WORKING PAPER
ITS-WP-99-11

Measuring Service Quality and Evaluating its Influence on the Cost of Service Provision

By

Paola Prioni
& David A. Hensher

June,1999

ISSN 1440-3501

Established and supported under the Australian Research Council's Key Centre Program.

INSTITUTE OF TRANSPORT STUDIES
The Australian Key Centre
in Transport Management

The University of Sydney
and Monash University

1. Introduction

Although transportation researchers recognise output in all transportation industries as being multi-product and multi-dimensional, empirical studies on cost functions mainly restrict the specification of output to simple physical measures. Output in the bus industry has been measured in vehicle-kilometres, and alternatively in passenger-trips, as in Berechman (1987) or in bus-miles, as in Viton (1986). Other empirical studies have recognised the importance of the shape of the network (Windle, 1988, Filippini et al., 1992). Examples of network descriptions are the length of the network (eg Caves at al., 1985) or the number of stops (or stations) as in Filippini et al. 1992. More sophisticated descriptions consider the structure of the network in terms of the graph of a transport network (eg Filippini, 1991). Using the notions of nodes (stops) and arcs (connections) of a transport network, graph theory enables the derivation of a network indicator that contains information about length and structure of the network.

Several authors (eg De Borger, 1991) have pursued another approach based on hedonic output aggregator functions, specifying the cost function as a function of some output function.[1] De Borger, for example, specifies two Cobb Douglas type functions for F (Freight-kilometres) and R (Passenger-kilometres) for Belgian railroads. The cost function is estimated jointly with the aggregator function. A potential advantage of this procedure is that it is usually less parameter intensive and allows the use of flexible functional forms (Jara Diaz 1982).

However, despite the attempts to include service quality variables in cost function estimation, and the large amount of literature on the underlying dimensions of service quality in user preferences surveys (eg Pullen 1993, Swanson et al 1997, Cunningham et al 1997), previous cost studies simplify the concept of service quality and measure it without input from users of the service. This paper introduces a revised cost model in which output heterogeneity explicitly takes into account the level of service as perceived by users which impacts on costs. A service quality indicator (SQI) is derived from a revealed preference discrete choice model, enriched by a stated preference experiment, as a representation of the quality level currently on offer. Changes in service levels have a direct influence on costs as quality represents an input which has costs and an indirect influence via SQI and its parameterisation, which influences the demand for bus travel, which itself influences costs in a model in which physical output is defined by final demand. An important feature of our approach is the distinction between those attributes in an SQI which are directly linked to the cost of service provision and enter as additional arguments into the cost function, and those that are indirectly linked to the cost through their influence on final demand. The complete model system includes a cost function, a demand function for passenger travel, and a discrete choice model to identify the choice of bus service quality under alternative potential offerings.

The data for the empirical model system is sourced from a sample of bus operators and their passengers in New South Wales. The results have important consequences for bus operators and regulators. Firstly, for bus operators in terms of output cost elasticities, an improved understanding of customers' perceptions and use-responses of different service levels as well as the marginal cost of providing best-practice service quality. Secondly,

---

[1] Spady and Friedlaender (1978) used the hedonic approach first in the US trucking industry.

for transport regulators as input into establishing rules for competitive tendering and definitions of a performance assessment regime.

The paper is structured as follows: Sections 2 to 5 introduce the revised cost models, with Section 5 introducing the linkage between a cost function, a demand function and a discrete choice model. Section 6 presents the empirical approach. Estimation results derived from this model are discussed in Section 7. We conclude with comments on particular issues.

2. From the Traditional to the Revised Cost Model

In traditional microeconomic theory, a cost function is specified as a function of physical output y and factor prices $\vec{w}$. Equation *(1)* illustrates this relation:

$$C = c(y, \vec{w}) \qquad (1)$$

The cost function describes the minimum cost of producing a *given* level of output y at given factor prices $\vec{w}$. Output in all transportation industries is best described as multi-product and multi-dimensional. Bus operators provide seat-kilometres in school transport and regular passenger services. Depending on the composition of patronage we can distinguish output in student-kilometres or in regular passenger-kilometres. In general we can treat output as produced or consumed, alternatively referred to as intermediate and final output (Small, 1992). For example, vehicle (or seat)-kilometres are produced by the transit firm and used as inputs by passengers (together with fares and frequency, and other attributes of competing modes) in the production of final outputs such as passenger-kilometers (or trips). The service quality accounts for the multi-dimensional character of output. The quality standard in the provision of school services will probably differ in some aspects from the quality in regular passenger transport.

This output heterogeneity can be represented as:

$$C = c(y, \vec{w}, \vec{q}) \qquad (2)$$

Output is defined by the vector y specified as final output (i.e. total passengers or passengers-km). The vector $\vec{q}$ captures observable output quality dimensions, such as the availability of bus shelters, adherence to on-time running, the number of cleaning hours of the fleet, the length of the network and the amount of money spent on drivers' training.

Model *(2)*, given an appropriate functional form, could be estimated consistently if one assumes that the arguments y, $\vec{w}$ and $\vec{q}$ are exogenous. Factor prices can be considered as exogenous, based on the assumption that bus operators do not have monopoly power in factor markets. The final output cannot be assumed exogenous a priori, as the number of passengers is determined by passengers' travel behaviour. For this same reason we introduce in Section 5 the link between the cost function in *(2)* and a continuous passenger travel demand function.

What about the quality of service? To assess if service quality can be assumed to be exogenous or not, we require a better knowledge of its definition.

3. Service Quality

The concept of service quality includes aspects of transportation service which are not always well-defined and easily measured. For the purposes of this paper we define quality of service in terms of a set of attributes which each user perceives to be the sources of utility or satisfaction in bus use.

The dimensions of quality, viewed from a customer’s perspective, are complex. Consumers might consider the comfort at the bus stop and the time to get a seat, or only the comfort of the seats. Modal choice surveys have identified a large number of influences on the use of buses in contrast to other private and public modes. Service quality can be divided into six broad classes of effects, each containing different quality dimensions (Hensher, 1991). The left column of *Table 1* summarises one possible classification of the main influences on the demand side.

Table 1: Demand Side Effects and their Equivalence on the Supply Side

Demand Side Effects	Supply Side Equivalence
‘Getting to the bus stop” Quality -Ease, safe, time (distance), knowing where the bus stop is	*‘Getting to the bus stop” Quality* -frequency, availability of bus shelter and seats
Wait Quality -wait time at stop, punctuality of bus -wait comfort, wait safety	*Wait Quality* -frequency -availability of bus shelter and seats
Trip Quality -time to board a bus -time to get a seat -moving to your seat -travel time -trip cost	*Trip Quality* -frequency, % of low floor buses -number of seats available -average speed, network shape -travel time -fare
Vehicle Quality -cleanliness -comfort of seats (types), spaciousness -temperature control (ventilation) -noise -safety -modernity -ease of use for those with disabilities	*Vehicle Quality* -hours of vehicle cleaning/vehicle -% of buses with cloth seats -% of buses with air conditioning -visual surveillance -average age of the fleet -wheelchair access (yes/no)
Driver Quality -appearance -helpfulness	*Driver Quality* -years of driving experience, money spent on drivers’ training
Information Quality -pre-trip information	*Information Quality* -Avail. of timetable/destination signs

Source: Brewer and Hensher, 1997, Hensher, 1991, Swanson et al 1997.

Some demand side measures can be translated (or mapped) into a set of supply side equivalences (resources that the operator has partial or total control of) such as the timetable, fleet age, and/or the buses that are air conditioned; the number of vehicles that are wheelchair accessible, or the number of cleaning hours of the vehicles, and the money spent on driver training.

The attributes on the supply side are, in contrast to the quality attributes in the left column, to varying degrees, observable and under the direct control of the bus operator. For example a change in the average fleet size will have, *ceteris paribus,* a direct influence on the time to get a seat. On the other side we expect the supplied level of service quality to be a function of consumer preferences. If the supplied quality level is a response to customer preferences, and not only to some regulatory restrictions, quality exogeneity in model (*2*) cannot be assumed. In this circumstance we need to develop a capability to represent the quality of service as determined by users. The discrete choice approach is an appealing framework (see below). Given these considerations about service quality we are able to better discuss the model in *(2)* and introduce an improved version of the traditional cost model.

4. Deriving a Used-Based Service Quality Indicator

In Model *(2)* we defined a vector $\overset{1}{q}$ of measurable output qualities from an operator's perspective, as illustrated in the right column of *Table 1*. This model could be estimated consistently only if the assumption of exogenous quality dimensions holds. This could be the case, where the quality level in terms of timetable, age of the fleet, etc. is more or less determined from the government and not influenced by customer demand.

An alternative quality measure could be achieved by analysing customer preferences for different levels of bus service quality and deriving the utility of the actual supplied quality level. To this extent we need to identify and quantify the preferences for service levels from bus travellers. We restrict our analysis to actual bus users but recognise that non-users also provide useful information on the levels of service offered by bus operators. Within a performance regime based on the acceptability of service levels to actual users and with a focus on the service quality that influences operator costs, the emphasis on users is appropriate.

To reveal user preferences for service quality, we need to obtain data of sufficient richness to capture the behavioural responses to a wide range of levels of service quality defined on an extended set of attributes such as those given in *Table 1*. Revealed preference (RP) data is typically restrictive in its variance properties, but is an important input into the assessment. The preferred approach is a stated preference (SP) experiment combined with existing levels of service. A sampled passenger would evaluate a number of alternative service levels together with the level experienced and choose the most preferred. Systematically varying the levels of the attributes in repeated experiments enables us to obtain a profile of each passengers preferences for bus services. The data is analysed as a discrete choice model in which we combine the SP and RP data to obtain estimated parameters for each attribute. We estimate the simple multinomial logit model

(MNL) in which all random components are independently and identically distributed (IID)[2].

A service quality index (SQI) for each bus firm can be derived from the application of the parameter estimates to the current RP levels which each operator-specific passenger sample currently experiences. This index is not a probability (of choice) weighted indicator that is typically derived from a choice model (and referred to as the inclusive value or expected maximum utility index); rather we seek to establish an indicator based solely on the levels of service currently on offer. The SP-RP model's role is to provide a rich set of parameter estimates to weight each attribute of service quality.

Such a measure is useful as a stand alone index of passenger satisfaction for a performance assessment regime (PAR). It also provides the user-based service quality indicator for the passenger demand function (see below). The role of service quality is not only as an input, which influences operational costs, but it also represents an important determinant of passengers' travel demand. One of the principal difficulties in passenger travel demand studies is the specification of the relevant set of service attributes. Previous empirical studies on passenger demand restricted service quality specification to some measurable characteristics of the supplied service, which are normally selected from a limited set of observable variables. The service quality indicator we have derived represents a new contribution in service quality measurement as it is based on user perception for different quality levels and not on some set of ad hoc plausible quality attributes. It is the passengers' perception of quality changes, which has an impact on final demand and not the physical changes in some output characteristics.

Given its "users-character", SQI enters as a theoretically valid argument in a travel demand function. A general form of passenger demand can therefore be written as:

$$y = d(y_s, sqi_1,.., sqi_k, c, m, \vec{r}) \tag{3}$$

Or alternatively:

$$y = d(y_s, SQI, c, m, \vec{r}) \tag{4}$$

The first specification assumes passengers' travel demand as a function of the physical output y_s, the cost of the competing mode *c*, the income *m*, some socioeconomic variables $\vec{r}$ and the parameterised quality attributes sqi_1, ..,sqi_k. The *sqi's* are the components of the SQI and represent the weighted quality attributes levels resulting from the discrete choice model estimation. The alternative specification *(4)* considers service quality in its weighted aggregate form (*SQI*).

---

[2] The MNL and more advanced methods are discussed in detail in Louviere, Hensher and Swait (in press).

5. Interfacing the Cost Function with a Demand Function

This section provides the link between the cost function derived in *(2)* and the passengers' travel demand function derived in *(4)*[3]. The model recognises firstly output endogeneity in the cost function and secondly that the service quality indicator, via an impact of passenger demand, influences costs. For example, a change in the amount of time spent to access a bus stop will affect passengers' demand and therefore cost. However it may have a direct impact on costs if it is linked to the density of the bus network[4]. Another example could be a change in driver behaviour due to increasing driver training expenditure. In this case we might expect a double impact on cost: first through the increased training expenditure (affecting $\vec{q}$) and second through the induced change in passenger demand. As a consequence of this distinction, some of the attributes influencing a user-defined service quality indicator may not have a "mapped" counterpart ($\vec{q}$) in the cost function.

In summary, service quality can influence cost via both output y and $\vec{q}$. This makes intuitive sense and provides greater scope in evaluating the interactive influences impacting on both the demand for passenger services and the cost of delivering such service. The proposed system of equations is:

Operator Cost Function:

$$C = c(y, \vec{w}, \vec{q}) \tag{5}$$

$$\text{where} \quad \vec{q} = q(\overrightarrow{SQI})$$

Passenger Demand Function:

$$y = d(y_s, SQI, c, m, \vec{r}) \tag{6}$$

Quality of Service Choice Model (SP/RP):

$$SQI = f(x_1, ..., x_k) \quad k = 1, ..., K \text{ service quality attributes} \tag{7a}$$

$$= \sum_{i=1}^{K} \hat{g}_i x_i$$

(7b)

---

[3] Due to the restricted data sample of operators (in contrast to the large user sample) we prefer model *(4)* to model *(3)*.

[4] In this case a network variable should be specified in *(2)*.

The choice model *(7a)* identifies the parameter estimates γ_i of the service quality index (*SQI*) for each bus operator. This indicator feeds first into a bus passenger demand model *(6),* together with the relative cost of competing transport modes, etc. and is used to determine the demand for bus services. The demand function is specified as a continuous function of the supplied level of output (y_s), the quality indicator (*SQI*), the cost of competing modes (c), an income variable (m) and some socioeconomic chracteristics ($\vec{r}$). Only the quality attributes affecting directly operating cost enter in the cost function *(5)* as part of the vector $\vec{q}$. Quality attributes such as time spent walking to the bus stop directly affect y, and through y they impact on operator costs.

6. The Empirical Approach

The empirical study is focussed on the full model system with estimation of the choice, demand and cost models. The choice model requires data from a sample of bus users on their preferences for different bus service levels. An appealing paradigm, consistent with the economic theory, to obtain robust models of consumer behaviour is the combination of RP and SP data. The merging of these two data sources has been successfully applied in several empirical studies (eg Hensher, Louviere, Swait, 1999; Louviere, Hensher and Swait in press; Hensher, 1994). The major advantage of SP data compared with RP data is that they exploit a more extensive attributes space. RP (or market) data vary only within the frontier of the existing alternatives, restricting the variability of the quality attributes. Even within the technology frontier, the variability of service attribute levels in real markets is typically limited. Increasing the attributes' range through SP improves the identification of the willingness to pay for a particular service attribute, reduces the risk of multicollinearity and produces more robust parameters in the discrete choice model estimation. RP data has still to be considered, as it represents both an anchor around which the SP attributes levels are systematically varied and an important input into the evaluation of the expected maximum utility associated with a specific level of service quality (ie the SQI of a particular bus operator).

The following paragraphs outline the major phases in choice modelling. Section 6.1 discusses the choice of the relevant attributes and their levels in the SP experiment. Section 6.2 and section 6.3 provide details on the survey and the experimental design, respectively. In Section 6.4 we specify the cost and demand system for bus operators.

6.1 The selection of the attributes and levels for the experimental design

To assist in the selection of attributes for the stated preference experiment, we designed a broad based pilot survey instrument which listed the full set of service attributes (around 40) that potentially influence bus users' preferences. Thirty-nine metropolitan operators in Sydney were faxed the instrument and asked to evaluate each attribute on a 0-100 importance scale, using their own experience in assessing the relative importance to their passengers.

18 operators replied to the pilot survey. The attributes' rankings were analysed using descriptive statistics, frequency tables and factor analysis. To keep the experiment to a

manageable size, we restricted the number of attributes to 13. The selection of the key 13 service attributes for the SP design were based on the findings of the pilot survey, a literature research and interviews with bus industry specialists. The final set of the 13 attributes and their levels is shown in *Table 2*.

Table 2: The Set of Attributes and Attributes Levels in the SP Experiment

Attribute	Levels	Interpretation of levels
Reliability	3	• on time (2) • 5 minutes late (1) • 10 minutes late (0)
Fare	3	• 25% more than the current one-way fare (2) • same as now (1) • 25% less than the current one-way fare (0)
Walking distance to the bus stop (in minutes)	3	• same as now (0) • 5 minutes more (1) • 10 minutes more (2)
Waiting safety	3	• very safe (2) • reasonably safe (1) • reasonably unsafe (0)
Travel Time	3	• 25% quicker than the current travel time (0) • same as now (1) • 25% longer than the current travel time (2)
Bus stop facilities	3	• Bus shelter with seats (2) • Seats only (1) • No shelter or seats at all (0)
Air conditioning	3	• Available with no surcharge (2) • Available with a surcharge of 20% on existing one-way fare (1) • Not available (0)
Information at the bus stop	3	• Timetable and map (2) • Timetable but no map (1) • None (0)
Frequency	3	• every 15 minutes (2) • every 30 minutes (1) • every 60 minutes (0)
Safety on board	3	• The ride is very smooth with no sudden braking (2) • The ride is generally smooth with rare sudden braking (1) • The ride is jerky; sudden braking occurs often (0)
Cleanliness of seats	3	• Very clean (2) • Clean enough (1) • Not clean enough (0)
Access to the bus	3	• Wide entry with no steps (2) • Wide entry with 2 steps (1) • Narrow entry with 4 steps (0)
Driver attitude	3	• Very friendly (2) • friendly enough (1) • Very unfriendly (0)

Each attribute has three levels. We defined attribute levels to be realistic with values varying in a broad interval to ensure clear trade-offs between attributes. The number in brackets corresponds to the associated code in the SP experiment.[5]

6.2 The survey

---

[5] Note: the attribute "air conditioning" was added in a second stage, as experts found that the availability of air conditioning on buses influences operating cost and is an important policy issue in NSW. Similarly we introduced the attribute "access to the bus" defined by the number of steps and the width of the bus entrance as suggested by some specialists.

The sample selection is restricted to scheduled[6] bus users of 25 private bus operators in NSW. As our interest focuses on assessing traveller’s preferences or satisfaction for service quality for a specific bus service the exclusion of other modes is defensible. The survey is conducted as a simple “paper and pencil” survey. In the revealed preference part of the study, scheduled bus users reported details of their current trip in addition to some socioeconomic characteristics.

In the SP experiment passengers were asked to evaluate two other bus packages in addition to the service level experienced on their current trip and indicate which of the three bus packages they preferred. In a second question they reported which of the two additional bus packages (ie current bus package excluded) they preferred. Each respondent was asked to evaluate three SP experiments.

6.3 The statistical design

Through a formal statistical design the attribute levels are combined into *bus packages* before being translated into a survey form. The full factorial design (ie all possible bus packages) consists of 3^{13} combinations of the 13 attributes each of three levels. To produce a practicable and understandable design for the respondents, we restricted the number of combinations to 81 (ie 81 choice sets) using a fractional design. Fractional designs permit the reduction in the number of combinations (ie the number of bus packages) without losing important statistical information (see Louviere, Hensher and Swait in press).

The pre test of the survey showed that respondents were able to evaluate consistently three choice sets (ie different scenarios of bus packages). We reduced the number of different survey forms to 27. Each of the 32 bus operators received eight survey sets each consisting of 27 different survey forms or 27*8=216 survey forms and some instructions on how to organise the survey. An example of a choice set consisting of three paired comparisons is given in *Table 3*.

Table 3: Example of a survey form.

Bus Package of the Bus Company A	Bus Package of the Bus Company B
0 1 1 0 2 0 1 1 2 0 1 2 1	2 1 1 1 0 1 1 1 1 0 1 1 2
0 1 1 0 1 0 2 2 1 0 2 1 2	1 2 2 2 0 2 2 2 2 0 2 2 1
0 1 1 1 1 1 0 1 1 1 1 1 1	1 1 0 1 1 0 1 1 0 1 0 1 1

Each of the three coded lines correspond to a choice set or a scenario. The values 0, 1 and 2 correspond to the levels assigned to an attribute (see *Table 2*). For example, row 1 begins with a 0, which is the low level (10 minutes late) of the attribute “reliability” for the Bus Package of the Bus Company A in the first scenario.

6.4 The specification of the cost and demand function

To estimate the model system described in Section 5, additional financial and operational data from the sampled operators was required. The financial data provided by the

---

[6] Children travelling to school were excluded from the sample.

operators is critical to the study since we have to understand the impact that service levels have on cost. Given the small sample of operators, we assumed a production technology with four major inputs: labour, capital, maintenance and others.

Labor price (w_L) is defined as the ratio of annual labour costs (incl. on-cost) to total number of employees. Cost of maintenance divided by the total bus and coach seat capacity approximates the unit cost of maintenance (w_M). The capital price (w_C) is calculated as annualised capital cost divided by the number of vehicles in the operator's fleet.[7] Finally the item "other" (w_{OT}) summarises the unit price of those inputs not captured by the above three factors and is defined as residual cost per vehicle-kilometre[8]. The output of bus operators (y) is specified by the total number of passengers.

To explore the impact of quality changes on total cost, we add to the cost model four (supply-side) quality variables ($\overset{1}{q}$), which account for levels of resources committed to deliver service. q_{clean} is measured by the annual cleaning hours of all vehicles, q_{driv16} represents the percentage of drivers with more than 16 years of driving experience, q_{ontime} is defined as the percentage of on time buses per week (ie within 5 minutes of timetabled schedule), and q_{train} is the annual amount of money spent on drivers' training.

Given the above variable specification, the cost function for the 25 bus operators can be written:

$$\begin{aligned}\ln C = a_0 + a_y \ln y + a_L \ln w_L + a_C \ln w_C + a_M \ln w_M + a_{OT} \ln w_{OT} + \\ a_{ontime} \ln q_{ontime} + a_{driv16} \ln q_{driv16} + a_{clean} \ln q_{clean} + a_{train} \ln q_{train} + e\end{aligned}$$

(8)

In accordance with the model described in the expressions *(5)*, *(6)* and *(7)*, we specify a passenger travel demand model. The demand function that the operator faces is defined by:

$$\ln y = b_0 + b_{size} \ln SIZE + b_{SQI} \ln SQI + b_{inco} \ln INCO + m$$

(9)

The variable SIZE, measured by the total number of vehicles in the operator's fleet, represents the supplied output, *SQI* is the aggregated user-based quality indicator and *INCO* the average income of the operated area. A bus fare has not been specified in expression *(9)*, as it is already included in *SQI*. The variable for the price of the competing mode (car) is not included in the demand model because of the lack of variability in the analysed cross section. The cost function in *(8)* and the demand function in *(9)* are jointly estimated by three stage least squares (3SLS) using the method of maximum likelihood. A comparison of the estimated parameters for passenger demand in

---

[7] See Hensher and Daniels (1995) for a complete derivation of the capital price.

[8] Due to the lack of data we aggregated several cost items and derived a correspondent factor price.

the cost function in the presence and absence of the SQI variable enables us to derive an average cost of delivered service quality per passenger over the range provided in real markets.

7. The Empirical Findings

7.1 Results of the User Preference Model

Twenty-five operators returned data from the on-board RP-SP user survey. Each operator was invited to collect the data over an eight week period in April-May 1999. A total of 3,849 useable observations (out of 4,334 returns) were incorporated in the estimation of the discrete choice model. A multinomial logit (MNL) specification was selected. This is appropriate for a model form in which the utility expressions associated with the current trip and two attribute packages are unlabelled (or unranked) alternatives. Consequently all design attributes were generic across the three alternatives. In addition in the current trip alternative we considered alternative-specific characteristics of the passenger (income, gender, age and car availability) and of the operator together with a number of other potential influences on relative utility such a treatment effect, trip purpose and access mode.

The final user attribute choice model is summarised in *Table 4*. The model includes the attributes of the SP experiment, operator-specific dummy variables and three user characteristics. The overall goodness of fit (adjusted pseudo-R^2) of the model is 0.324. The service attributes provide very important information on the contribution of each service dimension to overall service quality (equating service quality from a user perspective to the derived utility from bus use). The 13 service attributes have been specified as either continuous where they are ratio scaled or as dummy variables on each attribute level relative to a base level. Reliability, fare, access time and bus travel time are ratio-scaled and enter each utility expression as a single attribute. The other nine attributes, each of three levels, are represented by 18 variables in the choice model. Frequency of service, although a potentially continuous variable has been specified as two dummy variables for reasons given below.

The great majority of the design attributes are statistically significant. Service reliability (ie the extent to which buses arrive on time), fares, access time and travel time are all highly significant with the expected negative sign. The value of bus travel time savings implied by the ratio of the parameter estimate of travel time to fare is $4.01 per person hour; and the value of access (to bus) travel time savings is $5.39 per person hour. This is impressive, lining up closely with the evidence from other studies. This adds much credence to the empirical outputs. When we consider the dummy attributes, we find systematically plausible results. Relative to ‘reasonably unsafe’, we find a positive (almost) significant parameter estimate for ‘reasonably safe’ (0.1510) and for ‘very safe’ (0.1889). The higher estimate for ‘very safe’ in contrast to ‘reasonably safe’ is plausible. The infrastructure at the bus stop appears not to be a major influence on service quality with both ‘seats only’ and ‘bus shelter with seats’ not being statistically significant relative to ‘no shelter or seats’. If reproducible in further studies this has important policy implications as to priorities in service improvement. The availability of air conditioning is another interesting result. We find that ‘air conditioning without a fare surcharge’ is not statistically significant relative to no air conditioning. In contrast the provision of air conditioning with a 20% surcharge on existing fares is statistically significant with a negative sign suggesting that users would sooner not have air conditioning if it means paying higher fares.

On-board safety defined by the smoothness of the ride is a statistically strong attribute. Relative to 'the ride is jerky with sudden braking occurring often', we find that 'the ride is generally smooth with rare sudden braking' and 'the ride is smooth with no sudden braking' are both very important positive attributes of service quality. This suggests both policy initiatives in driver skill as well as vehicle quality. Cleanliness of the bus is statistically significant when 'very clean' relative to 'not clean enough'. The non-statistical (1.830) significance of 'clean enough' suggests that we really have a dichotomy between very clean and not very clean. Ease of access to a bus, closely linked to the issue of accessible transport turns out to be not so important overall, presumably because the majority of users (including many aging users) are sufficiently healthy to not be concerned with the configuration of steps and entry widths. The attitude of the driver is a statistically strong influence on a user's perception of service quality. Indeed, relative to 'very unfriendly' we might expect a significant increase in the mean parameter estimate when we go from 'friendly enough' to 'very friendly'. This is the most non-linear effect on utility of all the attributes of service quality. Finally, the availability of information at the bus stop (timetable and map) is statistically important compared to 'no information', although surprisingly the key information item is a timetable, with a map being a liability (possibly because of experience with vandalism?).

Finally, bus frequency defined as 15, 30 and 60 minutes was found to be significant when treated as a dummy variable distinguishing 60 minutes from 15 and 30 minutes. There is a strong negative sign for the 60 minute dummy variable suggesting that a 60 minute service reduces relative utility significantly compared with a service frequency of every 15 or 30 minutes. Not statistically significant is the 30 minutes dummy variable, defined equal to one for frequencies equal to 30 minutes.

Table 4: Final User Preference Model

Variable	*Units*	*Acronym*	*Parameter*	*t-value*
Reliability	mins	RELI	-.05821	-8.411
Bus fare	$	TARIF	-.4780	-6.406
Access time	mins	ACCESST	-.04317	-5.311
Bus time	mins	TRATIM	-.03200	-5.435
Very safe	1,0	VSAFE	.18895	2.255
Reasonably safe	1,0	RSAFE	.15108	1.820
Seats only at bus stop	1,0	SEATS	-.03411	-.510
Seat plus shelter	1,0	SEATSHEL	.09040	1.503
Air conditioning free	1,0	AVALFREE	.07131	1.112
AC at 20% extra fare	1,0	AVALPAY	-.17432	-2.207
Ride-generally smooth	1,0	GSBRAKE	.20788	2.963
Ride-very smooth	1,0	VSNBRAKE	.35232	4.904
Clean enough	1,0	CENOUGH	.13867	1.830
Very clean	1,0	VCLEAN	.20446	2.713
Wide entry/2 steps	1,0	WIDE2STP	.09589	1.499
Wide entry/no steps	1,0	WIDENSTP	-.10319	-1.372
Driver friendly enough	1,0	FRIENDEN	.19798	2.572
Driver very friendly	1,0	VFRIEND	.42287	5.564
Timetable only	1,0	TIMNOMAP	.29609	4.745
Timetable and map	1,0	TIMWMAP	.19720	3.021
Frequency/every 60 mins	1,0	FREQ60	-.58595	-6.902
Frequency/every 30 mins	1,0	FREQ30	-.12221	-1.640
Female	1,0	FEMALE	.09986	1.198
Personal income	$’000s	PINCO	.00905	3.817
Age of passenger	years	AGES	.01379	5.787
Operator 1	1,0	Op1	.37358	1.671
Operator 2	1,0	Op2	.19642	.654
Operator 3	1,0	Op3	-.94098	-5.497
Operator 4	1,0	Op4	-.17726	-1.080
Operator 5	1,0	Op5	-.12964	-.653
Operator 6	1,0	Op6	.97267	1.937
Operator 7	1,0	Op7	-.18127	-0.982
Operator 8	1,0	Op8	.35723	1.294
Operator 9	1,0	Op9	-.26210	-1.215
Operator 10	1,0	Op10	-.56626	-1.845
Operator 11	1,0	Op11	-1.2555	-4.850
Operator 12	1,0	Op12	-.22189	-0.842
Operator 13	1,0	Op13	-.47366	-1.210
Operator 14	1,0	Op14	.01784	.072
Operator 15	1,0	Op15	.06911	.084
Operator 16	1,0	Op16	-.37973	-1.685
Operator 17	1,0	Op17	.06878	.292
Operator 18	1,0	Op18	-.36574	-0.825
Operator 19	1,0	Op19	1.1207	4.218
Operator 20	1,0	Op20	.10014	.488
Operator 21	1,0	Op21	.11275	.546
Operator 22	1,0	Op22	.32239	.781
Operator 23	1,0	Op23	-.53292	-1.845
Operator 24	1,0	Op24	.08878	.161
Log-likelihood		-2839.25		
Pseudo R^2 (adjusted)		0.324		

The socio-economic characteristics sought from bus users were limited to personal income, age, gender and car availability. We found that individuals on higher incomes and of more years were more likely to prefer the levels of service offered by the existing trip than by the alternative packages. What this suggests is that as individuals age and increase their income, they see existing service quality as increasingly satisfying their requirements for service quality. Alternatively it is the younger and those on lower incomes that see a greater need for improved service quality. Car availability was not statistically significant.

We investigated the potential for systematic bias due to the sequence in which the SP treatments were given on the survey instrument. We were not able to find any evidence of bias in selection from the current and two alternative service packages. We also analysed possible effects of the survey administration since a range of data collection procedures were implemented across the 25 operators (see *Table A* in the Appendix). For example, drivers were involved in the forms distribution in some cases while inspectors were involved in some other instances. A series of dummy variables were introduced distinguishing distribution and collection by (i) the driver, (ii) an inspector who stayed on board and explained the survey, and (iii) an inspector handing out forms with a reply post-paid envelope to return the forms at a later date. The distribution and collection procedure was not a statistically significant influence on the choices made by respondents, despite the ex ante suggestion from some bus operators that the responses would be systematically biased (in favour of current service) by an approach which may appear to be coercing passengers to participate.

Trip purpose, with the exception of commuting, did not statistically impact on the choice, while commuting was marginally significant. We excluded commuting from the final model so as to limit the amount of data that will be needed to be obtained when constructing a service quality index for operators who were not participants of the SP survey. As a consequence the commuter effect is absorbed into the operator-specific dummy variables (assigned to the existing trip alternative). With 25 bus operators we have 24 operator-specific effects. These effects account for *other* influences on choice that are unique to each operator. A negative sign on the parameter estimate implies that a bus operator is perceived by users as delivering a quality of service that is, relative to the base operator, worse. By comparing the absolute magnitude of the parameter estimate we can see the extent to which an operator is delivering a service that is worse than other operators after allowing for the attributes explicitly taken into account from the SP experiment. We can see from *Table 4* that operators 3 and 11 have the highest negative operator-specific parameter estimates while operators 1, 6 and 19 have the highest positive operator-specific estimates.

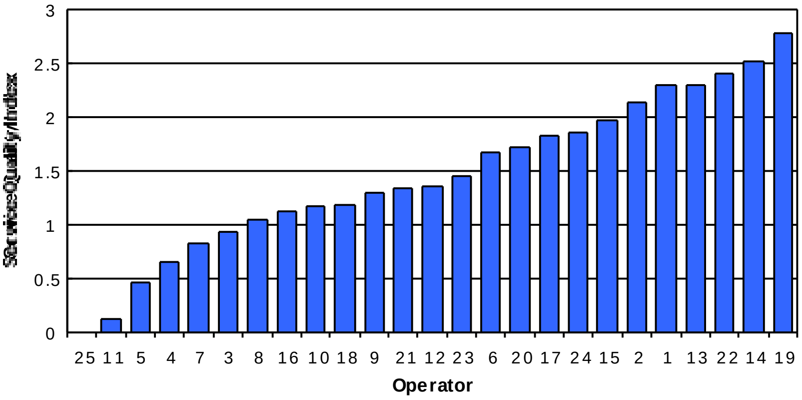
The Service Quality Index (SQI) for each operator can be calculated by the application of the utility expression in *Table 4* and the levels of each of the attributes associated with the current trip experience of each sampled passenger. In this initial study we have estimated a single set of utility weights across the sample of 3,849 passengers using the services of 25 operators. We investigated possibilities of differences in weights between segments of operators (eg Sydney metropolitan vs regional vs country towns) and found no statistically significant differences. This is most encouraging, suggesting a similar pattern of preferences of passengers across all operating environments. This does not mean however that the levels of service offered on each service attribute are the same (indeed there is substantial variation as shown in *Figure 1* of the mean and standard deviation of each attribute for each operator). Rather what we are noting is that the marginal utility of each attribute (ie the mean parameter estimate of part-worth weight) is well represented by a single mean estimate across all operators.

The SQI developed for each operator is summarised in *Table 5* and graphed in *Figure 1* at its mean for each operator. We have normalised SQI in Figure 1 to a base of zero for the operator with the lowest relative SQI. The range is from 0 to 2.70. This estimate is the SQI indicator imported into the passenger demand model.

Table 5: Summary Statistics of Service Quality Index

Operator	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*	*Sample Size*
1	0.5311	0.788	-2.39	2.28	249
2	0.3900	0.894	-1.87	2.00	96
3	-.8178	1.248	-4.88	1.92	508
4	-1.098	0.927	-5.58	0.58	374
5	-1.2840	1.406	-5.46	0.84	196
6	-.8377	0.383	-.525	0.80	24 *
7	-.9263	1.297	**-6.74**	1.82	412
8	-.7113	0.566	-2.12	0.44	150
9	-.4597	0.685	-2.55	1.06	173
10	-.5805	0.904	-3.06	0.67	64 *
11	-1.628	0.979	-4.55	0.55	90
12	-.3923	1.000	-3.80	1.40	100
13	0.5435	0.483	-.434	1.28	41 *
14	0.7636	0.940	-2.28	2.61	180
15	0.2079	0.637	-.638	0.692	9 *
16	-.6345	0.958	-4.00	1.03	159
17	-.0649	1.089	-2.86	2.09	190
18	-.5687	1.206	-3.24	1.04	27 *
19	**1.0174**	0.947	-.990	**2.70**	203
20	-.0444	0.639	-1.43	1.55	224
21	-.4212	0.852	-3.45	1.17	227
22	0.6466	0.643	-.600	2.01	46 *
23	-.3076	1.034	-4.28	.808	65*
24	.1051	1.156	-2.17	1.42	22*
25	**-1.7579**	.875	-3.01	-.096	20*
All	-.4067	1.224	-6.74	2.70	3849

Figure 1: The benchmarking of Mean SQI across operators (operator 25 set =0)

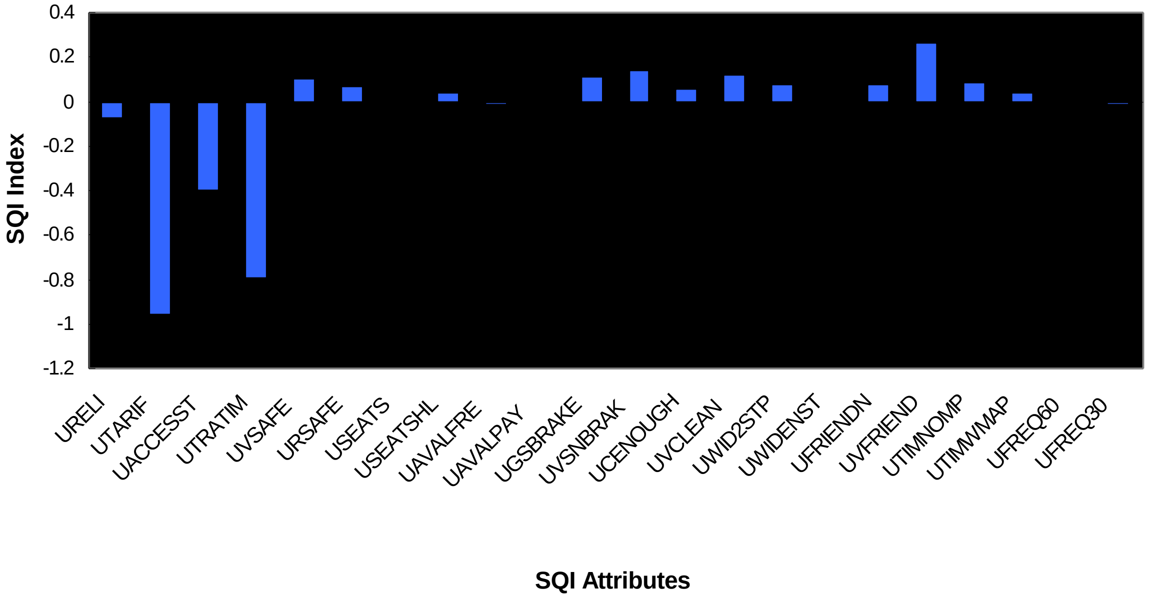


The parameters' estimates allow us to derive other interesting results. *Figure 2* shows the contribution (in terms of utility) of each single quality attribute over the entire sample[9]. Tarif (UTARIF), travel time (UTRATIM) and access time (UACCESST) have the highest impact on service quality On the positive side of SQI the major influence is given by the friendliness of the driver (UVFRIEND) and the smoothness of the ride (UVSNBRAK).

---

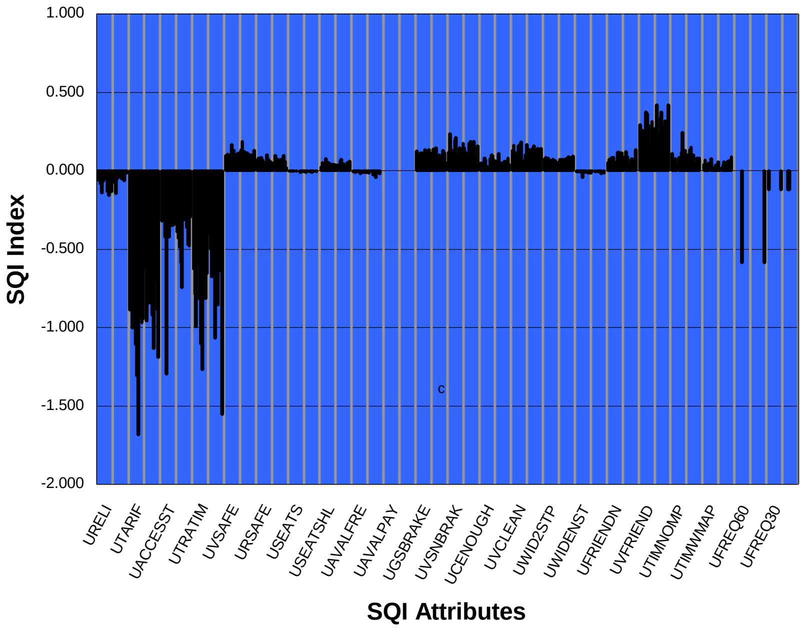
[9] See Table 4 for a complete list of the attribute definitions.

Figure 2: The SQI Composition



The same kind of figure can be plotted for the 25 bus operators in the sample. *Figure 3* confirms the major influences found over the sample and shows “nicely” shaped attributes’ distributions with the exception of few outliers. This kind of analysis is very useful for bus operators as it depicts in a very understandable way the dominant service quality dimensions representing at the same time an effective managerial decision making instrument.

Figure 3: The SQI Composition for each Operator in the sample



7. 2 Results of the cost and demand model

Twenty-one operators provided a complete set of financial and operational data for the financial year 1997/1998. Estimation results for the cost model *(8)* and the demand model *(9)* are presented in *Tables 6a* and *6b*. Both tables report the results of the joint model with the only difference that the model in *Table 6b* does not include *SQI* in the demand function.

Although the adjusted R^2 is only an indicative criteria in assessing the overall goodness of fit of a nonlinear model system, its high value still implies that the model "fits' well. The results from both models have a high degree of similarity emphasising the stability of the model. The parameters of labour and maintenance price are both significant and carry the expected signs. However, the unit price of capital and of the residual input ("other") do not seem to influence total cost. The low explanatory power of these variables is probably due to the small sample size.

The parameters of the output variable, 0.963 and 0.925, respectively suggest a slight presence of economies of scale. This result confirms the findings of a previous study by Hensher (1987) on 15 Australian urban bus firms in 1986. Moreover, the comparison between the two model specifications indicates a slight downward bias in the parameter estimates, implying an underestimation of the output cost elasticity.

The results obtained for the supply-side quality variables confirm partly our expectations. The variable representing driver experience is not significant (though positive). It should be noted however, that the influence of this variable is indirectly captured by the labour price variable. The parameter estimate a_{ontime} indicates that an improvement in service reliability (in terms of an increase in the percentage of on time buses per week) increases cost. The reason could be represented by the higher cost incurred in coordination, supervision and adoption of GPS, etc. An increase in annual cleaning hours increases total operating cost, as expected, as evidenced by the positive and strong significant parameter a_{clean} (.155 and .153).

Table 6a: Estimation Results of the Cost and Demand Model (3SLS)

Cost Model (8)

Dependent Variable ln(Total Cost)

Variable		Parameter	t-value
Constant	a_0	-13.127	-2.942
ln(Output (tot passengers))	a_y	.963	16.629
ln(Labour price)	a_L	1.144	3.446
ln(Capital price)	a_C	.034	.388
ln(Maintenance price)	a_M	.481	4.808
ln(“Other” price)	a_{OT}	.092	.742
ln(% of on time buses per week)	a_{ontime}	-.081	-2.267
ln(% of drivers with more than 16 years experience)	a_{driv16}	.062	1.323
ln(Cleaning hours of all vehicles)	a_{clean}	.155	4.489
ln(Tot expend on drivers’ training)	a_{train}	-.155	-4.484
Adjusted R^2 0.906			

Demand Model (9)

Dependent Variable ln(Total Passengers)

Variable		Parameter	t-value
Constant	b_0	5.133	2.387
ln*(SIZE)*	b_{SIZE}	.924	10.450
ln*(SQI)*	b_{SQI}	.026	.313
ln*(INCO)*	b_{INCO}	568	2.672
Adjusted R^2 0.849			

Finally the parameter of the attribute “training cost” suggests that a growth in driver training expenditure decreases operating cost. Training costs are not included in the dependent variable. We conclude that higher investments in human resources succeed in attaining significant cost savings through productivity and efficiency gains.

For the demand model, the parameters of fleet size (SIZE) and income (INCO) are significantly different from zero, indicating that an increase in the *produced* output (measured here by the size of the fleet) as well as an income increase result in a demand increase. The results suggest inelastic demand for bus passengers with respect to both attributes. Similar results are obtained by Appelbaum and Berechman (1991) using data from the Israeli bus transit sector. We also tested for cars per capita and found it was highly correlated with income. The service quality indicator does not (though positive) have a statistically significant influence on passenger demand, due largely, we suspect, to the small number of operators and the large variability in SQI. The lack of a restricted range of observations also prevented the specification and testing of more flexible demand functions.

Table 6b: Estimation Results of the Cost and Demand Model (without SQI)

Cost Model (8)
Dependent Variable **ln(Total Cost)**

Variable		Parameter	t-value
Constant	a_0	-11.954	-2.468
ln(Output (tot passengers)	a_y	.952	15.680
ln(Labour price)	a_L	1.051	2.953
ln(Capital price)	a_C	.026	.301
ln(Maintenance price)	a_M	.484	4.935
ln(“Other” price)	a_{OT}	.084	.710
ln(% of on time buses per week)	a_{ontime}	.081	-2.267
ln(% of drivers with more than 16 years experience)	a_{driv16}	.072	1.440
ln(Cleaning hours of all vehicles)	a_{clean}	.153	4.466
ln(Tot expend on drivers’ training)	a_{train}	-.155	-4.464

Adjusted R^2 0.908

Demand Model (9)
Dependent Variable **ln(Total Passengers)**

Variable		Parameter	t-value
Constant	b_0	5.392	2.596
ln*(SIZE)*	b_{SIZE}	.930	10.608
ln*(INCO)*	b_{INCO}	.541	2.651

Adjusted R^2 0.858

The joint estimation of the cost and demand models with and without the service quality variable (Table 6a cf 6b) enables us to derive the average cost of delivered service quality per passenger over the range provided in real markets. By computing the difference between the the estimated parameters for passenger demand in the cost models ($e^{.963}$-$e^{.952}$) and multiplying this difference by the annual number of scheduled passengers we estimated the cost impact of service quality for each operator (see *Figure 4*).

Figure 4: Cost of delivered service quality by operator

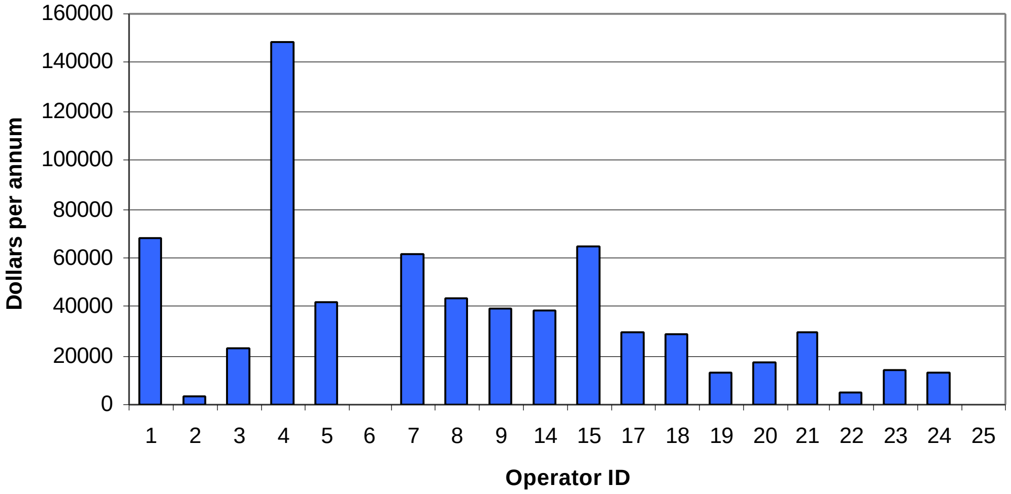


Figure 4 describes the annual cost in dollars of the delivered service quality for the produced output level (ie scheduled passengers) for each operator. Apart from operator 4, who is a relatively large bus company and a few very small operators, the values obtained for the other operators are between $12,750 and $68,505 and an average of $35,000. To gain insight into these results, we have determined the average extra burden to be added on top of the average bus fare. Assuming an average fare of 2 dollars the supplementary fee to be charged as internalisation of service quality costs amounts to 3 cents. This results in an average total bus fare per trip of 2.03 dollars.

This result is very important from a managerial point of view since it establishes the effective cost of service quality supply and how this could be translated in the form of a fare surcharge. Similarly, regulators have an instrument capable of estimating the extra cost of additional quality requirements in a performance assessment regime.

Conclusions

This paper has presented a new approach to measuring service quality and incorporating a user-based service quality index (SQI) into a passenger demand and operator cost function. An SQI enables the regulator and a bus operator to benchmark service effectiveness, adding this much neglected dimension of performance assessment. We have now filled a gap in the literature on performance measurement, establishing a global measure of service effectiveness to parallel the global indicators used to measure cost efficiency and cost effectiveness (ie total factor productivity) (see Hensher 1992, Fielding et al 1985).

The parameter estimates identified in the development of the SQI index can be implemented in bus operation contexts which are comparable to the range of service levels evaluated in the stated preference survey detailed above. Where an operator exhibits service levels noticeably different to this range, a new SP survey would need to be undertaken, using the exact method developed herein. Regulators wishing to implement a performance assessment regime based on a subset of the attributes evaluated herein can select the subset of parameter estimates and derive a partial SQI indicator, without the need to re-estimate the user preference model.

References

Appelbaum, E., Berechman, J. (1991) Demand Conditions, Regulation and the Measurement of Productivity, *Journal of Econometrics*, 47, 379-400.

Berechman, J. (1987) Cost Structure and Production Technology in Transit: An Application to the Israeli Bus Transit Sector, *Regional Science and Urban Economics*, 17 (4), 519-34.

Brewer, A., Hensher, D.A. (1997) *Operating a Bus and Coach Business: Insights and Practice*, Allen & Unwin, Sydney.

Caves, D.W., Christensen, L.R., Tretheway, M.W. and Windle R.J. (1985) Network Effects and the Measurement of Economies of Scale and Density for U.S. Railroads, in Daughety, A.F. (eds), *Analytical Studies in Transport Economics,* Cambridge University Press, 97-120.

Cunningham, L.F., Young, C. and Lee, M. (1997) Developing customer-based measures of overall transportation service quality in Colorado: Quantitative and qualitative approaches, *Journal of Public Transportation*, 1 (4), 1-22.

De Borger, B.L. (1991) Hedonic versus Homogeneous Output Specifications of Railroad Technology: Belgian Railroads 1950-1986, *Transportation Research A*, 25A (4), 227-38.

Fielding, G.J., Babitsky, T.J. and Brenner, M.E. (1985) Performance evaluation for bus transit, *Transportation Research*, 19 (1), 73-82.

Filippini, M (1991) *La Struttura dei Costi delle Ferrovie Private Svizzere secondo la Teoria del Duale: Implicazioni per una Politica delle Fusioni*, Zuercher Dissertation, Zentralstelle der Studentenschaft, Zuerich.

Filippini, M., Maggi, R. and Prioni, P. (1992) Inefficiency in a Regulated Industry –The Case of the Swiss Regional Bus Companies-, *Annals of Public and Cooperative Economics*, 63 (3), 437-55.

Hensher, D.A. (1987) Productive Efficiency and Ownership of Urban Bus Service, *Transportation*, 14, 209-225

Hensher, D.A. (1991) Hierarchical Stated Response Designs and Estimation in the Context of Bus Use Preferences, *Logistics and Transportation Reviews*, 26 (4), December, 299-323

Hensher, D.A. (1992) Total factor productivity growth and endogenous demand: establishing a benchmark index for the selection of operational performance measures in public bus firms, *Transportation Research,* Special Issue on Performance Measurement, Guest Edited by D.A. Hensher, 26B (5), 435-48.

Hensher, D.A. (1994) Stated preference analysis of travel choices: the state of the practice, *Transportation, 21 (2),* 107-33.

Hensher, D.A. and Daniels, R. (1995) Productivity Measurement in the Urban Bus Sector, *Transport Policy,* 2 (3), July, 179-94.

Hensher, D.A. Louviere, J.J. and Swait, J. (1999) Combining Sources of Preference Data, *Journal of Econometrics*, 89, 197-221.

Jara-Diaz, S. (1982) The Estimation of Transport Cost Functions: a Methodological Review, *Transport Reviews*, 2, 257-78.

Louviere, J.J., Hensher, D.A. and Swait, J. (in press) *Stated Choice Methods, Analysis and Applications in Marketing, Transportation and Environmental Valuation*, Cambridge University Press, Cambridge, 697pp.

Pullen, W.T. (1993) Definition and measurement of quality of service for local public transport management, *Transport Reviews*, 13 (3), 247-64.

Small, K.A. (1992) *Urban Transportation Economics*, Chur, Switzerland, Philadelphia, Harwood Academic Publishers, 185 pp.

Spady, R.H. and Friedlaender, A. (1978) Hedonic Cost Functions for the Regulated Trucking Industry, *Bell Journal of Economics*, 9, 159-79.

Swanson, J., Ampt, L. and Jones, P. (1997) Measuring Bus Passenger Preferences, *Traffic Engineering and Control*, June, 330-36.

Viton, P.A. (1986) The Question of Efficiency in Urban Bus Transportation, *Journal of Regional Science*, 26 (3), 499-513.

Windle, R.J. (1988) Transit Policy and the Cost Structure of Urban Bus Transportation, in Dodgson, J.S. and Topham, N. (eds), *Bus Deregulation and Privatization: an International Perspective*, Avebury, Aldershot, 119-40.

***Appendix** Table A: Summary of response rate and administration procedure by operator*

OPNO	Distributed	Returned	Inconsistent choices*	Blanks	Valid choices	Response Rate**	Administration pro
1	106	106	0	57	261	82.07	Distribution/Explanation: Two inspectors. Drivers not involved. Try to cover a v home; otherwise completed forms were returned on the same trip.
2	181	44	2	29	101	18.60	Drivers did everything. Passengers filled the form on the bus. Some regular pass Few like 1-2% mailed it back.
3	216	215	11	26	608	93.82	4 persons from the staff hand out forms. Extra explanation was given in particul not involved.
4	432	254	83	225	454	35.03	Inspectors hand out forms. Back on the same trip.
5	194	80	0	30	210	36.08	Person from the personal staff hand out and sorted problems. Completed forms b
6	10	9	0	0	27	90.00	Drivers did everything. Small company, where drivers know customers personal day(s) later.
7	216	193	0	100	479	73.91	No inspectors. Pencils and some folders/cupboards provided. Drivers involved. F passengers. Hand back to drivers or took them home. 95% hand back on the sam
8	216	56	0	4	164	25.30	Drivers hand out forms. Back on the same trip.
9	216	76	1	50	177	27.31	Drivers not involved. 2 persons hand out forms on buses. On peak hours passeng rate). Not regular passengers (off-peak) filled the form on the bus.
10	216	31	0	24	69	10.64	Inspectors +reply paid envelopes. Only 6 forms were returned on the bus. Inspec
11	206	54	6	48	108	17.47	Inspector on the bus. Bus passengers could take the survey home. No good respo
12	206	83	7	114	128	20.71	Inspectors hand out forms and collect them at the end of the journey. Users were not involved.
13	216	19	0	13	44	6.79	One person distributed forms on buses. Return to drivers next day or back to insp
14	216	68	1	13	190	29.32	Inspectors hand out forms. Back on the same bus or reply paid envelops
15	216	5	0	6	9	0.13	Bus inspectors hand out forms at bus terminals. Return to the drivers or mail bac
16	432	69	5	23	179	13.81	No drivers involved. Extra persons hand out forms. Explanations were given if a passengers used the envelope and mailed the form back.
17	175	66	0	5	193	36.76	Distribution: Supervisors. Drivers not involved. Covering letter and pre-paid env
18	216	10	0	0	30	4.6	Inspectors hand out the forms. Extra explanations if requested. Back to the drive
19	216	83	0	40	209	32.25	Drivers were instructed. A letter and an envelope were attached to the survey
20	181	107	1	70	250	46.04	Distr.: Inspectors (instructed). Returned to inspectors on the same trip. A small
21	216	195	5	314	266	41.04	Inspectors hand out forms. Explanations were given on request. Clipboards and
22	216	34	2	42	58	26.85	Distr./Return: Inspectors. No drivers. Most of the forms returned by mail (rest o
23	108	30	0	12	78	72.22	Distr./Return: Drivers and Managers.
24	108	8	0	2	22	6.79	Distr./Return: Drivers and Managers. Forms back on the same bus. Few returned the day after. No mail.
25	8	8	0	4	20	100	Distr./Return: Drivers only. Small company, drivers know customers. Back on th
Total	9057	1903	124	1251	4334	15.95	

**   Inconsistent choices are situations where a user when evaluating the current and packages A and B chose an alternative that was inconsistent with their of the current alternative.*

*** The response rate is calculated as the ratio between valid responses and distributed forms multiplied by 3 (no. of scenarios). eg. OPNO 2: RR=101/(181**

ITS

INSTITUTE OF TRANSPORT STUDIES

The Australian Key Centre
in Transport Management

The University of Sydney
and Monash University