> 120 min	-	0.05	1.01
Algers et al., 1995	1994	Sweden	Car	-	0.14	1.01
			Company Car	-	0.19	1.11
			Car - Self Employed	-	0.10	1.20
			Train - InterUrban	-	0.28	1.03
			Train - Self Employed	-	0.23	1.08
			Train - X2000	-	0.28	1.04
			Train - Urban	-	0.18	1.15
			Bus - InterUrban	-	0.13	0.93
			Bus - Suburban	-	0.17	1.26
			Air	-	0.13	0.97
			Air - Self Employed	-	0.11	1.02
Hague Consulting Group, 1998	1997	Netherlands	Car	-	0.04	0.93
			Train	-	0.16	0.90
			Bus	-	0.03	0.89
Ramjerdi et al., 1997	1997	Norway	Car - Inter Urban		0.03	0.32
			Car – Urban		0.21	0.02
			Train - Inter Urban		0.18	0.39
			Bus - Inter Urban		0.06	0.20
			PT – Urban		0.30	0.07
			Air		0.07	0.28
			Ferry		0.03	0.19
Beca Carter Hollings et al., 2002	2002	New Zealand	Car	0.03	0.22	0.93
VSS, 2009	2003	Switzerland	Car	0.64		0.98
Mott MacDonald et al., 2009	2008	UK	Train	0.41	0.46	0.97
			< 45 min	0.60		0.98
			45-89 min	0.35		0.97
			90-149 min	0.28		0.98
			150 min+	0.22		0.96
Significance et al., 2012	2011	Netherlands	Car	-	0.04	0.91
			Train	-	0.16	0.94
			Bus	-	0.06	0.83
			Air	-	0.14	1.00

Note: PT is a combination of bus and rail, including tram and metro; X2000 is a fast train in Sweden.

The 2008 study by Mott MacDonald et al. (2009) sought to compare its findings with those derived from questions designed by Lyons et al. (2007) in the November 2004 National (Rail) Passengers Survey (NPS). The comparison suggested, that over this short period, the proportion of business travellers reporting doing some work on the train had increased from around 50% to 80% while an estimate of p* showed a change from 0.30 to 0.57. However, as is seen below in Section 3.2, results from a repeat of the NPS questions in 2010 portray a somewhat different picture of change. Taken together this underlines the paucity of reliable longitudinal data where like-for-like comparisons can be made.

As for *q*, the Norwegian study from the 1990s (and to a lesser extent the early Australian study) is atypical in reporting very low values and we consider this suspect. Across the other studies, the variation in q (sometimes capped at 1 for any individual) is much less than for p*: car – 0.90-1.20; bus – 0.83-1.26; train – 0.89-1.15; and air – 0.99-1.02. Within-study variation across modes shows little consistency across studies in terms of indicating any ordering of modes according to q. It is also apparent that relative productivity across attempts to measure it gravitate strongly to 1. Taken together, there may be two rather divergent interpretations, either: travellers are indifferent to a mobile or office environment in terms of what they believe they are achieving when they work, and this may relate to different specific tasks being performed in each environment; or they are ambivalent towards or are unable to easily judge relative productivity and thus default towards responses at or near to 1.

Both *p** and *q* (and *p*) might be expected to be influenced by crowding levels. As far as we are aware, Mott MacDonald et al. (2009) provided the first and only insights into how crowding impacts on the HE parameters. It was only at load factors over 90% with some (others) standing that the study identified q being impacted. At that level *q* falls from around 1 to 0.9. We can only speculate that it would be very much lower if standing were actually involved. Even if we accept that *q* does not vary greatly with load factor providing it is possible to be seated, we might expect the ability to work during the journey to fall with the load factor. It appears that at 75%-90% load factors, p* averaged 0.5 whilst at load factors over 90% (without standing) it was 0.38. For passengers who are forced to stand, the evidence denotes that *p** might be halved. Interesting and novel though this study was, it was hampered by limited variations in crowding levels and few of the sample experiencing crowding. The study itself concluded that, "*the effect of crowding, and/or seating availability, needs therefore to be explored further*".

Notable features of the literature covered in Table 1 are:

- There is little by way of credible evidence on how p, p* and q have varied over time and what has driven any variation. Such quantification would contribute to, for instance, speculation on how these parameters might vary in the future.
- There has been little attempt to provide a detailed account, let alone a quantitative explanation, of how p, p* and q vary across situations within studies, such as with journey distance, size of time variation, time gain or loss, type of time, degree of crowding, in-journey facilities and vehicle type.
- It has generally been recognised that it is not straightforward to collect reliable data. For example, in the earliest study, Hensher (1977) pointed out that business travellers might overstate the extent to which they work so as not to appear lazy. This has been used as a reason for retaining the CSA for VBTTS (Mackie et al., 2003). Our earlier remarks about ownership of time, assignment of time between work and leisure activity and challenges in accurately measuring (relative) productivity in the knowledge economy underline this problem of data reliability.

- It is perhaps for this latter reason that a recurring theme in the literature dealing with the HE parameters is the extent that the available evidence is largely centred upon p* and this will tend to reduce HE VBTTS compared to the CSA by more than would be the case with using p as the more appropriate term.

We can reasonably draw from this evidence that p and p* can be quite large, and that there is clearly scope for increase over time. It would suggest that some discount on the gross wage rate would be appropriate in calculating VBTTS, as is currently done in Sweden for rail travel, and that uplifting the VBTTS simply in line with wages might not be appropriate. The work of Fowkes et al. (1986), which found the VBTTS obtained from the CSA, HE and WTP methods to be broadly similar, has proved influential in justifying for many years the status quo, but this position we consider to be increasingly untenable in the light of recent and expected future trends in p. The more commonly estimated p* tends to be higher for train and lowest for car, and it might be expected to be having a significant influence on mode choice.

3.2 Broader examination of business travel time use

A wider evidence base, beyond that with a direct interest in addressing VBTTS, has also been emerging which considers business travel time use. Empirical insights are summarised below, though few at present exist.

Time use during rail travel

Unique longitudinal data has been secured from the NPS (referred to above) for Great Britain (Lyons et al., 2007; Lyons et al., 2013). Questions were asked in 2004 and 2010 about how rail travel time was used and how worthwhile the time on the train was considered to be (‘very worthwhile’, ‘of some use’ or ‘wasted’). In 2004, 55% of business travellers spent some of their time on the train working/studying on their outbound journey (for 35% it is the activity they spent most time on); the figures were 48% and 27% respectively for the return journey. The figures for 2010 were comparable but with some modest increase. In 2010, 34% of business travellers reported making very worthwhile use of their time compared to 28% in 2004. This is a statistically significant increase over the period. Correspondingly the proportion of business travellers reporting their time on the train to have been wasted went down by 37%. Increasing availability and use of mobile technology was also recorded between 2004 and 2010 by the surveys.

A Norwegian study in 2008, drawing upon the survey approach above and with nearly 1200 respondents (Gripsrud and Hjorthol, 2012), found that “*a high proportion of ordinary commuters and business people work on board while travelling by train, i.e. 35% of commuters and 43% of business people”.*What is perhaps surprising is that 27% of rail commuters and 53% of business travellers indicated having travel time approved of as working hours by their employer. The study’s findings broadly concurred with those from Great Britain in terms of mobile technologies improving time use experience and the passage of time. Similar proportions of business travellers reported making good/worthwhile use of their time – about a third.

The most recent UK data in relation to rail travel time use comes from the April 2012 omnibus survey commissioned by the Department for Transport (Department for Transport, 2012b). It was found (for long distance journeys across all rail users, not only business travellers) that 11% spent most time doing work for their job (including work text/calls/emails) – 20% spent some time doing this. These figures are comparable to (though slightly lower than) those from the 2004 and 2010 National Rail Passenger Surveys’ results.

Time use by car drivers

Value of time literature has tended to dismiss much prospect of productive time use by car drivers travelling on business – something perhaps borne out by the results in Table 1. Yet there is at least some evidence that suggests a closer look is required. Eric Laurier has been noted as one of the pioneers of in-depth work into the use of the car as a mobile office or place for activity (Laurier et al, 2008). Hislop (2013), who consulted nearly 150 individuals for whom journeys "*were intrinsic to their work, and involved travelling between diverse locations during the working day*", found that nearly a third of respondents regularly (2-3 times per week) used their car for work-related purposes and over half used their phone while driving either 'quite a lot' or 'a great deal'. Hislop suggests that drivers use their phones extensively whilst being aware of the distraction they cause because "*they felt under pressure both to make use of their driving time productively, and to deal with calls regarded as urgent or necessary*". He also found that "*a number of interviewees argued that driving time could be used for thinking about work*".

Understanding business travel time

Gustavson (2012) undertook 12 semi-structured interviews with travel managers in Sweden followed by interviews with 22 employees (within the travel managers' organisations) in relation to their business travel. He found that employers do not tend to have explicit expectations about work during travel time – however, expectations were instead about "*getting one's work done in a satisfactory way*". The study revealed that "*although travellers often appreciate having good working conditions while travelling, the first priority for many frequent travellers is to minimize time spent away from home and family, rather than to make productive use of their travel time*". In this regard there were strategies to replace physical meetings with virtual equivalents or to combine meetings associated with a given journey. The author identified four different attitudes to travel time and working time: (i) travel as any other working time; (ii) travel (long distance) as a special kind of working time; (iii) travel as inappropriate for or a poor second for undertaking work; and (iv) travel as valuable 'time out' (see also Jain and Lyons, 2008). Such attitudes ought to be included in any improved understanding of the Hensher parameters and further WTP studies.

In terms of an evidence-based understanding of worthwhile use of travel time by business travellers, the reluctant summary observation is that we still known very little with much confidence – especially once the variables of mode, journey distance/duration, location and change over time are accounted for. This is in spite of the potentially profound significance such understanding may have for how transport investment decisions are informed.

4. EMPIRICAL INSIGHTS INTO NON-BUSINESS TRAVEL TIME USE

This section seeks to examine how WTP studies assess, or suggest implications for, worthwhile use of travel time. As will be revealed, there is a distinct paucity of explicit consideration of worthwhile travel time use.

Estimates of VTTS are almost always obtained from travel choice models, and from the earliest applications it has been common practice to distinguish the effects of key variables, including journey purpose, distance and, with Stated Preference (SP) data, mode used. Initially, such modelling took the form of estimating separate models for different categories and this approach remains common even now. However, the first national[4] value of time study (MVA et al., 1987) pioneered another approach that is more efficient and supports more extensive examination of a broader range of socio-economic and trip characteristics within a single model. It involves the specification of interactions terms between the socio-economic and trip characteristic variables and the time and cost variables guided by theoretical considerations.

This approach to segmentation has come to typify national value of time studies, whilst also being apparent in other investigations, to the extent that as we shall see below these studies have covered a wide range of what are termed covariates. Of relevance here is the extent to which this segmentation approach and its resulting covariates have covered variables representing the worthwhile use of time and its impact on VTTS. But first, what are the theoretical considerations that drive this segmentation approach?

Based around their neo-classical economics derivation of VTTS, as represented by equation 4, MVA et al. (1987) set out 12 hypotheses for variations in the VTTS that underpin the segmentation methodology outlined above. Their Hypothesis 3 is relevant to the worthwhile use of time and specifically relates to MVT_i. It stated that "*the value of time savings may be influenced by the scope for activities which can be undertaken during the journey*". The study stated that "*particularly in the case of journeys in the course of work, the value of time saved can be expected to be lower to the extent that useful work can be done while travelling*" and also that "*the extent to which useful activities can be performed in the course of travel is particularly significant for business travel*". This emphasis on business travel and productive time is perhaps ironic, given that the study's remit

[4] These can be regarded as those sponsored by government bodies with the explicit aim of informing official recommendations and guidance.

specifically excluded business travel, and it was a missed opportunity given that, even then, the possibilities to make worthwhile use of travel time would have influenced MVT_i and hence VTTS.

4.1 Variations in VTTS in National Studies

It is argued that studies to establish VTTS implicitly capture any effects of worthwhile use of time during a journey because "*people are assumed to be factoring in their views on this utility when making their choices in the experiments*" (Lyons, 2006). Given therefore what might be expected to be significant cross-sectional and inter-temporal variations in VTTS due to how usefully travel time can be spent by non-business travellers, it is illuminating to clearly establish what the body of available empirical evidence has to say on such matters – which is not a lot.

The VTTS evidence has long been vast (Abrantes and Wardman, 2011), and for pragmatic reasons we have here restricted our investigation to the national studies, but which in any event by their very nature tend to conduct far more extensive examinations of variations in VTTS than do other studies[5].

In addition to the 8 national studies covered in Table 1 for business travel, we here cover a further 6 national studies (MVA et al., 1987 [UK]; Pursula and Kurri, 1996 [Finland]; Small et al., 1999 [US]; Fosgerau et al., 2007 [Denmark]; Ramjerdi and Flügel, 2010 [Norway]; and Börjesson and Eliasson, 2012 [Sweden]). Table 2 summarises the covariates that have had significant effects on the estimated VTTS. Of course, in most cases other variables would

[5] We should though point out that from our extensive experience we are not aware of any study that has explicitly examined the impact of the worthwhile use of time on the value of time savings for non-business travel (VTTS), and contacting numerous leading practitioners in the area on this issue drew a blank.

have been tested but would not have been retained on the grounds of statistical significance[6]. The many reported covariates imply quite large systematic variations in VTTS according to personal and trip characteristics, with income (I), distance (D) , purpose (P) and mode (M) generally standing out as the key drivers. However, *there has been noticeably scant attention paid to the impact of the worthwhile use of time* as incorporated in MVT_i of equation 4. The only exception is that a number of these national studies have reflected on vehicle occupancy and its effects on the VTTS. We therefore summarise this in the following paragraphs.

Table 2: Covariates reported in models of national VTTS studies

Reference	Country	Study Year	Modes	Statistically significant covariates
MVA et al., 1987	UK	1985	C, T, B, Coach	I, E-S, H-C, M, P, D, C-O, Group Size, Time of Day, Day of Week, Arrival Time Constraints, Type of Working Hours, T-F, A-G, G, Class of Travel
Hague Consulting Group, 1990	Netherlands	1988	C, T, B, Tram	I, E-S, H-C, M, P, D, C-C, A-G, G, Amount of Free Time
Hague Consulting Group et al, 1999	UK	1994	C	I, E-S, H-C, P, TT&C, C-O, C-C, Road Type, Time of Travel, A-G, G, Amount of Free Time, Cost Reimbursed,
Algers et al., 1995	Sweden	1994	C, T, B, A, Coach	I, H-C, M, P, D
Pursula and Kurri, 1996	Finland	1995	C, B	I, M, Road Type
Hague Consulting Group, 1998	Netherlands	1997	C, T, B, Tram	I, E-S, H-C, M, P, D, C-C, A-G, G, Amount of Free Time
Ramjerdi et al., 1997	Norway	1995	C, T, B, A, Tram, Metro, Ferry	I, E-S, H-C, M, P, D, Time of Travel, Direction of Travel, T-F, A-G, G, Location
Small et al., 1999	United States	1995	C	I, E-S, H-C, P, Trip Time, A-G, G
Beca Carter Hollings et al., 2002	New Zealand	2001	C, T, B	I, M, P, D
VSS, 2009	Switzerland	2003	C, T, B	I, M, P, D, G, Car Availability
Fosgerau et al., 2007	Denmark	2004	C, T, B, Tram, Metro	I, E-S, H-C, M, P, TT&C, C-O, C-C, T-F, A-G, G, Arrival Time Constraints, Cost Reimbursement, Location
Börjesson and Eliasson, 2012	Sweden	2007	C, T, B, Coach	I, E-S, H-C, M, P, TT&C, Location
Ramjerdi and Flügel, 2010	Norway	2009	C, T, B, A, Tram, Metro	I, M, P, D, TT&C, C-C, A-G, G, Region
Significance et al., 2012	Netherlands	2011	C, T, B, A, Tram	I, H-C, Education Level, M, P, D, Time of Travel, A-G, G

Abbreviations:
C - car, T - train, B – bus, A- air;
I – income, M – mode, P – purpose, D – distance, E-S – employment status, H-C – household composition, T-F trip frequency, C-C car congestion, C-O car occupancy, A-G – age group, G – gender, TT&C – trip time and cost

Note: The statistically significant covariates listed do not necessarily apply to all modes and data types within a study.

[6] Studies do not always set out the full range of covariates that had been tested. An additional dimension, although not relevant here, is the considerable amount of attention that has been paid to the size and sign of time and cost variations.

Vehicle occupancy might impact on VTTS on the grounds that the journey is more pleasant when a traveller can interact with a companion. The first UK study (MVA et al., 1987) made the following comment on the empirical results relating to car occupancy: *"[p]eople travelling alone appear to have higher values of time than people travelling with passengers. The only rationalisation would appear to be that people appreciate company while travelling to work*!" Whilst this seems to have been regarded as some surprise, compared to the expected effects relating to cost sharing and time savings for occupants both of which will increase VTTS, it is entirely consistent with more worthwhile use of time when spent with companions.

Subsequent studies examining occupancy also seem to have been more pre-occupied with expected impacts from the values of other passengers. The second Norwegian study (Ramjerdi and Flügel, 2010) tested occupancy terms. Whilst there was no significant effect, their conclusion was that "*the value of an additional passenger in a car is not captured by the car driver*". The Danish national study (Fosgerau et al., 2007) examined accompanying car passengers on the basis that, "*It is possible that respondents take their passenger's VTT into account when making a choice*". The only significant effect was from accompanying children in a car and then the VTTS was lower which again might seem odd. The second UK study (Hague Consulting Group et al., 1999) specified a covariate on time covering car occupancy. For trips with the purpose of Other, the VTTS was 15% lower when there was one extra passenger. The explanation offered was that time constraints are less binding for specific purposes undertaken by groups but there was no recognition that it might be because travel is more enjoyable in a group.

In the most recent Dutch study (Significance et al. 2012) it was stated that "*train travellers have a lower other VOT (possibly because they can use their time in the train more pleasantly and productively than in other modes, using information technology)*" whilst the first Norwegian study (Ramjerdi et al., 1997) found the VTTS for car commuters to fall with occupancy and although they cite income variations as a causal factor they also speculated that "*It is also possible that ………… the driver might enjoy the company of a passenger*".

National studies do not have anything to say on how VTTS might be influenced by opportunities for worthwhile use of travel time, despite the possibilities for doing so, particularly for public transport, even in the older studies. Nor are we aware of other such evidence in the broader literature. The evidence from national studies relates to occupancy, which can impact on travel time utility, but the emphasis has been on its impact on cost sharing and the values of other occupants both of which would increase the recovered VTTS. For sure there has been no explicit testing of variables specifically representing the worthwhile use of time.

4.2 Variations in VTTS over Time

Another body of relevant evidence, only partly contained in national studies, relates to repeat studies that explore how the VTTS varies over time. If we believe that the potential for the worthwhile use of time has increased over time then we would, all else equal, expect the VTTS to have fallen over time[7]. Gunn (2001) reports what we understand to be first exact repeat of a Stated Preference (SP) study. In this controlled comparison of SP based valuations from 1988 and 1997, after isolating other influential variables, valuations

[7] Although, of course, the extent to which there is a tendency for reported values from separate studies to be consistent with the 'conventional wisdom' will tend to confirm 'expected' variations in VTTS over time at the expense of a dampening effect from reductions in VTTS attributable to improvements in the opportunity and quality of worthwhile time use.

were around 9% lower in real terms in 1997 despite income growth of around 2% per annum over the period. This "*non-helpful finding*" was attributed to, "*net systematic decreases in the disutility of travel time over time*" and speculation that it stemmed from the advent of mobile technology in the period. There have since been a number of exact repeat studies.

Tapley et al. (2007) repeated in 2006 two car-based SP exercises from the second national UK study of 1994. They concluded that "*comparing the two studies in 1994 prices reveals a slight decrease in the money value of travel time*". Hague Consulting Group et al. (1999) report on their repeat in 1994 of the 1985 Tyne Crossing study of the first UK national study. The VTTS does not exhibit growth in real terms for either commuting or other trips despite 25% growth in real incomes per capita.

The recent Dutch study (Significance et al., 2012) reported the variations in nominal VTTS, uncorrected for inflation, in Table 3 below. This is in the context of inflation of 32% in the period and real income growth of 30%, implying an expected 70% growth in VTTS if, as is widespread practice, an income elasticity of unity is used. Ignoring business trips by bus as a very small market, all but one of the figures fall short of expectations, although there would be much greater consistency by following the Dutch practice of an income elasticity of 0.5 which implies a 50% increase in VTTS. Nonetheless, the study commented that, "*VOTs could have been going down in the period 1997-2010 because it has become much easier to use travel time in all of the modes in a more productive and/or enjoyable way, since new technologies such as mobile phones (also hands free), laptops, iPads and smartphones with mobile internet have been introduced or become much more common in The Netherlands over this period*".

Table 3: 1997 to 2010 Changes in Nominal Dutch VTTS

	Car	Train	Bus/Tram/Metro
Commuting	+13%	+49%	+9%
Business	+13%	+60%	+98%
Other	+71%	+59%	+52%

As part of the second Swedish national value of time study, Börjesson et al. (2012) repeated in 2007 the car driver SP exercise conducted as part of the first national study undertaken in 1994. Depending upon which model is selected, the VTTS increased in real terms by between 13% and 39%. Both figures are less than the growth in GDP per capita of 46% over the period when mobile technology would have started to have a bearing for car drivers, as well as cars becoming more comfortable. Whilst there were also Norwegian national studies in 1997 and 2009, these are not strictly controlled comparisons because different data collection, design and analysis procedures were used in each. Nonetheless, the outcome was generally some small increases over time, but again somewhat less than the real GDP per capita growth over the period of 28%.

The evidence here does provide some support for VTTS being impacted by the increasing opportunities for the worthwhile use of time over time. Of course, there could have been an impact from the more worthwhile use of time even where VTTS has exhibited strong growth, but it is more likely a contributory factor where values do not increase or actually fall. Nonetheless, given the lack of detailed analysis, and possible confounding factors, such as cars becoming more comfortable, more crowding on trains and income elasticities differing from the conventional value of one, we cannot be sure from this evidence what the impact has been on VTTS from improvements in worthwhile use of travel time.

We can also observe that the cross-sectional income elasticity is typically less than one. This might be because those with higher incomes are more able and prepared to undertake activities during the course of a journey that reduce its disutility and hence dampen the positive effect of income on variations in VTTS across income groups. This endogeneity represents a challenge in empirically isolating the effects of activity patterns on values of time.

5. Demand Impacts of Worthwhile Use of Time

Our interest thus far has been in the treatment of and implications from worthwhile use of travel time for appraisal. However, worthwhile use of travel time and how it may be changing over time also has significant implications for travel behaviour and hence for future profiles of travel demand.

It is the Hensher parameter p denoting the marginal change in productive time that is important for the appraisal of business time savings rather than p* which represents the mean proportion of time spent productively. However, the latter is likely to be important in relation to behavioural decisions regarding which mode to use or whether to make a journey at all and hence has relevance in terms of *forecasting travel demand* by mode.

We would expect modes where travel time can be used in a worthwhile fashion to claim increasing competitive advantage as the opportunity for, and quality of, activities while travelling continues to increase. This could induce more overall travel as well as switching to these modes and perhaps also switching of operators, routes, destinations and departure times.

Not only might behaviour be influenced by the opportunity for and quality of worthwhile time use and increases in them, but time based elasticities might be also. Given that a change in time has the same impact on demand as a change in price when the latter is converted into equivalent time units using the value of time (λ), then we can express the time elasticity (η_t) as a function of the price elasticity (η_p) as:

$$\eta_t = \eta_P \frac{\lambda T}{P} \qquad (5)$$

where T and P are the prevailing times and prices. Given that λ will increase with income over time, we would expect η_t to increase over time, all else equal. However, if opportunities for worthwhile use of time continue to increase as a consequence of the digital revolution then this will lead to a dampening effect on the increase in η_t. Even if there is no direct relationship between time and price elasticities, we might reasonably expect estimated time elasticities to increase as time becomes relatively more important but for improvements in time use to reduce or offset such increases. In both cases, we might expect to see relatively smaller elasticities for modes, such as rail, where there is greater scope to use time in a worthwhile fashion.

A significant trend that is relevant to the issues being considered here is that the rail market in Great Britain retained growth despite the economic downturn of 2008 and subsequent financial austerity. The attractiveness of rail may well be increasing since it is in a strong position to allow travellers to exploit the increased opportunities to undertake activities while travelling. It is worth speculating that if the impact on the value of time has been only a 2% reduction in the value of time per annum, which is equivalent to a 2% journey time reduction, and knowing what we do about time elasticities, then this could account for growth in rail trips in excess of 1% per annum.

What we observe (Department for Transport, 2014) is that between 2007 and 2009 there was around a 5% reduction in real GDP per capita in the UK, and over the period 2007-2011 it was around a 4% reduction. Contrast this with increases in passenger kilometres on non-season tickets of over 7% between 2007 and 2009 and around 21% between 2007 and 2011, and set against the absence of large scale improvement in service quality or extensive price discounts. For passenger kilometres across all tickets, these figures were very similar for long distance and regional operators and also for London and South East operators over the longer time period (2007-2011). Whilst not claiming that these demand increases stem solely from increases in the worthwhile use of time, it would be hard to dismiss the latter as a contributory factor. Indeed, there was very buoyant rail demand growth prior to the financial crisis and improvements in digital technology could have contributed to it. Nor are such trends restricted to the UK[8].

Whilst drawing conclusions from such aggregate demand data is fraught with difficulties, in principle, econometric analysis could be undertaken of how demand and journey time elasticities are varying over time. We are not aware of such studies. In any event, isolating the dampening effect of more worthwhile use of time would be an order of magnitude more difficult than estimating any overall inter-temporal effect. We would point out though that the largest meta-analysis of time based elasticities of which we are aware (Wardman, 2012) did not find any variation in the elasticities by time period, nor any trend towards relatively lower elasticities for rail where the worthwhile use of time is more possible.

[8] Nash (2014) provides evidence on how rail demand in mainland Europe has grown over the period of the financial crisis between 2007 and 2011. Demand growth (and GDP changes in brackets) were: Germany 7% (0%); France 11% (-1.5%); Netherlands -4% (-0.4%); Spain 4% (-3.1%); Switzerland 15% (+3%); Belgium 5% (0.5%) and Sweden 11% (1%).

6. CONCLUSIONS AND RECOMMENDATIONS

This paper addresses an issue of very considerable significance to transport planning and appraisal. In the context of what can only be described as a modern-day transport revolution, brought about by significant, sustained and ongoing developments in portable digital technology and mobile communications, along with a travelling population clearly eager to embrace such developments, we are observing considerable reductions in the disutility of travel. These benefits are not being brought about in the conventional manner, where significant travel time savings are purchased through what can be enormous investment costs, but instead they stem from considerable, ongoing and, importantly, very widespread improvements in the opportunities for and quality of worthwhile use of travel time which in turn reduce the unit disutility of travel time. Indeed, it might be speculated that, in recent times, the benefits of the latter compare very favourably with the benefits of the former even without taking the considerable cost differentials into account[9].

Not only should these developments have a significant bearing on the appraisal of transport schemes, and indeed greater prioritisation of investment funds towards facilitating worthwhile use of travel time, but we can also expect there to be very appreciable financial and planning consequences of a shift towards modes that enable worthwhile use of time. To the extent that these are expected to be modes other than car, there will be notable environmental, energy, health and de-congestion benefits.

[9] Some very useful research might be conducted to test our speculation, and compare the benefits from time savings with the benefits (once quantified) of being able to spend time more usefully.

Although there have been significant advances in recent years in the ability to make worthwhile use of time spent travelling, the evidence for business and non-business travel indicates that there is scope for the proportion of travellers partaking of such opportunities to increase as those making considerable use of mobile technology form a larger proportion of the travelling population over time. Downward pressure on the value of time savings, all else equal, can be expected to continue due to cohort effects, existing technology becoming better and new technology emerging. In this context, we note that p and p* for car business trips are generally very low, and we might expect the equivalent for non-business car trips to be low, although there must be scope for developments here with 'hands free' devices as well as automated vehicles. Whilst the benefits of significant improvements in the worthwhile use of time have largely been discussed in the context of the developed economies, the trends in emerging economies might be expected to be particularly profound as digital technology becomes more available and affordable.

This paper provides the most extensive evaluation of how the worthwhile use of time and increasing opportunities for it are included in transport appraisal. An original aspect of the paper is to report and appraise the available international evidence on the productivity related parameters that enter the Hensher Equation relevant to business travel. We have also undertaken the most extensive examination of the extent to which worthwhile use of travel time has been allowed to influence valuations of travel time in the non-business market.

As far as business travel time savings are concerned, there has long been concern that the traditional Cost Savings Approach (prevalent across administrations that conduct cost-benefit analysis) overstates the benefits of travel time savings since it does not allow for the time savings encroaching upon productive use of travel time. This has been one of the central tenets of Hensher's alternative approach. The evidence covered here suggests that the Cost Savings Approach is becoming increasingly untenable and implies that there is a need to apply discounts, particularly for rail as is currently done in Sweden, and this can only be expected to increase over time and extend to other modes. The p and p* values are largest for rail, followed by air, bus and car, with the figures for car generally low. The figures are influenced by crowding levels for rail and there is some evidence that the p and p* values are, at least for rail, increasing over time.

When we examine the non-business travel market, we uncover that very little research has been conducted into the impact of worthwhile use of time on the value of time, despite the fact that the long-established neo-classical economics approach to the value of time savings includes a term that explicitly relates to the disutility of travel time itself. Nonetheless, there is now a large body of 'repeat-study' evidence, covering a quarter of a century, that does not demonstrate increases in valuations in line with income which is consistent with a dampening effect from the worthwhile use of time.

Although more difficult to estimate, and with even less available evidence, we might expect there to have been a switch toward modes which support the worthwhile of time and for an impact on travel time elasticities. European rail demand trends in challenging economic circumstances are consistent with the former.

As far as international appraisal practice is concerned, the Cost Savings Approach dominates for VBTTS. If the Hensher Equation is an accurate representation of the benefits of business travel time savings, then it would seem inevitable that discounts would have to be applied to the wage rate to account for increasingly productive use of travel time. However, another candidate approach is based around how much companies are prepared to pay to reduce their employees’ travel time. It is an empirical issue as to which is more appropriate. Matters are more clear-cut for non- business travel. Given the digital revolution has transformed travel and will continue to do so, it seems clear to us that the long tradition of increasing values of time directly in line with income will have led to inflated valuations given the dampening effect of worthwhile use of time on the marginal utility of time spent travelling. The empirical evidence also indicates this position is untenable. Given these uncertainties surrounding the value of time, the UK Department of Transport has made clear its intention to embark on a major programme of research covering journeys for all purposes and modes (Department for Transport, 2013).

The traditional approach to transport planning has been centred around primary journey purpose. We here show that in this modern digital age the opportunities to conduct a wide range of different activities while travelling and to transfer activities between travel and non-travel time requires a different approach to appraisal. We believe that treatment of travel time use and savings using different methods according to primary journey purpose is becoming less defensible. Assumptions about ownership of time as within the course of work (employer’s time) or outside the course of work (employee’s time) are ambiguous. It would be appropriate to consider whether a WTP approach that addresses all travel (that explicitly encourages consideration of worthwhile use of time) could overcome this.

As far as further research is concerned, the accurate calculation of the p, as opposed to p*, parameter of the Hensher Equation remains a challenge. There is also a need to obtain a better understanding of the influential variables, such as distance, size of time variation, gain or loss, crowding levels, type of time and in-journey facilities, not only to contribute to cross-sectional transferability but importantly to provide insights into how it might evolve over time.

Turning to non-business travel, there is a glaring need for further research into how the opportunities for the worthwhile use of travel time impact on the value of time, including the impacts of thresholds and non-linearities in how time can be spent usefully. However, it is not sufficient to simply include as a covariate in a standard value of time model what activities are being undertaken in the travel time. This is because those who have more important uses of travel time or for whom the 'boredom' of 'no activity' is greater will be more inclined to ensure that they have such things to do on the journey. As a result of this 'endogeneity', there is the confounding effect that those who are pursuing such activities might actually have higher values! We therefore cannot simply compare values of time across activity patterns of different people. Research would have to control for this by estimating the effect on any traveller's value of time, regardless of their existing value, of removing or diminishing the ability to undertake worthwhile activities while travelling. This would mean an SP exercise where the respondent is placed in the position of spending travel time undertaking their preferred activity compared to situations where the travel time is spent undertaking other activities.

With regard to both journey purposes, there is an undoubted need to determine how these changes in the worthwhile use of time impact on the demand for different modes. We are convinced that the effects that we are here dealing with are not neutral but equally convinced that there is a dearth of compelling evidence in this area. Nonetheless, the challenges facing econometric analysis to detect such effects are significant.

References

Abrantes, P.A.L. and Wardman, M. (2011) Meta-Analysis of U.K. Values of Time: An Update. *Transportation Research A* 45 (1), pp. 1-17

Algers, S., Lindqvist-Dillén, J. and Widlert, S. (1995). The National Swedish Value of Time Study. Paper presented at the PTRC European Transportation Forum. *Proceedings of Seminar F*, P393.

Batley, R.P. (2014) The Hensher Equation: Derivation, Interpretation and Implications for Practical Implementation. Transportation (in press)

Beca Carter Hollings and Ferner, Steer Davies Gleave, Forsyte Research and Brown Copeland and Co. (2002). *Project Evaluation Benefit Parameter Values*. Prepared for Transfund New Zealand.

Börjesson, M. and Eliasson, J. (2012) *Experiences from the Swedish Value of Time Study*. Working Paper 2012:8, Centre for Transport Studies, Royal Institute of Technology (KTH), Stockholm.

Börjesson, M., Fosgerau, M. and Algers, S. (2012). On the Income Elasticity of the Value of Travel Time. *Transportation Research A*, 46, 368-377.

Bruzelius, N. (1979) The Value of Travel Time, Croom Helm, London.

Coburn, T.M., Beesley, M.E. and Reynolds, D.J. (1960) The London-Birmingham Motorway. Road Research Technical Paper 46. London, HMSO.

DeSerpa A. J. (1971) A Theory of the Economics of Time. Economic Journal 81, pp.828-45.

Department for Transport (2012a) *Values of Time and Vehicle Operating Costs TAG Unit 3.5.6*. Department for Transport, August.

Department for Transport (2012b). *Public attitudes towards train services: results from the April 2012 Opinions Survey*. Department for Transport.

Department for Transport (2013) Understanding and Valuing the Impacts of Transport Investment. Department for Transport, October.

Department for Transport (2014) Transport Statistics Great Britain. www.gov.uk/government/statistics/transport-statistics-great-britain-2014

Drucker, P. (1999). Knowledge-worker productivity: the biggest challenge. *California Management Review*, 41(2), 79-94.

Fosgerau, M., Hjorth, K. and Lyk-Jensen, S.V. (2007). *The Danish Value of Time Study: Results for Experiment 1*. Danish Transport Research Institute, Lyngby, Denmark.

Foster, C.D. and Beesley, M.E. (1963) Estimating the Benefits of Constructing an Underground Line in London. Journal of the Royal Statistical Society, Series A, 126 (1) pp. 46-58.

Fowkes, A.S. (2001). *Principles of Valuing Business Travel Time Savings*. Working Paper 562, Institute for Transport Studies, University of Leeds, December.

Fowkes, A.S., Marks, P. and Nash, C.A. (1986). *The Value of Business Travel Time Savings*. Working Paper 214, Institute for Transport Studies, University of Leeds.

Gripsrud, M. and Hjorthol, R. (2012). Working on the train: from 'dead time' to productive and vital time. *Transportation*, 39, 941–956.

Gunn, H.F. (2001). Spatial and Temporal Transferability of Relationships between Travel Demand, Trip Cost and Travel Time. *Transportation Research E*, 37, 163-189.

Gustafson, P. (2012). Travel time and working time: What business travellers do when they travel, and why. *Time & Society*, 21(2), 203–222.

Hague Consulting Group (1990). *The Netherlands' Value of Time Study: Final Report*. Prepared for Dienst Verkeerskunde Rijkswaterstaat.

Hague Consulting Group (1998). *Value of Dutch Travel Time Savings in 1997*. Final Report to Rijkswaterstaat – AVV.

Hague Consulting Group, Accent Marketing and Research and Department for Environment, Transport and the Regions (1999). *The Value of Travel Time on UK Roads*. The Hague.

Harrison, A.J. (1974) The Economics of Transport Appraisal. Croom Helm, London.

Hensher, D.A. (1977). *The Value of Business Travel Time*. Pergamon Press, Oxford.

Hislop, D. (2013). Driving, Communicating and Working: Understanding the Work-related Communication Behaviours of Business Travellers on Work-related Car Journeys. *Mobilities*, 8(2), 220-237.

Holley, D., Jain, J. and Lyons, G. (2008). Understanding Business Travel Time Use and its Place in the Working Day. *Time & Society*, 17(1), 27–46.

Jain, J. and Lyons, G. (2008). The gift of travel time. *Journal of Transport Geography*. 16, 81-89.

Laurier, E. et al (2008). Driving and 'Passengering': Notes on the Ordinary Organization of Car Travel, *Mobilities*, 3:1, 1-23.

Lyons, G. (2006). *Travel Time Use – Developing a Research Agenda*. Report to Department for Transport.

Lyons, G. and Urry, J. (2005). Travel time use in the information age. *Transportation Research*, 39(A), 257-276.

Lyons, G., Jain, J. and Holley, D. (2007). The use of travel time by rail passengers in Great Britain. *Transportation Research*, 41(A), 107-120.

Lyons, G., Jain, J., Susilo, Y. and Atkins, S. (2013). Comparing rail passengers' travel time use in Great Britain between 2004 and 2010. *Mobilities*, 8(4), 560-579.

Mackie, P. J., Fowkes, A. S., Wardman, M., Whelan, G., Nellthorp, J. and Bates, J. (2003). *Value of Travel Time Savings in the UK*. Institute for Transport Studies, University of Leeds, Report to Department for Transport.

Mokhtarian, P.L. and Salomon, I. (2001). How Derived is the Demand for Travel? Some Conceptual and Measurement Considerations. *Transportation Research*, 35(A), 659–719.

Mott MacDonald et al (2009). *Productive Use of Rail Travel Time and the Valuation of Travel Time Savings for Rail Business Travellers*. Final Report to the Department for Transport.

MVA Consultancy. Institute for Transport Studies University of Leeds, Transport Studies Unit University of Oxford (1987). *The Value of Travel Time Savings*. Policy Journals, Newbury.

Nash, C.A. (2014) Comparison of How Rail Demand is Changing in Britain and Mainland Europe. Paper presented at PDFC Rail Demand Forecasting Conference, London. http://www.sparkrail.org/Lists/Records/DispForm.aspx?ID=15265

Pursula, M. and Kurri, J. (1996). *Value of Time Research in Finland*. Paper presented at the Value of Time Seminar, Easthampstead, Berkshire, 29-30 October.

Ramírez, Y.W. and Nembhard, D.A. (2004). Measuring knowledge worker productivity – a taxonomy. *Journal of Intellectual Capital*, 5(4), 602-628.

Ramjerdi, F. and Flügel, S. (2010). *The 2009 Norwegian Value of Travel Time Study*. Prepared for the Norwegian Public Roads Administration, The Norwegian National Rail Administration, The Norwegian Coastal Administration, Avinor AS and The Ministry of Transport and Communications.

Ramjerdi, F., Rand, L., Sætermo, I.F. and Sælensminde, K. (1997). *The Norwegian Value of time Study Part 1*. TØI Report 379. Report to Ministry of Transport and Communications, The Norwegian Railways, the Norwegian Public Road Administration and the Norwegian civil Aviation Administration.

Redmond, L.S. and Mokhtarian, P.L. (2001). The positive utility of the commute: modeling ideal commute time and relative desired commute amount. *Transportation* 28, 179–206.

Rittel, H.W.J. and Webber, M.M. (1973). Dilemmas in a General Theory of Planning. *Policy Sciences*, 4, 155-169.

Roberts, N.C. (2000). Wicked Problems and Network Approaches to Resolution. *The International Public Management Review*, 1(1), 1-19.

Significance, VU University Amsterdam and John Bates (2012). *Value of Time and Reliability in Passenger and Freight Transport in the Netherlands*. Report for the Ministry of Infrastructure and the Environment, The Hague.

Small, K.A., Noland, R., Chu, X. and Lewis, D. (1999). *Valuation of Travel-Time Savings and Predictability in Congested Conditions for Highway User-Cost Estimation*. Transportation Research Board, National Academy Press, Washington D.C.

Tapley, N., Wardman, M., Gunn, H. and Hyman, G. (2007). *Inter-Temporal Variations in Values of Time in Great Britain*. Paper Presented at European Transport Conference.

Taylor, F. (1911). *The Principles of Scientific Management*. Harper & Brothers, New York.

VSS (2009). SN 641 822a Zeitkosten im Personenverkehr: Kosten-Nutzen-Analysen im Strassenverkehr, EK 2.02, VSS, Zürich. (Erath, A., S. Hess and K.W. Axhausen).

Wardman, M. (2012) Review and Meta-Analysis of U.K. Time Elasticities of Travel Demand. *Transportation*. 39 (3), pp.465-490.

Wardman, M., Batley, R., Laird, J., Mackie, P., Fowkes, T., Lyons, G., Bates, J. and Eliasson, J. (2013). *Valuation of travel time savings for business travellers*. Prepared for the Department for Transport, February.

Watts, L. (2008). The Art and Craft of Train Travel. *Journal of Social and Cultural Geography*, 9(6), pp. 711–726.