



<b>Title</b>	The use of stated preference techniques to model modal choices on interurban trips in Ireland
<b>Authors(s)</b>	Ahern, Aoife, Tapley, Nigel
<b>Publication date</b>	2008-01
<b>Publication information</b>	Ahern, Aoife, and Nigel Tapley. "The Use of Stated Preference Techniques to Model Modal Choices on Interurban Trips in Ireland." Elsevier, January 2008. <a href="https://doi.org/10.1016/j.tra.2007.06.005">https://doi.org/10.1016/j.tra.2007.06.005</a> .
<b>Publisher</b>	Elsevier
<b>Item record/more information</b>	<a href="http://hdl.handle.net/10197/2873">http://hdl.handle.net/10197/2873</a>
<b>Publisher's statement</b>	All rights reserved.
<b>Publisher's version (DOI)</b>	10.1016/j.tra.2007.06.005

Downloaded 2026-05-01 23:34:16

The UCD community has made this article openly available. Please share how this access benefits you. Your story matters! (@ucd\_oa)



© Some rights reserved. For more information

# The use of stated preference techniques to model modal choices on interurban trips in Ireland

Aoife A. Ahern<sup>\*</sup>, Nigel Tapley

School of Architecture, Landscape and Civil Engineering, College of Engineering, Mathematical and Physical Sciences,  
University College Dublin, Earlsfort Terrace, Dublin 2, Ireland

---

## Abstract

The study examines the perceptions and preferences of passengers on interurban rail and bus and compares the preferences of passengers on both these modes. This is carried out to identify where passengers feel changes are needed to both modes to improve services, and to contrast the services offered by bus and train in Ireland. The preferences and perceptions of passengers are collected using both stated preference and revealed preference techniques. The impacts that different types of stated preference questionnaire have on the responses of individuals can, therefore, be examined. The study also compares stated preference models with revealed preference models and looks at if these can be pooled to take advantage of the benefits offered by both stated preference and revealed preference models.

© 2007 Elsevier Ltd. All rights reserved.

Keywords: Bus; Train; Interurban; Stated preference; Revealed preference; Modal choice

---

## 1. Introduction

This paper describes a study carried out to examine the perceptions and preferences of passengers on inter-urban routes in Ireland. Passengers on both bus and rail routes are examined. Many factors influence the demand for interurban travel. [Wardman \(2006\)](#) describes some of these as car travel time, car ownership, travel costs, fuel costs, population and GDP. Several of these factors are external to the rail and bus industry and so it is difficult for the industry to control them.

After decades of under-investment, there has been a fundamental change in the Irish Government's transport policy, driven primarily by safety considerations, committing significant new funding to the renewal and development of the rail system ([MPE, 2001](#)). The purpose of most of the Irish Government's investment in renewal and expansion of the rail services is to improve passenger transport and consequently increase the modal share of rail. Even though there is huge investment in railways, the question is 'will investment alone lead to increased demand for rail passenger transport?' especially when rail tickets prices are higher than the

---

competing intercity bus services and the relatively low cost of motoring and airline services in Ireland ( Ahern and Anandarajah, 2006).

Ireland is a small, modern, trade-dependent economy experiencing high economic growth in the last decade with an annual average growth rate of 7.6% in the period from 1991 to 2001. Public transport has an important role to play in supporting economic growth and social progress. Rail and bus are important modes of public transport for people mainly on intercity routes.

In this study, the preferences of passengers on interurban rail and bus journeys have been examined. The objective is to establish the differences between the passengers on both modes and the differences in the transport services that are available. In the conclusion, the consequences of these differences for transport policy in Ireland are discussed.

To gather data on the preferences and perceptions of passengers on both modes, a series of stated preference and revealed preference studies have been carried out on-board interurban trains and buses. Stated preference studies have been used in the past to look at the relative importance of different modal attributes. Hensher (2003) used stated preference studies to determine the value of time, for example. In the mid-1980s the Department of Transport in the UK conducted a major study into the value of travel time, using stated preference methods primarily ( MVA et al., 1987) and this proved to be a turning point for the acceptance of stated preference methods in the UK, as this study seemed to demonstrate that stated preference studies could give the same results as revealed preference studies but could do so more cheaply. Apart from the Strategic Rail Review ( Department of Transport, 2003) there have been very few studies of the value of time in the Irish context. Even in the Strategic Rail Review, it is unclear whether the value of time in this example was derived from Irish studies or whether it was adapted from international studies. Also the study assumes that individuals on different routes have the same values of travel time.

The paper is divided into several sections: the context of the study. Section 2 describes the studies that took place and includes discussions of the relative merits of revealed preference and stated preference studies, and the differences between the two methods. Section 3 describes the results of the study – both in terms of the differences between the stated preference and revealed preference studies and the usefulness of pooling Revealed Preference and Stated Preference studies and also the perceptions and preferences of rail and bus passengers, examining what these perceptions and preferences mean for transport policy.

## 2. The study context

Ireland's rail network follows a radial pattern, extending out from Dublin. The lines are controlled and operated by Irish Rail, a subsidiary company of CIE and there are nine interurban rail routes: Dublin–Cork, Dublin–Galway, Dublin–Limerick/Ennis, Dublin–Sligo, Dublin–Wexford/Rosslare, Dublin–Belfast, Dublin–Tralee, Dublin–Waterford and Dublin–Westport/Ballina. In terms of passenger numbers, the Dublin–Cork route is the busiest with 3.9 million passengers in 2002, while the Dublin–Westport is the least busy with 403,000 passengers in the same year. Altogether, the interurban rail network is estimated to have carried approximately 9.3 million passengers in 2002 ( Department of Transport, 2003).

There are several studies examining the use of rail and bus on interurban trips and on the factors that influence modal choice on these trips. Coto-millan et al. (1997) presented a theoretical model of intercity passenger transport demands (road, rail and air transport) in Spain using co integration and error-correction techniques. Owen and Phillips (1987) and Wardman (1997) analysed intercity rail passenger demand in Great Britain. The former used the tools of econometrics while the latter used direct demand models. Ponnuswamy (2004) finds out to what extent the fare structure and service level affect the patronage of urban rail transit in India. Other researchers such as Bel (1997) have looked at the impacts of non-monetary characteristics, such as travel time, on rail demand on interurban trips. Bel (1997) points out that journey time by rail represents a negative relationship with rail demand. Bel (1997) stresses the importance of road travel times on interurban rail. According to Bel's research (1997) journey time by road coach represents a positive relationship with rail demand.

In this study it was essential that participants had a choice between bus and rail for their journeys. This was because in this study the participants' SP responses would be compared to their real-world choices. Therefore, only routes where bus and rail were available could be included. In addition, only routes where bus and rail services were of a similar standard were considered. In this way it was hoped that individuals travelling on the

train could be expected to see the bus as a viable alternative and those travelling on the bus would see the train as an alternative. This led to the Dublin–Galway and the Dublin–Sligo routes being selected for the purpose of the study.

### 3. Survey design and distribution

In order to obtain information on the preferences and perceptions of passenger on bus and rail on inter-urban trips in Ireland, a study was carried out where questionnaires were issued on-board buses and trains on the Dublin–Sligo and Dublin–Galway routes. It was decided to use both a revealed preference study and a stated preference study and to explore the potential of pooling information from both studies. Therefore, the questionnaire was divided into two parts and each respondent was required to complete both parts of the survey. The first part contained a revealed preference study, collecting information on the individual's actual choices and the second section was a stated preference section where respondents were presented with a series of travel scenarios, which they were asked to choose between. Two types of state preference questionnaire were used:

- (1) Ranking
- (2) Stated Choice

This was with the intention of examining how using different stated preference questionnaires impact upon people's replies. [Hensher \(1994\)](#) states that there are three types of questionnaire that can be used in stated preference studies. These are: ranking, choice or rating. In a choice questionnaire, the task is simpler for the respondent. The respondent simply chooses the hypothetical combination of attributes that is most favourable to him or her and the researcher has an actual prediction of the respondent's choice in a hypothetical situation. In a ranking questionnaire, respondents must order the hypothetical situations in order of preference. In a rating questionnaire, the task becomes more complicated as respondents must be able to order their responses in order of preference but they must also be able to indicate how much they prefer one alternative over others. A rating questionnaire was not used in this study as it was considered to be too demanding for respondents. There is some evidence ([Hensher, 1994](#)) that in ranking questionnaires, there is limited relevant information provided below the 4th ranking of the respondent as at that stage it is too difficult for respondents to distinguish between choices.

Revealed preference and stated preference studies each have their advantages and disadvantages. According to [Swait et al. \(1994\)](#) the main advantage of using a revealed preference study is that it can represent current market situations better than stated preference studies. In revealed preference studies, the choices that are made by respondents are known outcomes, although they are dependent on the respondent's perceptions of attribute levels, which may or may not be accurate ([Hensher, 1994](#)).

Stated preference studies are less constrained than revealed preference studies and allow us to look at potential changes ([Swait et al., 1994](#)). Stated preference studies allow us to examine how decision-making varies as different types of attribute profiles and levels are considered ([Hensher, 1994](#)). Stated preference techniques were originally popularised by the work of [Louviere and Hensher \(1983\)](#) and [Davidson \(1973\)](#) in the 1970s and 1980s who demonstrated how researchers could examine trip-makers answers to hypothetical combinations of attribute levels for travel modes. In stated preference studies, outcomes are potential outcomes ([Hensher, 1994](#)).

According to [Wang et al. \(2000\)](#), stated choice and stated preference methods have limits, however. They are limited by a respondent's ability to understand the hypothetical situations with which they are presented and to provide reliable answers. [Wang et al. \(2000\)](#) argue that if hypothetical situations are far removed from the respondent's daily experience, the stated preference study will result in poor models and inaccurate results. Therefore, stated preference studies should have some relation to the real world. [Wang et al. \(2000\)](#) also make recommendations regarding strengthening stated preference models by some type of fusion with revealed preference models.

The complimentary strengths of revealed and stated preference studies should be emphasised. In this study, in addition to examining the transport choice and preferences of users, it is also an objective to look at how

revealed preference and stated preference studies might be used together to improve our understanding of travel behaviour and modal choice. Revealed preference studies allow researchers to examine actual choices made by travellers and to characterise how people really travel, while stated preference studies allow us to examine how people choices might change if there are changes in the alternatives available. [Cherchi and Ortuzar \(2006\)](#) argue that combining revealed and stated preference studies permits the advantages of both to be maximised while overcoming some of the limitations of each method. [Hensher \(1994\)](#) also states that using stated and revealed preference studies together can improve the explanatory power of revealed preference studies.

In the study described in this paper, each respondent completed a questionnaire that looked at their stated preferences and their revealed preferences. In the design of the questionnaire, a pilot study was conducted to examine the variables chosen. This questionnaire was distributed to public transport users in University College Dublin who had used interurban public transport in the past. The pilot questionnaires could not be distributed on the Dublin–Sligo or Dublin–Galway routes as permission was given to issue the surveys on each route on one day only by the relevant authorities. These authorities were worried about their customer being inconvenienced or annoyed by having to complete questionnaires.

The pilot questionnaires consisted of both a stated choice and ranking exercise. The variables used for the pilot study were cost, journey length, reliability, and presence of on-board toilet facilities and presence of catering facilities. This was to allow the researchers to examine particular factors that might make train travel more popular than bus travel on interurban routes – namely the inclusion of toilet and catering facilities. In Ireland, interurban rail has a very low modal share and the reason often given for this is that bus travel is relatively cheap, quick and comfortable, while there is a small rail network, ageing rail stock, low journey speeds and poor train frequencies. The data shows that in 2000, rail only accounted for 3.6% of modal share in inland transport, while bus accounted for 14.9% of modal share ([Eurostat, 2006](#); [Ahern and Anandarajah, 2006](#)).

The first three variables were varied over four levels while people could answer yes or no only to the last 2 variables. The values used for cost and journey length were based on the actual cost and travel time for a journey to Sligo. These values were then varied by  $\pm 10\%$  and  $\pm 20\%$  to obtain four levels for each. The levels used for reliability were “on time”, “10 minutes late”, “20 minutes late” and “30 minutes late”. A main effects design was used, from which profiles were randomly sampled to create the choice and ranking exercises. [Hensher \(1994\)](#) states that there should be enough attributes included in a stated preference study to allow respondents to answer meaningfully, in the context of the policies under study.

A sample of 20 individuals was obtained for the pilot study, 10 of whom also examined the revealed preference questionnaire. While this is a relatively small sample size, each individual was asked to complete seven choice replications (giving  $6 \cdot 20 = 120$  responses) and a six level ranking exercise (effectively  $5 \cdot 20 = 100$  choice responses).

The results of the pilot stated choice study gave the expected signs for each of the variables included, although the level of significance of the catering and toilet variables were below the critical value of 1.64 (t-values of 0.47 and 0.78 respectively). While the relatively small sample size used meant that the significance of the variables would be relatively low, it was decided that the catering variable would be excluded from the main study. Instead, it was replaced with a frequency of service variable.

The ranking model yielded similar results, again giving a relatively low level of significance to both the toilet and catering variables (t-values of 0.65 and 0.24 respectively). Similarly to the choice questionnaire, it was decided to replace the catering variable with a frequency attribute.

In the main survey, people were asked to indicate the purpose of their trips and people on business-related trips were excluded from analysis as [Balcombe \(2004\)](#) have found that people on business-trips tend to assign different levels of importance to their attributes of choice.

As in the pilot study, there were two types of stated preference questionnaire used: ranking and stated choice. There were three forms of stated choice questionnaire used: 5-choice set, 10-choice set and wide-attribute questionnaire. The 5-choice set questionnaire was distributed on the Sligo train, the Sligo bus and the Galway train. The 10-choice set questionnaire was only issued on the Sligo train as was the wide-attribute questionnaire.

The choice attributes used were cost, journey length, frequency, reliability and presence of toilet facilities. The first four variables were varied over four levels while the last variable was varied over two levels. A main effects fractional factorial design was used to create the profiles used in the experiment.

Table 1  
Questionnaires completed

Route	Mode	Questionnaire type (SP section)	% Questionnaires used	Number of questionnaires used
Sligo	Train	5-choice	75.7	28/37
		10-choice	83	25/30
		Wide-attribute	69	27/39
		Ranked	92	37/40
	Bus	5-choice	80	24/30
		Ranking	80	24/30
Galway	Train	5-choice	66.7%	24/36

As in the pilot survey, the levels chosen for the cost and journey time variables were based on the average values for a complete journey on each route. The levels used for frequency and reliability were the same for both routes. However, the levels used for frequency differed between the train and bus. It was found on both the Dublin–Sligo and Dublin–Galway routes that the bus service was more frequent; this was therefore reflected in the questionnaire design.

The 5-choice set questionnaire used the same basic design for all modes and routes. However, the cost and journey time variables were changed due to differences on each route. For each route, the average journey time and ticket price were obtained and varied by  $\pm 10\%$  and  $\pm 20\%$ . There were 16 profiles generated and random sampling was used to generate choice pairs. The 10-choice set questionnaire was designed in the same way although 10 choice pairs were sampled instead of 5. This was so the impact of varying the number of choice sets on people's responses could be assessed. Finally, the wide-attribute questionnaire also contained 5-choice sets although journey time and cost were varied more substantially ( $\pm 20\%$ ,  $0\%$ ,  $+33\%$  and  $\pm 66\%$ ).

The ranking questionnaire was distributed to Sligo bus and train users. This contained 6 options – 3 bus and 3 train choices. The respondent had to rank these in order of preference. The options were randomly selected using fractional factorial design. This allowed comparisons to be made between the ranking and choice questionnaires.

Hensher (2003) states that the ideal number of respondents required per design treatment is between 30 and 50 individuals. Accordingly, for the purposes of this study, 40 questionnaires were produced for each stated preference questionnaire type. It was hoped that this would allow for any incorrectly or inappropriately completed forms. Table 1 shows the response rates on each route and the number of questionnaires used.

Some questionnaires that were completed were not used for analysis for three reasons. First and most obviously, stated preference sections, which had been left blank, were not used. Second, the questionnaires were checked for non-trading behaviour. This occurs when the individual selects the same response option in all replications of the stated preference exercise. Typically, the mode selected in the stated preference questionnaire is the same as mode the individual has selected in real-life. Data from this type of response contributes no information about an individual's sensitivity to different design variables. As a result, these questionnaires were not included in the analysis. Third, the questionnaires were examined for lexicographic behaviour, which occurs when the individual uses only one attribute to determine their choice.

An on-board survey approach was decided upon early on in the project as time and resources were limited. It was hoped that this approach would maximise the number of respondents obtained. Interurban travel is well suited to on-board survey analysis as commuters have time to complete written questionnaires. Individuals were selected from the on-board population in a semi-random way (for example, individuals who were asleep were not selected). They were asked if their journey purpose was for business, or if they had free travel provided. It was also ensured that respondent's had a choice between the train and bus for their journey. If these criteria were met, they were shown the questionnaire, which was briefly described to them. They were then asked to complete the questionnaire, which was collected later in the journey.

#### 4. Results and conclusions

This research attempted to identify the factors that are important to travellers when choosing between bus and train on interurban trips in Ireland. The objective was to examine the preferences of passengers on

particular interurban routes on both bus and train. In addition, the research looked at the impact of different stated preference and revealed preference designs on the responses of travellers.

The results were analysed using Stata v 8.0. The choice data was analysed using the conditional logit algorithm, while the ranking data was analysed with the Rank-ordered logistic regression algorithm. Along with the coefficient estimates and their corresponding levels of significance, STATA also provides all of the basic post-estimation statistics, including include the goodness-of-fit indicator,  $R^2$ .

Tables 2–9 show the results.

In all cases, it was found that travel time and cost are the most important factors in people's choices of mode. While the relative importance of these attributes differed in the different stated preference designs, it was always the case that people chose modes based on cost of use and length of journey. On the other hand, while frequency and reliability had the expected signs, they seem to have relatively low levels of significance for people's modal choices.

Why is this? It may be because in the stated preference studies, people found it easier to measure the importance of time and cost to their decisions whereas frequency and reliability are more nebulous concepts to for respondents to grasp. Both the train and bus services on the routes are quite frequent and reliable. Therefore, people may undervalue these attributes. The concepts of expensive fares and long trips are more tangible to

Table 2  
Sligo train SC 5-choice set

Location	Mode	Survey type	Statistic	Result	Variable	Coefficient	t-Value	Standard error
Sligo	Train	5-choice set	Observations	280	Cost (€)	3.1746062	33.92	.0445236
			Log likelihood <sub>2</sub>	372.205928	Journey length (min)	3.41502	35.47	.0075926
			LR chi <sup>2</sup> (6df) <sub>2</sub>	49.67	Reliability (mins late)	3.0058429	3.38	.0154552
			Pseudo R <sup>2</sup>	0.2559	Toilet (1, yes; 0, no)	3.0535529	3.14	.028341
			Correctly classified	78.6%	Mode (1 train; 0 bus)	3.1856897	3.48	.3880756
			Value of travel time savings	€14.26/h				

Table 3  
Sligo train SC 10-choice set

Location	Mode	Survey type	Statistic	Result	Variable	Coefficient	t-Value	Standard error
Sligo	Train	10-choice set	Observations	500	Cost (€)	3.2208404	36.36	.0347343
			Log likelihood <sub>2</sub>	3125.55598	Journey length (min)	3.0392599	36.79	.005781
			LR chi <sup>2</sup> (6df) <sub>2</sub>	95.46	Reliability (mins late)	3.0165527	31.44	.0114648
			Pseudo R <sup>2</sup>	0.2754	Toilet (1, yes; 0, no)	3.1544009	3.52	.29280
			Correctly classified	76.3%	Mode (1 train; 0 bus)	.3652432	1.28	.2864597
			Value of travel time savings	€10.67/h				

Table 4  
Sligo train SC 5-choice set, wide attribute

Location	Mode	Survey type	Statistic	Result	Variable	Coefficient	t-Value	Standard error
Sligo	Train	5-choice set, wide attribute	Observations	270	Cost (€)	3.1946261	34.97	.0391962
			Log likelihood <sub>2</sub>	346.95371	Journey length (min)	3.0357553	35.59	.0063973
			LR chi <sup>2</sup> (6df)	93.24	Reliability (mins late)	.0095496	0.46	.0207964
			Pseudo R <sup>2</sup>	0.4982	Toilet (1, yes; 0, no)	3.7020393	31.3	.5410269
			Correctly classified	87%	Mode (1 train; 0 bus)	.2971777	30.75	3.3974854
			Value of travel time savings	€11.02/h				

Table 5  
Sligo train ranking

Location	Mode	Survey type	Statistic	Result	Variable	Coe cient	t-Value	Standard error
Sligo	Train	Ranking	Observations	222	Cost (€)	3.1371906	35.44	.0251992
			Log likelihood <sub>2</sub>	3199.4301	Journey length (min)	3.0182553	34.89	.0037361
			LR chi (6df) <sub>2</sub>	88.0	Reliability (mins late)	3.0234745	32.23	.0105126
			Pseudo R	.1808	Toilet (1, yes; 0, no)	3.2319077	3.81	.2855907
					Mode (1 train; 0 bus)	1.32378	4.64	.2854465
			Value of travel time savings	€7.98/h	Frequency	3.017794	3.10	.0174764

Table 6  
Sligo bus SC 5-choice set

Location	Mode	Survey type	Statistic	Result	Variable	Coe cient	t-Value	Standard error
Sligo	Bus	5-choice set	Observations	244	Cost (€)	3.1560293	33.58	.0436264
			Log likelihood <sub>2</sub>	367.864466	Journey length (min)	3.0293899	34.16	.0070679
			LR chi (6df) <sub>2</sub>	33.4	Reliability (mins late)	30.123048	30.9	.0137034
			Pseudo R	0.1975	Toilet (1, yes; 0, no)	3.8458008	32.04	.4128651
			Correctly classified	73%	Mode (1 train; 0 bus)	3.1480992	3.39	.3829692
			Value of travel time savings	€11.30/h				

Table 7  
Sligo bus ranking

Location	Mode	Survey type	Statistic	Result	Variable	Coe cient	t-Value	Standard error
Sligo	Bus	Ranking	Observations	144	Cost (€)	3.1415655	34.34	.0325814
			Log likelihood <sub>2</sub>	3135.6754	Journey length (min)	3.0145105	33.33	.0043549
			LR chi (6df) <sub>2</sub>	44.45	Reliability (mins late)	3.0079004	3.66	.012037
			Pseudo R	0.1408	Toilet (1, yes; 0, no)	.127021	.35	.367746
					Mode (1 train; 0 bus)	3.11468	3.33	.3461148
			Value of travel time savings	€6.15/h	Frequency	.0069501	.29	.23585

Table 8  
Galway train SC 5-choice set

Location	Mode	Survey type	Statistic	Result	Variable	Coe cient	t-Value	Standard error
Galway	Train	5-choice set	Observations	240	Cost (€)	3.1152467	32.79	.0413339
			Log likelihood <sub>2</sub>	358.534192	Journey length (min)	3.0904882	34.69	.0064972
			LR chi (6df) <sub>2</sub>	49.29	Reliability (mins late)	3.0231483	31.36	.01703
			Pseudo R	0.2963	Toilet (1, yes; 0, no)	3.9379646	32.06	.4546361
			Correctly classified	83%	Mode (1 train; 0 bus)	.0788568	.09	.8389891
			Value of travel time savings	€15.87/h	Frequency	.0148437	.45	.0327158

the passengers. It would be interesting to see if reliability and frequency are more highly valued on services that have poor reliability and frequency and where passengers are looking for improvements.

In the pilot studies, the presence of toilet facilities was examined. It was found to have a negative sign. However, a reason that this may have happened is that passengers perceive toilet facilities on Ireland's

Table 9  
Revealed preference model

Location	Mode	Survey type	Statistic	Result	Variable	Coefficient	t-Value	Standard error
	Revealed preference		Observations	264	Cost (€)	3.0214167	3.46	.0468484
			Log likelihood <sub>2</sub>	366.087774	Journey length (min)	3.0266892	32.31	.0115543
			LR chi <sup>2</sup> (6df) <sub>2</sub>	50.82	Reliability (mins late)	3.0693963	32.61	.0265787
			Pseudo R	0.2777	Out of vehicle time (mins)	3.031674	31.60	.0197749
			Correctly classified	79.4%	Excess cost (€)	3.2326152	31.98	.1174041
					Mode (1 train; 0 bus)	3.2784013	3.66	.423582

interurban rail network to be very poor and of low quality (CIE, 2002). It may be that passengers feel that the absence of a toilet facility is better than the presence of a substandard, poor quality toilet facility. This underlines the fact that it is not adequate to simply provide services on-board trains or buses without ensuring that these services are of a sufficient quality.

The mode attribute had a negative sign for 4 models and a positive sign for 4 models. However, it was significant only once – in the Sligo train-ranking model. In this ranking exercise it seems that respondents simplified the task by ranking the train modes more highly than the bus modes. In effect, they are using the relatively simple distinction between bus and train to be the main choice determinant.

In all other cases, the mode attribute was not significant. This implies that all things being equal, in most cases these travellers did not have a preference for either the train or the bus. This was contrary to what was expected. Conventional wisdom holds that people prefer the train to the bus as the train appears to have a better image than the bus. However, other studies have also identified that there is an overestimation of the inherent attractiveness of rail travel (Ben-Akiva and Morikawa, 2002). As Ben-Akiva and Morikawa (2002) state rail is usually seen as having some “image benefits” over bus travel. This would appear not to be the case in this study.

On the routes chosen, the bus services were very similar to the train services in terms of frequency and reliability. Therefore, it may be that the traditional image benefits associated with train travel were not present. In Ireland, coach travel is relatively inexpensive and vehicles are comfortable. Rolling stock for trains, on the other hand, is quite old. At present, almost half the fleet is virtually life expired. On average: the locomotives are over 28 years old, the locomotive hauled carriages are over 24 years old, and the rolling stocks are over 25 years old. The fleet age profile and the replacement of life expired rolling stock has been a significant issue in discussion on rolling stock with Irish Rail (Department of Transport, 2003).

Wardman (2006) showed that in London interurban rail travel is seen as a luxury good. However, in Ireland intercity rail services are not seen as particularly more luxurious than intercity coach services. In Ireland, it would appear that rail travel is not seen as a luxury good but as an inferior good. This may be due to old rolling stock and poor rail services. Some routes still have Mark II rolling stock from the 1970s in operation, although these were due to be phased out in 2007. This rolling stock is currently being upgraded and Mark IVs came into operation on the Dublin–Cork route in summer 2006 and on other routes at a later date, although industrial action in early May 2006 delayed this introduction of the new rolling stock. This new rolling stock may lead to changes, as rail travel may be perceived as more of a luxury good and the inherent attractiveness of train travel may become more apparent.

If rail services are to offer a realistic alternative to bus services and road travel on interurban trips, they need to be greatly improved. Kottenhof and Lindh (1996) demonstrated that high standard train services between cities will be more highly valued than bus services. At present, the train service in Ireland is not of a high service while the bus service that is offered is highly competitive. There are many private companies operating bus services on interurban routes, causing bus services to be of a high quality and vehicles tend to be quite young.

The value of time for train users in the stated preference studies ranged from €10.67/h to €15.87/h, and was consistently higher than the value of time used in the Strategic Rail Review, which put the value of time at €6.63/h. This would suggest that the value of time in the Strategic Rail Review has been underestimated.

The value of bus users time was €11.30/h. Train users value of time tended to be higher than that of bus users and this is consistent with other studies ( Balcombe, 2004).

Balcombe (2004) also suggests that interurban bus users have a lower value of time than train users (€10.50/ h vs. €12/h respectively). On the Galway route, there is intense competition between Bus Eireann and private operators (Citilink and Nestor). As a result of this, bus fares are relatively low on the Galway bus services compared to the train, which is not faced with direct competition. The price of an adult monthly return to Galway for Bus Eireann passengers is €16. This is approximately 44% of the price of an adult monthly return on the train service (€36.50). On the Sligo route, there is less competition between bus services, meaning that bus and train ticket prices are more similar. The price of a monthly return to Sligo for bus users is €23.50 while the cost for train users is €30. Therefore, Galway train users have a relatively high value of time compared to Sligo train users as they are paying a relatively high-ticket price for a similar saving in journey time.

The second objective of this study was to examine how different stated preference designs impacted upon the way respondents completed the exercise. To compare the effects of different stated preference designs on respondents, the 4 stated preference models estimated from the Sligo train users data were analysed. It was assumed that the preferences of individuals would be relatively homogenous as they were all train users on the same route. Therefore, any differences in the estimated models were assumed to arise from differences in the experimental design. The stated preference models were also compared with the revealed preference models to check if any of the stated preference data could be combined with real-world choice data.

The results of the pooled preference models are shown in Tables 10 and 11. The test statistic used for this test is given in the summary statistics as 'LR chi2(7d.f.)'. The next hypothesis to examine is whether the constituent data sets have the same degree of error variability. The chi-squared statistic for this analysis is given as 'LR chi2 (1d.f.)'.

It was found that the stated choice models from the Sligo train users could be combined as respondents had answered the questionnaires in the same way. While differences did occur between the three models, these

Table 10  
Pooled SP models – 5-choice set and 10-choice set

Location	Mode	Survey type	Statistic	Result	Variable	Coefficient	t-Value	Standard error
Sligo	Train	5-choice set and 10-choice set pooled	Observations	780	Cost (€)	.2072867	37.5	.0276317
			Log likelihood <sub>2</sub>	3198.7405	Journey length (min)	3.0407263	38.74	.0046593
			LR chi <sup>2</sup> (6df) <sub>2</sub>	143.17	Reliability (mins late)	3.0122753	31.33	.0092614
			Pseudo R	0.2648	Toilet (1, yes; 0, no)	3.11547	3.48	.2420344
			Correctly classified	76.03%	Mode (1 train; 0 bus)	.160203	.69	.2306539
			Value of travel time savings	€11.79/h	Frequency	.029228	1.68	.0173845
			Pooling stats	LR chi <sup>2</sup> (7df)	1.957184	LR chi <sup>2</sup> (1df)	.0455	

Table 11  
Pooled SP models: 5-choice set and wide-attribute models

Location	Mode	Survey type	Statistic	Result	Variable	Coefficient	t-Value	Standard error
Sligo	Train	5-choice set and wide-attribute models pooled	Observations	550	Cost (€)	3.1956021	36.72	.0291148
			Log likelihood <sub>2</sub>	3120.88614	Journey length (min)	3.0384235	37.84	.0048991
			LR chi <sup>2</sup> (6df) <sub>2</sub>	139.46	Reliability (mins late)	3.0000763	3.01	.0126976
			Pseudo R	.3658	Toilet (1, yes; 0, no)	.280254	3.87	.3230191
			Correctly classified	80.1%	Mode (1 train; 0 bus)	3.0937642	3.35	.2668328
			Value of travel time savings	€11.79/h	Frequency	.0130487	.57	.0227447
			Pooling stats	LR chi <sup>2</sup> (7df)	3.453004	LR chi <sup>2</sup> (1df)	.027712	

differences were not sufficient to reject the hypothesis of parameter equality. The pooling analysis also shows that the error variability in each of the stated choice models was equal, suggesting that the different designs do not affect the variability or randomness of individuals' responses. The wide attribution model gave the best fit and predictions. Respondents were presented with a lot of choices situated outside the normal expectations. The novelty of these scenarios may have caused respondents to consider their answers more carefully than the more typical choices presented in the 5 and 10-choice set questionnaires.

In comparison with Hensher (2003), this study also found that increasing the number of choice sets offered to respondents decreased the value of time in the resulting model. In this analysis, it appears that respondents gave a relatively equal weight to 'journey length' and 'cost' in the 10-choice set model (both t-values are similar), compared with the 5-choice set model. It is difficult to explain this behaviour as, before the analysis was conducted, it was assumed that the 10-choice set questionnaire would elicit a less considered response due to fatigue effects. However, the opposite may be true as both 'cost' and 'journey length' were given similar consideration while 'frequency' and 'reliability' were also close to an acceptable significance level. Thus, respondents may have given the lengthier task a more considered response.

The stated preference ranking model showed that the same decision-making process was not used in the choice and ranking exercises. This model combines both the 5-choice set and ranking Sligo bus data sets. In order to pool these two types of data, the ranking information must be converted into an implied discrete choice event where only one option is selected. This procedure is based on the assumption that a rank ordering of  $k$  options can be exploded into a set of  $k - 1$  independent choice events. In this example, the option ranked first (first-ordered ranking event) by respondents was treated as the chosen option from the choice set of six options. The remaining five options were considered to have been rejected in this choice event.

The 5-choice set data set was also pooled with the second, third, fourth and fifth order ranking choices to determine if the same decision process existed in these cases. The results of this analysis (Table 12) show that by the third order ranking event the fit of the pooled model has decreased to 0.0965 while the hypothesis of parameter equality can only just be accepted at the 0.05 level.

By the fourth order rank the fit of the model has increased and parameter equality can be accepted. However for the fifth and last rank order, we must reject the hypothesis of parameter equality. Thus it appears that, while parameter equality does exist for most of these cases, the overall similarity between the choice and ranking models decreases with increasing ranking levels.

This study argues that the stated choice experiments give more meaningful results than the stated ranking exercises. The stated choice exercises give the actual preference of the respondent while the ranking exercises need to be converted into useful predictions. It could be argued that the ranking exercises give more information about the respondents' choices but it would appear that at increased ranking levels, reliability of the responses is limited. It is more difficult to rank and give a degree of preference than to simply indicate a choice. Therefore, the authors would recommend stated choice studies over ranking studies. Hensher (1994) also argues that below the rank of 4, there is very limited information from ranking data.

The study also examined if pooling stated and revealed preference studies offered any advantages. There are those who believe that combining stated and revealed preference studies allows the advantages of both to be exploited while overcoming the limitations that are encountered with using only one of the methods (Cherchi and Ortuzar, 2006). The analysis demonstrated that only certain types of stated choice data could be combined with the revealed preference model. In this case the hypothesis of parameter equality could only be accepted for the 5-choice set data (see Tables 13 and 14).

One possible reason for this occurrence is the questionnaires' greater ability to replicate a real-world decision in which only one choice is made. The 5-choice set exercise is closest to this situation as it has the fewest

Table 12  
Pooled model results for different order ranking events

Ranking level	Pseudo $R^2$	LR $\chi^2$ (7df)	LR $\chi^2$ (1df)
2nd order	0.1875	3.331968	0.73104
3rd order	0.0965	12.719588	1.49876
4th order	0.1811	7.815786	0.649592
5th order	0.1734	14.899602	0.358338

Table 13  
Sligo train 5-choice set and RP model pooled

Location	Mode	Survey type	Statistic	Result	Variable	Coe cient	t-Value	Standard error	
Sligo	Train	5-choice set SP and RP model pooled	Observations	544	Cost (€)	3.1150881	33.95	.0291432	
			Log likelihood <sub>2</sub>	3146.74154	Journey length (min)	3.0353185	36.16	.0057379	
			LR chi <sup>2</sup> (8df) <sub>2</sub>	83.59	Reliability (mins late)	3.0303395	32.61	.0116372	
			Pseudo R	.2217	Toilet (1, yes; 0, no)	.2328759	.66	.3539841	
			Correctly classified	72.6%	Mode (1 train; 0 bus)	3.1372714	3.53	.2588386	
			Value of travel time savings	€18.41/h	Frequency	.0432528	1.79	.0240977	
					Travel time to/from station	3.29543	31.58	.0186661	
					Travel costs to/from station	3.155934	31.38	3.1130964	
			Pooling stats		LR chi <sup>2</sup> (9df)	16.895676	LR chi <sup>2</sup> (1df)	.00788	

Table 14  
Sligo bus SP 5-choice set and RP models pooled

Location	Mode	Survey type	Statistic	Result	Variable	Coe cient	t-Value	Standard error	
Sligo	Bus	5-choice set SP and RP model pooled	Observations	508	Cost (€)	3.1028589	32.74	.0375175	
			Log likelihood <sub>2</sub>	3141.09758	Journey length (min)	3.033791	34.46	.0075718	
			LR chi <sup>2</sup> (8df) <sub>2</sub>	69.92	Reliability (mins late)	3.05357	33.55	.0150832	
			Pseudo R	.1986	Toilet (1, yes; 0, no)	3.6942889	31.14	.6070105	
			Correctly classified	68%	Mode (1 train; 0 bus)	3.2166931	3.66	.3286259	
			Value of travel time savings	€19.71/h	Frequency	.0175812	.44	.0395295	
					Travel time to/from station	3.0302505	31.59	.0190761	
					Travel costs to/from station	3.1786155	31.55	.1149795	
			Pooling stats		LR chi <sup>2</sup> (9df)	14.29068	LR chi <sup>2</sup> (1df)	1.69528	

replications, possibly followed by the 10-choice set and then the wide-attribute exercise. As stated previously, the wide-attribute questionnaire presented respondents with attribute levels that were far outside their experience. Consequently, this may have influenced their decision process just enough for the rejection of parameter equality. In a similar way, the 10-choice set exercise required respondents to make 10 times the number of real-world choices, which may again have affected their decision process more than the 5-choice set exercise.

Therefore, the study shows that it is possible to pool some stated choice and revealed preference models but that care must be taken when doing this as it is not valid to pool all stated choice exercises with revealed preference data. Those stated choice exercises that mostly closely mirror real-world situations are the best candidates for pooling with revealed preference models.

However, is it useful to combine revealed and stated preference models? Revealed preference data allows researchers to examine the actual choices of travellers and to characterise their travel choices. However, this data is only useful for relatively short-term predictions and forecasts as it reflects the current situation only.

Stated preference data allows us to look at preferences in hypothetical situations and to make longer-term predictions. These forecasts may not, however, be reliable. Therefore, pooling the data from both types of models should allow the advantages of each to be maximised and the disadvantages to be minimised. However, if stated choice exercises are too different from real-world situations, as in the wide-attribute choice set, the results differ too significantly from revealed preference models for them to be pooled.

Pooling stated preference data with revealed preference data to estimate the benefits of attributes anchors stated preference data in the real world and to real decisions. However pooling stated preference and revealed preference data must be done with great care as not all stated preference studies can be pooled with revealed preference studies.

The authors would argue that there is some benefit from pooling stated and revealed preference data. Collecting revealed preference data is more accurate than stated preference data as we must treat what passengers say they are going to do with some cynicism. However, collecting only revealed preference data does not allow researchers to examine potential changes in the future or hypothetical situations.

In conclusion, the passengers in this study chose their modes based predominantly on the times and costs associated with travelling. Frequency and reliability appeared to be less important to travellers. Of particular interest was the fact that there did not seem to be an inherent preference for the train over the bus on these interurban trips. It is postulated that this might be because the traditional advantages that trains offer over buses – more comfortable vehicles, faster journeys – were not actually present in these situations. The passengers' experiences of train services in Ireland are that rolling stock is old and trains are relatively slow and therefore they did not demonstrate any preference for rail over bus in the stated preference studies. It may be that as train services are upgraded and as the Irish government continues to invest heavily in improving rail services that the inherent attractiveness of rail over bus will become more apparent to passengers. In conclusion, the lack of investment in rail services in Ireland have led to a service that is slow and rolling stock that is old. Therefore, while conventional wisdom holds that passengers value rail over bus on interurban trips, this was not the case in this study. Irish passengers have not experienced high-quality rail services that offer any great advantages over a competitive and reasonably priced rail service. Rail services need to be significantly improved if the inherent attractiveness of rail is to become apparent to passengers.

## References

- Ahern, A., Anandarajah, G., 2006. Influence of price and income on rail travel in Ireland. *Transport* 159 (4), 177–183.
- Balcombe, R. (Ed.), 2004. The demand for public transport: a practical guide. TRL Report 593.
- Bel, G., 1997. Changes in travel time across modes and its influence on inter-urban rail travel. *Transportation Research E: Logistics and Transportation Review* 33 (1), 43–52.
- Ben-Akiva, M., Morikawa, T., 2002. Comparing ridership attraction of rail and bus. *Transport Policy* 9, 107–116.
- Cherchi, E., Ortuzar, J., 2006. On fitting mode specific constants in the presence of new options in revealed preference/stated preference models. *Transportation Research A: Policy and Practice* 40, 1–18.
- CIE, 2002. Quality Customer Service Committee Annual Report 2002. Dublin Stationary Office.
- Coto-millan, P., Pino, Banos J., Inglada, V., 1997. Marshallian demands of intercity passenger transport in Spain: 1980–1992. An economic analysis. *Transportation Research Part E: Logistic and Transportation* 33 (2), 79–96.
- Davidson, D., 1973. Forecasting traffic on STOL. *Operation Research Quarterly* 24, 561–569.
- Department of Transport, 2003. Strategic Rail Review.
- Eurostat, 2006. Statistical offices of the European Commission. See <<http://epp.eurostat.ec.eu>> (last accessed 1 August 2006).
- Hensher, D.A., 1994. Stated preference analysis of travel choices: the state of practice. *Transportation* 21, 107–133.
- Hensher, D.A., 2003. Revealing differences in willingness to pay due to the dimensionality of stated choice designs: an initial assessment. Design of Designs Report #1, Institute of Transport Studies, The University of Sydney.
- Kottenhof, K., Lindh, C., 1996. The value and effect of introducing high standard train and bus concepts in Blekinge. Sweden, *Transport Policy* 2 (4), 235–241.
- Louviere, J.J., Hensher, D.A., 1983. Using discrete choice models with exogenous design data to forecast consumer demand for unique cultural events. *Journal of Consumer Research* 10 (3), 348–381.
- Minister for Public Enterprise, 2001. Iarnród Éireann: The Way Forward. Report to the Minister for Public Enterprise, by the review group established by the Minister for Public Enterprise.
- MVA, Institute of Transport Studies, University of Leeds, Transport Studies Unit University of Oxford, 1987. The value of travel time savings, *Policy Journals*, Newbury, Berkshire.
- Owen, A.D., Phillips, G.D.A., 1987. The characteristics of railway passenger demand: an econometric investigation. *Journal of Transport Economics and Policy* 21 (3), 231–253.
- Ponnuswamy, S., 2004. Patronage impacts of change in fares and services on urban rail transit in India. In: Proceedings of the International Conference on Transportation System Planning and Operations, February 18–20, 2004, IITM, Chennai, India, pp 297–306.
- Swait, J., Louviere, J.J., Williams, M., 1994. A sequential approach to exploiting the combined approach of stated preference and revealed preference data: applications to freight shipper choice. *Transportation* 21, 135–152.

- Wang, D., Borgers, A., Oppewal, H., Timmermans, H., 2000. A stated choice approach to developing multi-faceted models of activity behaviour. *Transportation Research Part A: Policy and Practice* 34, 625–643.
- Wardman, M., 1997. Inter-urban rail demand, elasticities and competition in Great Britain: evidence from direct demand models. *Transportation Research Part E: Logistics and Transportation* 33 (1), 15–28.
- Wardman, M., 2006. Demand for rail travel and the effects of external factors. *Transportation Research Part E: Logistics and Transportation* 42 (3), 129–148.